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SEP 1999
RECEIVED

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SUBJECT: DP CANYON REACH REPORT

Dear Mr. Kieling:

Enclosed please find three copies of the DP Canyon Reach Report, "Evaluation of Sediment and Alluvial Groundwater in DP Canyon Reaches DP-1, DP-2, DP-3, and DP-4" LAUR-99-4238. We are submitting this document to the New Mexico Environment Department consistent with the Fiscal Year 1999 Work Narrative.

If you have any questions, please call Dave McInroy at (505) 667-0819 or Joe Mose at (505) 667-5808.

Sincerely,

Brad

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EXECUTIVE SUMMARY

This report presents the results of sediment and alluvial groundwater investigations in DP Canyon and recommendations for additional characterization, assessments, and remedial actions. Data from this investigation were used to determine the nature and extent of contamination, revise a conceptual model for contaminant distribution and transport, and assess the potential for human-health and ecological risk under present-day land use. The human-health risk assessment considers trail-user, construction-worker, and resource-user scenarios. Trail use is the predominant land use in DP Canyon, and a well-used trail runs within 50 ft of contaminated sediment in a portion of the canyon. These scenarios include different assumptions regarding the intensity of exposure to contaminated sediments, activities considered as part of the scenario, and the duration of exposure. The resource-user and trail-user scenarios are the same, except that resource-user scenario assumes some consumption of contaminated food from DP Canyon. The construction-worker scenario is used to model exposure to workers during excavation of contaminated sediments. The consumption of contaminated water was considered separately from sediments to evaluate the potential for chronic health effects from water consumption from DP Canyon. More comprehensive human-health and ecological risk assessments that incorporate additional data, such as surface-water data, will be presented in a future report for the Los Alamos Canyon watershed.

Several former Los Alamos National Laboratory sites within the DP Canyon watershed contributed or may have contributed contaminants to DP Canyon, beginning in 1945. The most important of these potential release sites (PRSs) to DP Canyon is PRS 21-011(k). Radioactive effluent was discharged from PRS 21-011(k) into DP Canyon from 1952 through 1986. The primary isotopes associated with the releases from PRS 21-011(k) include americium-241; cesium-137; plutonium-238; plutonium-239,240; strontium-90; tritium; and uranium isotopes. Another important PRS within the DP Canyon watershed is PRS 21-029 (the DP Tank Farm). The site was used as a fuel distribution station with aboveground and underground fuel tanks from 1946 to 1985. Diesel range organic hydrocarbon contamination was identified in bedrock in the DP Canyon channel and has been observed to form a sheen in surface water adjacent to the site. Other possible minor sources of contaminants in DP Canyon include septic systems and outfalls located along the north rim of DP Canyon in former TA-73 and other minor sites located throughout TA-21 such as PRS 21-024(f), a septic tank and outfall, and spills associated with operations at Material Disposal Areas (MDAs) T and U. Surface water runoff from residential and commercial areas in the Los Alamos townsite is also a potential contaminant source in DP Canyon.

The technical approach followed in the sediment investigation focused on detailed characterization within four sections of DP Canyon. These sections are called "reaches." The reaches were selected (1) to encompass the range of potential risk related to contaminated sediments along the full length of the canyon, and (2) to allow testing and refinement of a conceptual model describing the distribution and transport of sediments and associated contaminants. The phased investigation included detailed geomorphic mapping, field radiological measurements, and sampling of post-1942 sediments for laboratory analysis. An evaluation of data collected during each phase was used to revise the conceptual model, identify key uncertainties, and focus subsequent data collection.

Existing alluvial groundwater monitoring wells and DP Spring were utilized to characterize the groundwater through a program of quarterly sampling and analysis. Storm water sampling was conducted in the upper portion of DP Canyon as part of the alluvial groundwater characterization to evaluate the chemistry of storm-water runoff entering the canyon from the Los Alamos townsite and subsequently recharging the alluvial aquifer.

The chemicals of potential concern (COPCs) in the sediments of DP Canyon are inorganic and organic compounds and radionuclides. Inorganic chemicals in sediments do not pose an unacceptable risk to human health. The most significant COPCs with regard to potential human-health risk are the organic

compounds dibenz(a,h)anthracene and benzo(a)pyrene. The highest potential risk from these organic compounds is to the resource user and occurs in a reach at the head of the canyon. The health risk in that reach is estimated to be on the order of 1 in 100,000 (1×10^{-5}). The spatial distribution of the organic contaminants suggests that runoff from the Los Alamos townsite is a likely source. No resource use is known to occur in DP Canyon. Radionuclide COPCs in DP Canyon are americium-241; cesium-137; plutonium-238; plutonium-239,240; and strontium-90. Cesium-137 is the most important radionuclide COPC from a human-health risk perspective and has the highest potential risk under the construction-worker scenario due to the external gamma radiation associated with cesium-137. The highest potential dose from radioactive contamination is in the canyon sediments near PRS 21-011(k) and is estimated at 30 mrem/yr.

The risk assessment for contaminants in alluvial groundwater show that there are no chronic human-health risks for exposure under the trail-user, construction-worker, or resource-user scenarios. The contaminants 1,2-dichloroethane and bis(2-ethylhexyl)phthalate exceed the screening criteria, but were not consistently detected in the alluvial groundwater, and their presence is not confirmed. Strontium-90 is present as an important radionuclide contaminant in the alluvial groundwater, but does not pose an unacceptable risk under these land-use scenarios.

Refinement of the conceptual model focused on results for five key radionuclides in sediments (americium-241; cesium-137; plutonium-238; plutonium-239,240; and strontium-90). These radionuclides were selected based on a known source [PRS 21-011(k)] and their importance in understanding the distribution of contaminants in the entire upper Los Alamos Canyon watershed. Concentrations of the individual key radionuclides are highly variable within reaches, but mean concentrations between reaches are more similar. Inventories of the key radionuclides within DP Canyon are highest in the fine-grained sediments and are highest near the source of contamination [near PRS 21-011(k)]. The highest radionuclide concentrations also generally occur in fine-grained sediments, but are also found in relatively coarse-grained sediments near the source of contamination, where they probably were deposited concurrently with or soon after the peak contaminant releases from PRS 21-011(k) (sometime between 1952 and 1961). Mixing of sediment from contaminated and uncontaminated sources has reduced the concentrations of the key radionuclides over time. These concentrations were highest during the early period of releases of radioactive effluent from PRS 21-011(k), and have dropped since that time. Therefore, these concentrations can be expected to remain stable or to decline during the next several decades.

The results of the human-health and ecological-risk assessments presented in this report indicate that levels of contamination in the sediments and alluvial groundwater in DP Canyon do not pose an unacceptable risk or require remedial actions under present-day land use. Under current conditions in the watershed, floods will continue to transport contaminated sediments from DP Canyon into Los Alamos Canyon. However, the long-term impact to Los Alamos Canyon is uncertain. It is also uncertain whether remediating contaminated alluvial groundwater will be necessary in the future, given that the contaminants pose no unacceptable risk under the evaluated land-use scenarios. Additional alluvial groundwater monitoring will be conducted in DP Canyon and coupled with groundwater monitoring in Los Alamos Canyon to refine the conceptual model for the relation between the alluvial groundwater systems. Surface water characterization, including the surface-water pools in DP Canyon, will also be conducted as part of the ongoing characterization activities in the Los Alamos Canyon watershed. A tracer study is planned for DP Canyon to acquire information on the travel and residence times for alluvial groundwater within the DP Canyon geohydrologic system. This monitoring program also will enhance understanding of the fate and transport of contaminated alluvial groundwater and support any possible future remedial action. Additional risk assessments that incorporate these additional data and, where appropriate, incorporate concentrations and inventory of contaminants at hillslope PRSs, still need to be conducted. Decisions to implement any remedial actions in DP Canyon should be made in the context of future assessments and/or future policy directives.

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1.0 INTRODUCTION

1.1 Purpose

This interim report describes sediment, alluvial groundwater, and storm water investigations conducted from 1997 to 1999 in DP Canyon (Figure 1.1-1). These investigations were conducted in accordance with the sampling and analysis plan (SAP) for DP Canyon (Environmental Restoration Project, 1998, 57595), following the technical strategy described in the task/site work plan for Operable Unit (OU) 1049 for Los Alamos and Pueblo Canyons (LANL 1995, 50290; LANL 1997, 56421) and modified by the core document for Canyons investigations ("core document") (LANL 1997, 55622; LANL 1998, 57666). The DP Canyon SAP was submitted to the New Mexico Environment Department (NMED) on April 14, 1998, as an addendum to the Los Alamos/Pueblo Canyon work plan. Data collected from the investigation are used to determine nature and extent of contamination within young (post-1942) sediments; revise a conceptual model for contaminant distribution and transport; perform screening assessments for potential human-health and ecological risk under present-day land use; and determine if there is a need for remedial action based on the risk evaluation. The data are also used to determine if there is a need for additional data collection and evaluation to meet assessment objectives. The results of this investigation are also directly relevant to the Environmental Restoration (ER) Project's watershed approach in that it provides information on nature and extent and long-term fate and transport of contamination. This information can be used in watershed-scale evaluations and decision-making for potential release sites (PRSs) and PRS aggregates. In a future report, these data and assessment results will be combined with data from other surface-based investigations (i.e., surface sediments, alluvial groundwater, and surface water) in the Los Alamos/Pueblo Canyon watershed to support a watershed-scale assessment that will involve a more comprehensive assessment of human and ecological risk and the effects of future contaminant transport.

1.2 Regulatory Context

Regulatory requirements governing the ER Project Canyons investigations are discussed in Section 1.4 of the core document (LANL 1997, 55622). In particular, these investigations address requirements of Module VIII of Los Alamos National Laboratory's (the Laboratory's) Hazardous Waste Facility Permit (the HSWA Module) under the Resource Conservation and Recovery Act (RCRA), including "the existence of contamination and the potential for movement or transport to or within Canyon watersheds" (EPA 1990, 1585). In addition to federal and state regulations, US Department of Energy (DOE) Order 5400.5, "Radiation Protection of the Public and the Environment," provides guidance on managing residual radioactivity at DOE facilities.

1.3 Background

1.3.1 Geography, Geology, and Hydrology

DP Canyon heads on the Pajarito Plateau in the southeastern portion of the Los Alamos townsite and extends east-southeasterly for 3.5 km to its confluence with Los Alamos Canyon. DP Canyon is located entirely within DOE-owned land except for a short segment approximately 40 m long at the head of the canyon, that is on land owned by Los Alamos County. DP Mesa, which is the location of Technical Area (TA) 21, and privately owned industrial and retail businesses comprise the southern boundary of DP Canyon. A portion of the Los Alamos townsite that includes housing and the Los Alamos airport lies along the northern boundary. The canyon has a topographic drainage area of 1.5 km^2 that includes a significant amount of paved and developed land west of the canyon head, but also receives runoff via storm drains from a portion of the townsite outside the topographically defined drainage area. Geologic units exposed

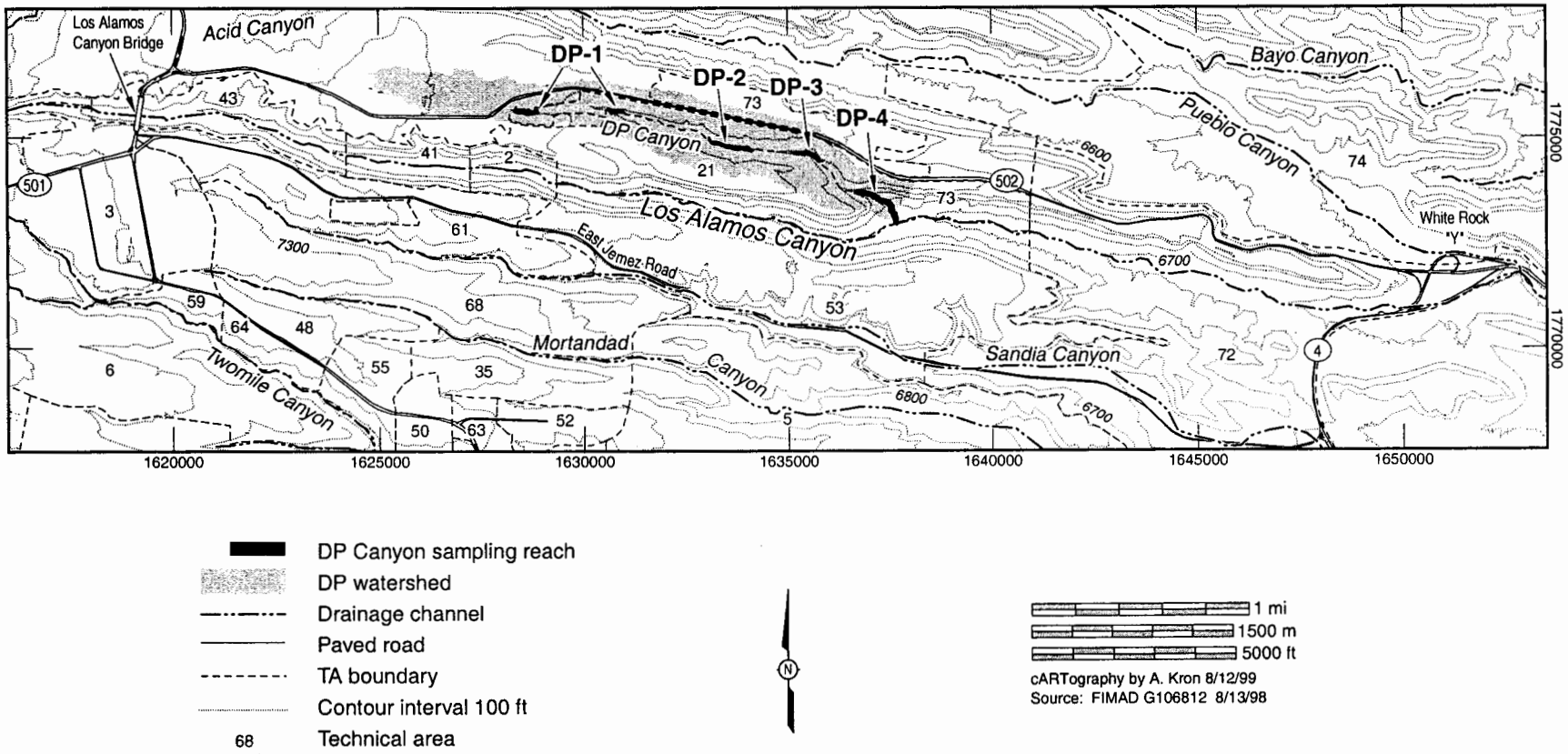


Figure 1.1-1. **Map of the part of the upper Los Alamos Canyon watershed that includes Los Alamos National Laboratory, showing Laboratory technical areas and sampling reaches**

within DP Canyon include Quaternary ignimbrites of the Otowi and Tshirege Members of the Bandelier Tuff and Quaternary pumice beds and volcaniclastic sediments of the Cerro Toledo interval (Griggs 1964, 8795; Smith et al. 1970, 9752; Goff 1995, 49862). The upper 1.8 km of DP Canyon is cut into Unit 3 of the Tshirege Member (Goff and Werner 1996, 63895; LANL 1995, 58207). The channel gradient in this upper portion is approximately 31 m/km. The lower 1.3 km of DP Canyon cuts through the following bedrock units in descending order: (1) Units 2, 1v, and 1g of the Tshirege Member; (2) tephras and volcaniclastic sediments of the Cerro Toledo interval, and (3) the upper part of the Otowi Member. This portion of the canyon is deep and narrow, and the channel gradient is approximately 144 m/km.

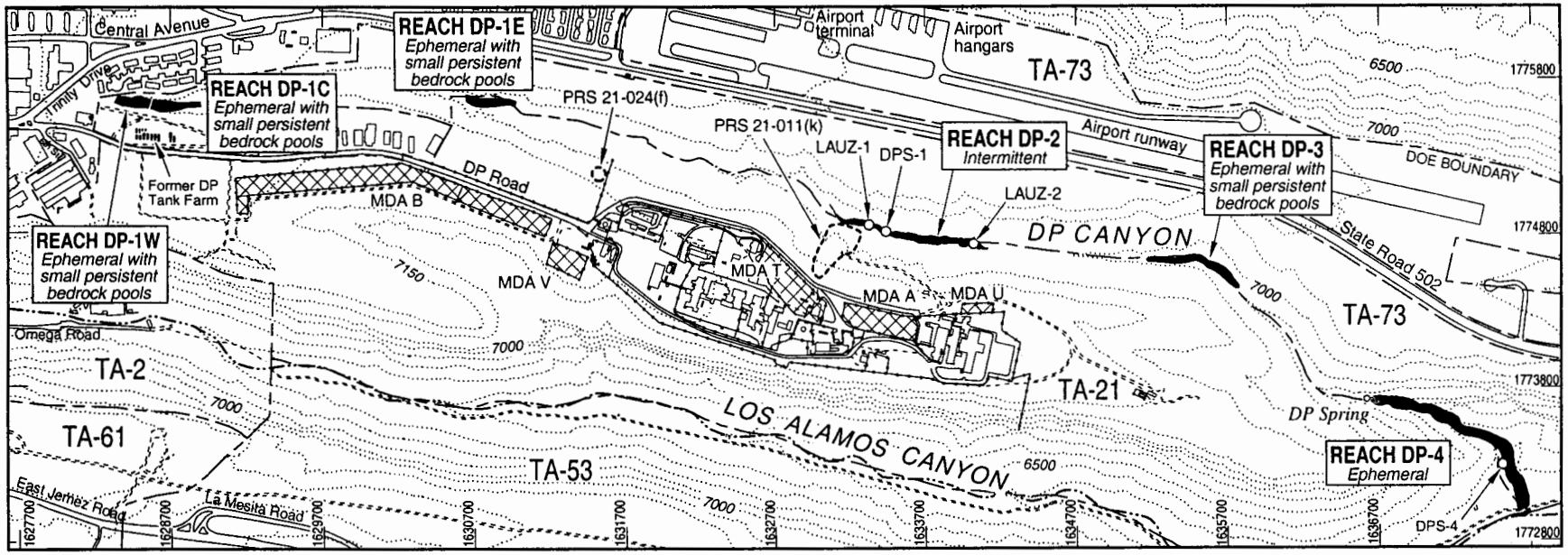
Stream flow in DP Canyon is largely controlled by ephemeral runoff from rain storms and snowmelt. Runoff from townsite activities such as lawn watering also contributes minor input to the canyon. Some surface runoff flows overland directly into the canyon along the entire length of DP Canyon, but most of this flow is believed to enter the canyon via the storm drain system that discharges into the head of the canyon. The role of townsite runoff is important to the conceptual model as a potential source of nonradiological contaminants.

Alluvial groundwater exists within two limited segments of DP Canyon (reach DP-2 and lower reach DP-4) and is recharged predominantly by storm runoff as described above. DP Spring discharges approximately 0.85 km down-canyon from the upper canyon segment that contains alluvial groundwater. A saturated zone consistently has been present in two monitoring wells during alluvial groundwater sampling efforts conducted between 1992 and 1998. More detail on the conceptual model describing the occurrence and relationship of surface water and alluvial groundwater is presented in Chapter 4).

1.3.2 Laboratory History and Operations

Several former laboratory sites within the DP Canyon watershed contributed or may have contributed contaminants to the canyon (Figure 1.3-1). Beginning in 1945, operations associated with the Laboratory's Chemistry Division were being transferred to newly built facilities at TA-21. Numerous known or potential sources of contamination to DP Canyon exist along the south edge of the canyon. The most important of these potential release sites to DP Canyon is PRS 21-011(k). Radioactive effluent originating in Buildings 21-35 and 21-257 was discharged into DP Canyon from 1952 through 1986 (Reneau 1999, 63138). The primary isotopes associated with the releases from PRS 21-011(k) include americium-241, cesium-137, plutonium-238 and -239,240, strontium-90, tritium, and uranium isotopes. Release records are not complete enough or of sufficient quality to quantify the total inventory for most of these radioisotopes, although estimates are available for total plutonium releases. However, the approximate timing of relative amounts of each isotope is available through historical records (Reneau 1999, 63138) and is useful for assessing the age of sediment deposits that contain these isotopes. A discussion of the release history of each radioisotope (and the associated radioisotope ratios) as it relates to determining the ages of canyon-bottom sediments is presented in Section 3.3.

Another potentially important contributor of contaminants to DP Canyon is PRS 21-029 (the DP Tank Farm). The site was used as a fuel distribution station with aboveground and underground fuel tanks from 1946 to 1985. Diesel range organic hydrocarbon (DRO) contamination has been identified in bedrock in the DP Canyon channel and has been observed to form a sheen in surface water adjacent to the site. Soil and tuff remediation was conducted in 1996, and approximately 1720 yd^3 of petroleum-contaminated soil were excavated from the site. Confirmation results indicate that total petroleum hydrocarbons (TPH) is present at levels up to 670 mg/kg and that BTEX compounds (benzene, toluene, ethyl benzene, and xylenes) are present at levels below the regulatory threshold (LANL 1996, 52270; Environmental Restoration Project 1996, 55347.401). A work plan for a follow-up investigation of the nature and extent of contamination at PRS 21-029 is pending NMED review (LANL 1998, 59976).



DP Canyon sampling reach
Building
Material Disposal Area
Paved road
Dirt road
Fence
TA boundary
Active stream channel
Contour interval 20 ft

N

0 500 1000 ft

cARTography by A. Kron 8/12/99
Data from FIMAD G105505 4/11/97
and G107666 5/20/99

Figure 1.3-1. Laboratory sites that potentially contribute to canyon contamination and nature of stream channel in reaches

Other possible minor sources of contaminants in DP Canyon include septic systems and outfalls located along the north rim of DP Canyon in former TA-73 and other minor sites located throughout TA-21 such as PRS 21-024(f), a septic tank and outfall, and spills associated with operations at Material Disposal Areas (MDAs) T and U.

1.4 Current Land Use

DP Canyon is located almost entirely on DOE-owned land. No active DOE facilities are located within the canyon. Present-day land use includes hiking, jogging mostly by Laboratory employees, although other individuals have been seen hiking and horse-back riding in the canyon. A trail along the south side of the canyon provides the predominant means for access through the length of the canyon. The trail can be accessed most easily in the western portion of the canyon as well as from the east, near the confluence with Los Alamos Canyon. The trail is not in the area of contaminated sediments, except for a short section approximately 180 m long near the west end of the trail.

1.5 Previous Investigations

1.5.1 Sediment Investigations

The Laboratory's Environmental Surveillance Program has been collecting sediment samples from the DP Canyon channel at two sediment sampling stations called DPS-1 and DPS-4 (Figure 1.3-1). Samples have been collected at DPS-1 since 1978 and at DPS-4 since 1968. These samples were analyzed for metals and radionuclides, including plutonium isotopes, cesium-137, strontium-90, and americium-241. Additional sediment samples have been collected in DP Canyon as part of various studies and analyzed for select radionuclides and these studies documented transport of radionuclides from DP Canyon into Los Alamos Canyon (e.g., Purtymun 1971, 4795; Hakonson and Bostick 1975, 29678; Nyhan et al. 1982, 7164; Purtymun et al. 1990, 6992). The upper Los Alamos Canyon reach report also provides a compilation of relevant studies within the Los Alamos Canyon watershed (Reneau et al. 1998, 59160).

An aerial radiation survey was conducted over DP Canyon in 1982 (Fritzsche 1990, 58971) Elevated gross gamma radiation interpreted to be from cesium-137 was observed throughout DP Canyon. The highest concentration is centered on PRS 21-011(k) and elevated concentrations extend down DP Canyon beyond the confluence with Los Alamos Canyon (Figure 1.5-1). Data obtained from this survey were used to estimate that the cesium-137 inventory in DP Canyon in 1982 was between 120 and 730 mCi. In 1997, an interim action was conducted at PRS 21-011(k). During this remediation, approximately 400 yd^3 of contaminated soil and tuff were removed from the hillslope below the outfall (LANL 1997, 55648). The inventory of radionuclides remaining at PRS 21-011(k) and its relation to the radionuclide inventory in DP and Los Alamos Canyons is unknown.

Beginning in 1992, samples were collected from a 40- by 40-m sampling grid that covered all the TA-21 area, including portions of DP Canyon. The purpose of this investigation was to identify contaminants deposited in the surficial soil layer by TA-21 airborne emissions. Samples were analyzed for semivolatile organic compounds (SVOCs), volatile organic compounds (VOCs), metals, and a large suite of radionuclides (LANL 1994, 26073). Elevated antimony, VOCs, and SVOCs (mostly polycyclic aromatic hydrocarbons [PAHs]) were detected at one location each (not the same location) at levels exceeding screening action levels (SALs). Thallium was detected at six locations at levels exceeding the SAL. Beryllium was elevated at many locations; however, beryllium data from the TA-21 grid sampling are unreliable, as discussed in the TA-21 RFI Report (LANL 1994, 26073). Radionuclides were detected at elevated concentrations over the entire area. Comparison of results from the two sampled depths (0- to 1-in. and 0- to 6-in.) demonstrates that downward transport was minimal (LANL 1994, 26073).

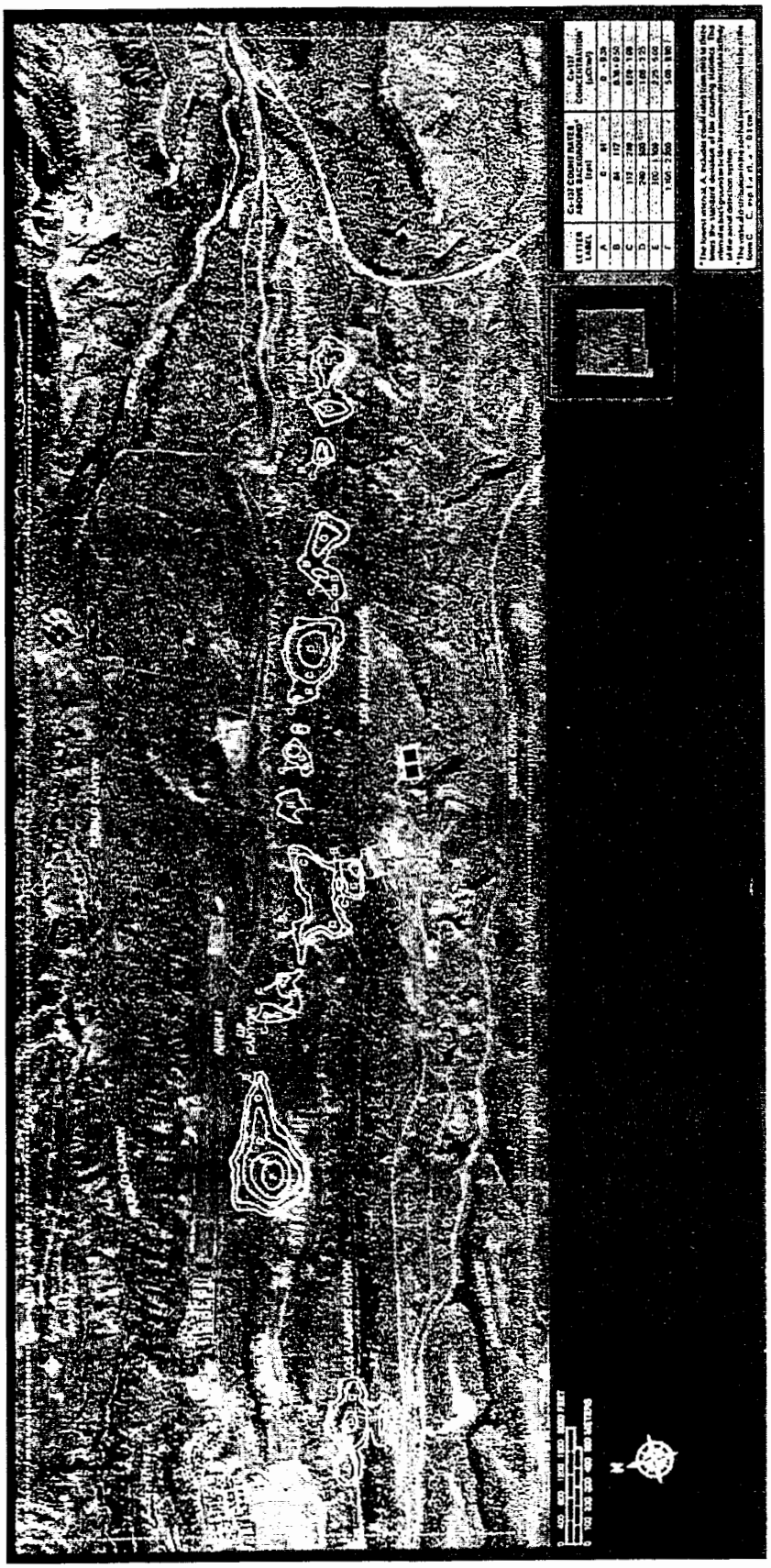


Figure 1.5-1. Gross gamma survey results

In 1993, the 1992 grid was extended by adding 15 sample locations on the western edge of the grid in DP Canyon. The grid was extended to identify a possible source farther up DP Canyon that could explain why 1992 samples contained plutonium-239,240 and americium-241 at levels exceeding background. Samples were also collected from 0- to 1-in. and 0- to 6-in. depths and analyzed for SVOCs, metals, and radionuclides (LANL 1995, 52350). The results from this investigation indicate that no contaminants are present at levels exceeding SALs. No upstream source of plutonium-239,240 or americium-241 was identified.

A geomorphic investigation was conducted in DP Canyon during 1992 and 1993 in conjunction with several other earth science investigations at TA-21 (Reneau 1995, 50143). The report from the investigation provides preliminary information on the conceptual model for surficial processes of sedimentation and erosion in DP Canyon and the geomorphic and stratigraphic setting of DP Spring. The report contains a geologic map showing rock units and sedimentary deposits in DP Canyon (Goff 1995, 49682).

1.5.2 Alluvial Groundwater Investigations

In 1994, two alluvial groundwater wells, LAUZ-1 and LAUZ-2, were installed for the OU 1106 (TA-21) RCRA facility investigation to characterize the shallow alluvial groundwater environment in DP Canyon (Figure 1.3-1). The wells were sampled in February 1995 and showed elevated concentrations of strontium-90 (526 pCi/L in LAUZ-1 and 142 pCi/L in LAUZ-2) (Goff and Werner 1996, 63895). The wells were not sampled again until the current investigation.

Characterization of water quality at DP Spring began shortly after the "discovery" of the spring in 1990 (Goff and Werner 1996, 63895). Goff and Werner (1996, 63895) prepared water quality tables from contaminant data collected from 1990 through 1995. Results showed elevated concentrations of boron, phosphate, nitrate, lead, chloride, and chlorate. Trend analysis of these constituents indicates a general decrease in concentration over the sampling period. Tritium analysis conducted at the spring between 1990 and 1995 shows a decreasing trend in concentration over that period. Results for strontium-90 from sampling events between 1993 and 1995 show variable concentrations ranging between 67.3 and 150 pCi/L with no apparent trend in concentration over time. Numerous additional analyses, including major cations/anions, trace elements, and stable isotope analyses, have been conducted and are reported by Goff and Werner (1996, 63895).

A tracer study was conducted in 1992 to determine if tritium detected in DP Spring water was related to effluent releases emanating from a sewage outfall at the east end of TA-21. The results of the study were presented by Goff and Werner (1996, 63895) and by Adams et al. (LANL 1995, 58207, pp. 111–118). The tracer study involved introducing fluorescein dye into a cattail pond and recording observations for a period of 60 days at several locations along a small tributary leading towards DP Spring and in the spring. Fluorescein dye was observed in the tributary channel, but was never observed in the spring. The conclusion was that there is no hydrologic connection between the sewage plant outfall and the spring. Investigators speculated that upper DP Canyon was the more likely source of the contaminants found in the spring.

1.5.3 Surface Water Investigations

Surface water investigations have been conducted by the Laboratory's Environmental Surveillance Program since 1967 at the same stations where sediments are collected (DPS-1 and DPS-4). These samples were analyzed for the following radionuclides: tritium, strontium-90, cesium-137, total uranium,

plutonium isotopes, americium-241, gross alpha, and gross beta. Other water quality parameters include sodium, chloride, fluoride, nitrate, total dissolved solids, and pH.

Purtymun (1974, 5478) reported on storm water-related transport of radionuclides in solution and as suspended solids in storm water in DP Canyon. The study primarily addressed transport of americium-241, plutonium isotopes, and strontium-90 and determined the concentration and volume of sediment, and concentration and inventory of contaminants transported during individual floods in DP Canyon. Dale also documented transport of radionuclides associated with storm water runoff in DP Canyon (Dale 1996, 58930).

1.6 Initial Conceptual Model and Technical Approach

1.6.1 Sediments

Sediment contamination in DP Canyon is primarily associated with historical releases from PRS 21-011(k) where processed wastewater was discharged directly into DP Canyon (see Section 1.3.2). Before the current investigation, available data on sediments in DP Canyon indicate that americium-241, cesium-137, plutonium isotopes, and strontium-90 released from PRS 21-011(k) are the primary contaminants found in DP Canyon sediments. Tritium and uranium isotopes were also released from PRS 21-011(k), but existing data indicate that they have not remained important contaminants in sediments. Minor releases of inorganic and organic contaminants also may have occurred from other PRSs. The spatial distribution of americium-241, cesium-137, and plutonium isotopes is controlled primarily by transport and redistribution of sediment during floods. Although the distribution of strontium-90 contamination in sediments is also controlled by flood processes, its relatively high solubility makes it susceptible to additional transport processes such as migration in solution in alluvial groundwater, surface water base flow, or storm water runoff.

Contaminant concentrations in post-1942 sediment deposits vary greatly, depending on factors such as distance from the contaminant source, sediment particle size distribution, and the age of the deposit. Radionuclide concentrations are expected to be generally higher in sediment deposits closer to the source and in finer-grained sediments. Radionuclide concentrations are also expected to be highest in sediment deposits that are close to the age of the highest contaminant releases. Additionally, isotope ratios (such as plutonium-239,240/plutonium-238) were expected to potentially reflect temporal variations in the radionuclide makeup of the effluent. The initial conceptual model also anticipated that the highest (relative to the active channel) post-1942 stream terraces would be composed of sediments that corresponded in age to the peak contaminant releases; thus those sediments would have the highest contaminant concentrations. Inset, younger terraces and active channel sediments would be composed of sediments post-dating peak contaminant releases.

The technical approach adopted in this sediment investigation includes detailed geomorphic mapping and sediment sampling in a series of reaches selected at key locations in the canyon, following the "representative reach" concept presented by Graf (1994, 55536) and adopted in the core document (LANL 1997, 55622). This investigation focused on determining the nature and extent of contamination, evaluating risk, and testing components of the preliminary conceptual model in a phased approach. Geomorphic mapping and sediment sampling concentrated on identifying and characterizing post-1942 sediments (those sediments younger than the initial contaminant releases). Data collected in each phase were evaluated to revise the conceptual model, identify key uncertainties, and focus subsequent data collection. Investigation goals include evaluating present and future potential risk, evaluating sediment transport processes and future contaminant redistribution, and providing data needed to make decisions about possible remedial action alternatives.

1.6.2 Alluvial Groundwater

The initial conceptual model for the hydrogeology of the alluvial groundwater system is derived primarily from field observations made during the preparation of the DP Canyon SAP (Environmental Restoration Project 1998, 57595). Results of investigations described in Section 1.5.2 provide most of the analytical information used to develop the initial conceptual model. For this report, the term "alluvial groundwater" will include water from DP Spring because of the inferred connection between water emerging at the spring and alluvial groundwater upstream.

Only two relatively short segments of DP Canyon contain alluvial aquifers. These two segments are separated by approximately 1.2 km of canyon dominated by a bedrock channel with discontinuous channel alluvium and alluvial terraces. The alluvial aquifers exist within reach DP-2 and in lower Reach DP-4 (Figures 1.1-1 and 1.3-1) (see Section 2.1 for details on the reaches). The initial conceptual model for the hydrologic system inferred that storm water draining from the townsite and entering the head of DP Canyon behind the Knights of Columbus Hall on DP Road flows rapidly through the upper portion of DP Canyon towards reach DP-2 where much of the storm water recharges the alluvium, and some of the storm water passes through the reach. Because of the direct hydrologic link in the system, it was inferred that the geochemical nature of the storm water would provide a baseline for comparison with the alluvial groundwater quality in DP-2. The initial conceptual model also inferred a hydrologic connection between the alluvial aquifer and DP Spring, which emerges approximately 0.84 km down-canyon from the east end of DP-2. The hydrologic connection is by way of "drainage" from the alluvial aquifer to the DP Canyon channel where surface water flows with minimal storage and infiltrates into a bouldery alluvial deposit known as "Valley Fill of Lower DP Canyon," which occupies the canyon bottom (Reneau 1995, 50143). Water then emerges from the contact between rounded stream gravels at the base of the valley fill deposits and Tshirege unit 1g. The historical contaminant signature in DP-2 alluvial groundwater and DP Spring, dominated by strontium-90 and tritium, strongly supports coupling between the two systems. Water that discharges then travels through a steep bouldery portion of the canyon (upper and middle reach DP-4) towards the lower portion of reach DP-4 where another alluvial aquifer exists. The lower DP Canyon alluvial aquifer merges with the alluvial aquifer in Los Alamos Canyon.

The method for characterizing the nature of contamination in the hydrologic system involved two primary aspects. The first is collection of storm water samples in the upper bedrock-dominated portion of DP Canyon in order to establish baseline water quality for comparison with the alluvial groundwater quality, and the second is characterization of the alluvial groundwater via two alluvial groundwater monitoring wells in reach DP-2 and DP Spring. For the baseline characterization, two separate storm events were sampled and analyzed to assess what contaminant contribution is coming from the townsite via storm water runoff. One monitoring station was placed at the head of the canyon, and the second was placed in the canyon, immediately below the row of industrial and commercial businesses along DP Road. Alluvial groundwater and DP Spring were sampled concurrently on a quarterly basis for four quarters, with no more than one day separating collection at these sites. Filtered and unfiltered samples were analyzed.

1.7 Unit Conventions

This report primarily uses metric units of measure, although English units are used for contours on topographic maps, in reference to elevations derived from topographic maps, and for New Mexico State Plane coordinates as shown on some maps. English units are also used for radioactivity (curies [Ci] instead of becquerels [Bq]). Scales with both metric and English units of distance are shown on maps. Conversions from metric to English units are presented in Section A-2.0 in Appendix A of this report.

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2.0 FIELD INVESTIGATIONS

2.1 Introduction to Reaches

The locations of the DP Canyon reaches were selected to address a variety of goals, including identifying variations in contaminant concentration, contaminant inventory, and risk along the length of DP Canyon, and improving the understanding of transport processes (Environmental Restoration Project 1998, 57595). Each reach was intended to be long enough to capture local variations in contaminant concentrations that are related to variations in the age, thickness, and particle size of young (post-1942) sediment deposits but short enough to minimize the effects of downstream contaminant dilution. During fieldwork, the geographic boundaries of the reaches were finalized. Subreaches were delineated to better define geographic variations in contamination and to better identify contaminant sources. Reach locations within the DP Canyon watershed are shown in Figure 1.1-1; a larger-scale topographic map showing the relation of the sampling reaches to key Laboratory sites is shown in Figure 1.3-1. The general nomenclature used in this report for the geomorphic units is discussed in Section 2.2.1. Specific units in each reach are discussed in Section 2.3. Geographic characteristics of these reaches are briefly summarized below.

Reach DP-1 comprises three subreaches: DP-1 West, DP-1 Central, and DP-1 East. Reach DP-1 West is located at the head of DP Canyon, which begins at a culvert just north of the Knights of Columbus Hall on DP Road. The east end of the reach is at the point in DP Canyon where tuff samples were collected in the channel for the DP Tank Farm investigation. Reach DP-1 Central is contiguous with reach DP-1 West and continues down-canyon for 100 m. Reach DP-1 East is located in a portion of DP Canyon just east of the section of commercial businesses along DP Road. These three subreaches are narrow and relatively steep with a bedrock-dominated channel incised into Unit 3 of the Tshirege Member.

Reach DP-2 is located along the portion of Technical Area 21 (TA-21) known as DP East. The west end of the reach is at the confluence of a deeply incised hillslope gully that drains potential release site (PRS) 21-011(k). The east end of the reach is just down-canyon of the drainage below Material Disposal Area (MDA) U. The reach is characterized by a relatively wide, low-gradient grassy meadow, and the alluvial channel rests on Tshirege Unit 2 at the east end of the reach.

Reach DP-3 is located in a segment of DP Canyon that is deeply incised into Tshirege Unit 2. The gradient is relatively steep. The channel is bedrock dominated with local accumulation of thin (less than 1-m-thick) alluvial deposits. No new PRSs drain into this reach. The reach was located to represent the physical setting for this part of DP Canyon. Reach DP-3 also provides an intermediate point for evaluating contaminant concentration trends between the PRS 21-011(k) outfall and the confluence of DP and Los Alamos Canyons.

Reach DP-4 is a continuous canyon segment between DP Spring and the confluence with Los Alamos Canyon at the west end of reach LA-2 East. Reach DP-4 is a narrow, steep reach incised through, in descending order, Tshirege unit 1g, Tsankawi Pumice, the Cerro Toledo interval, and the Otowi Member of the Bandelier Tuff. The TA-21 wastewater treatment plant (WWTP) [PRS 21-026(d)] drains into a small, unnamed tributary that joins DP Canyon immediately west of the west end of reach DP-4 near DP Spring.

2.2 Methods of Investigation and Geomorphic Mapping

2.2.1 Geomorphic Mapping

Field investigations in each reach began with the preparation of a preliminary geomorphic map that focused on identifying young (post-1942), potentially contaminated sediment deposits and subdividing these deposits into geomorphic units with different age, sedimentological characteristics, and/or

radiological characteristics. These geomorphic units delineate the horizontal extent of contamination in each reach and also permit grouping areas with similar physical and/or radiological characteristics. Where uncertainties existed in identifying the limits of potentially contaminated sediments, boundaries were drawn to over- rather than underestimate the area potentially impacted by post-1942 floods.

Mapping in each reach was at a scale of 1:200 and involved taping distances along the channel from known reference points and frequently measuring unit width. Aerial photographs were not useful in mapping reaches DP-1, -3, or -4 because of the narrowness of the active canyon floor and the density of vegetation. Aerial photographs were useful for identifying some post-1942 changes in channel position in reach DP-2. Boundaries between geomorphic units typically were defined on the basis of topographic breaks or vegetation changes. In some areas boundaries are approximated due to poor resolution of the contact between units. In reaches DP-2, -3, and -4, field radiological measurements were used to distinguish some geomorphic units on the basis of variations in gross gamma radiation.

Geomorphic mapping was iterative; the maps were revised after each phase of investigation in each reach. For example, in reach DP-2 field radiological measurements were used to subdivide a geomorphic unit into a subunit with relatively elevated cesium-137 concentrations, and a subunit with relatively low cesium-137 concentrations with possible implications for age and sediment transport. In addition, geodetic surveying of sample locations that followed each sampling event often led to map revisions to bring the surveyed sample locations into the appropriate geomorphic unit. For example, the surveyed location of a sample site on a stream bank could plot within the active channel on a preliminary geomorphic map because of small inaccuracies in unit boundaries. Refining the conceptual model during the investigations also resulted in reexamining and revising previous maps.

Nomenclature

The nomenclature used for geomorphic units is consistent among reaches and subreaches whenever possible, but complete consistency was not possible.

For all DP Canyon reaches the following general nomenclature applies. Although the nomenclature may be consistent among reaches in some cases, the geomorphic context (i.e., implications to the age of sediments) is different between reaches. Therefore, a direct correlation of units between reaches is not possible, except for the active channel unit. The designation "c" refers to post-1942 channel units, which are areas occupied by the main stream channel or that receive significant deposits of coarse-grained channel sediments sometime after 1942. The designation "c1" is assigned to the presently active channel in all DP Canyon reaches. The other "c" units in each reach (e.g., c2, c3a, c3b) are assigned uniquely for each reach as described below. The designation "f" refers to floodplain areas that were or may have been inundated by overbank floodwaters since 1942 but that were not occupied by the main stream channel; "f1" indicates areas that were probably inundated by floods during this period, as shown by geomorphic evidence and/or analytical data; "f2" indicates areas that were possibly but not conclusively subjected to minor inundation or floodplain areas where contaminant concentrations are low.

For DP-1 subreaches, "c2" is assigned to the lowest channel deposit terrace and is interpreted to be the youngest abandoned channel unit in each subreach; "c3" is assigned to the highest channel deposit terrace and is interpreted as older abandoned channel units. The "f1" units are floodplain areas overlying pre-1942 channel or floodplain deposits.

In reach DP-2, "c2" is assigned to the lowest channel deposit terrace and is interpreted to be the youngest abandoned channel unit. The "c3" units are subdivided into "c3a" and "c3b" subunits based on gross gamma field radiation data (walkover and fixed-point) and supplemented by analytical data. The "c3b" units have relatively high gross gamma radiation relative to the "c3a" units. The "f1" units are floodplain areas overlying pre-1942 channel or floodplain deposits.

In reaches DP-3 and DP-4, the canyon is steep and narrow. Abandoned channel terraces occur at random elevations above the active channel because of highly variable flood intensity and the effects of log or boulder jams that occur during floods. In reach DP-3 the "c" units are subdivided based on fixed-point gross gamma radiation. The "c" units with maximum values up to 10,000 counts per minute (cpm) are assigned "c2"; the "c" units between 10,000 and 20,000 cpm are assigned "c2a"; and the "c" units with greater than 20,000 cpm are assigned "c3b." The "f" units with maximum values up to 7000 cpm are assigned "f2," and the "f" units with greater than 7000 cpm are assigned "f1."

In reach DP-4, "c2" is used for all "c" units outside the presently active channel. Designation of "c2a" and "c2b" subunits is based on gross gamma radiation, with "c2b" assigned to units with higher gross gamma radiation. The "f1" units are floodplain areas overlying pre-1942 channel or floodplain deposits.

Other designations on the geomorphic maps delineate various areas that have not been directly impacted by post-1942 floods downstream of potential contaminant sources. Following standard geologic nomenclature, "Q" indicates deposits from the Quaternary period. "Qc" refers to colluvium. "Qt" refers to pre-1943 stream terraces that have not been inundated by post-1942 floods. "Qbt3," "Qbt2," "Qct," and "Qbo" refer to major stratigraphic units of the Bandelier Tuff or the Cerro Toledo interval that often bounded post-1942 deposits.

2.2.2 Physical Characterization of Young Sediments

Physical characterization of the geomorphic units included thickness measurements of the post-1942 sediments, general field descriptions of particle size, and laboratory particle-size analysis for samples submitted for standard chemical and/or radiological analyses. A variety of approaches were used to determine unit thicknesses, including identifying the depth to which tree bases are buried by sediment, recognizing buried soil horizons, and searching for the presence of "exotic" material that indicates a post-1942 age (e.g., quartzite clasts imported from quarries closer to the Rio Grande, plastic materials, or other man-made materials). Radioisotope analyses also were used at some sites to directly determine the thickness (i.e., vertical extent) of contaminated sediment and to provide supporting evidence for the inferred thickness of post-1942 sediment. However, in some areas these radionuclides may extend into pre-1943 sediment as a result of vertical translocation. Additional details of the methods and results of the physical characterization of post-1942 sediment in the DP Canyon reaches are presented in Appendix B of this report.

Facies Descriptions

An important distinction within the post-1942 sediments involves general particle-size variations because contaminant concentrations tend to be higher in finer-grained sediments of a given age. The term "facies" is used to describe the observed texture of the deposit (primarily grain size). Two primary facies are described in this report. The fine-grained facies generally contains median particle sizes of fine sand (0.125–0.25 mm) or smaller, is commonly stratified unless bioturbated by roots or burrowing animals, is moderately to well-sorted, and contains relatively high organic content. The coarse-grained facies generally contains median particle sizes of coarse sand (0.5–1.0 mm) or greater. The facies is often stratified, poorly to well-sorted, and lower organic content than the fine-grained facies. Medium sands can be assigned to either facies depending on the stratigraphic context.

Relation of Facies

The fine-grained facies occur as the primary deposit associated with "f" units, although thin deposits of coarse-grained deposits can be found on floodplains. Thicker deposits of fine-grained facies are most

commonly found overlying coarse-grained facies, although thinner deposits of fine-grained facies (typically less that 10–15 cm) are found interbedded within generally coarse-grained deposits. These facies relations lead to the interpretation that the fine-grained deposits are associated with deposition of sediments from suspension during floods. Coarse-grained deposits are interpreted as resulting from bedload deposition within or outside an established channel during floods. The fine-grained deposits that commonly overlie these coarse-grained deposits are interpreted as resulting from deposition of suspended load during waning portions of floods or from overbank flooding onto abandoned coarse-grained deposits in a floodplain setting.

2.2.3 Radiological Field Measurements

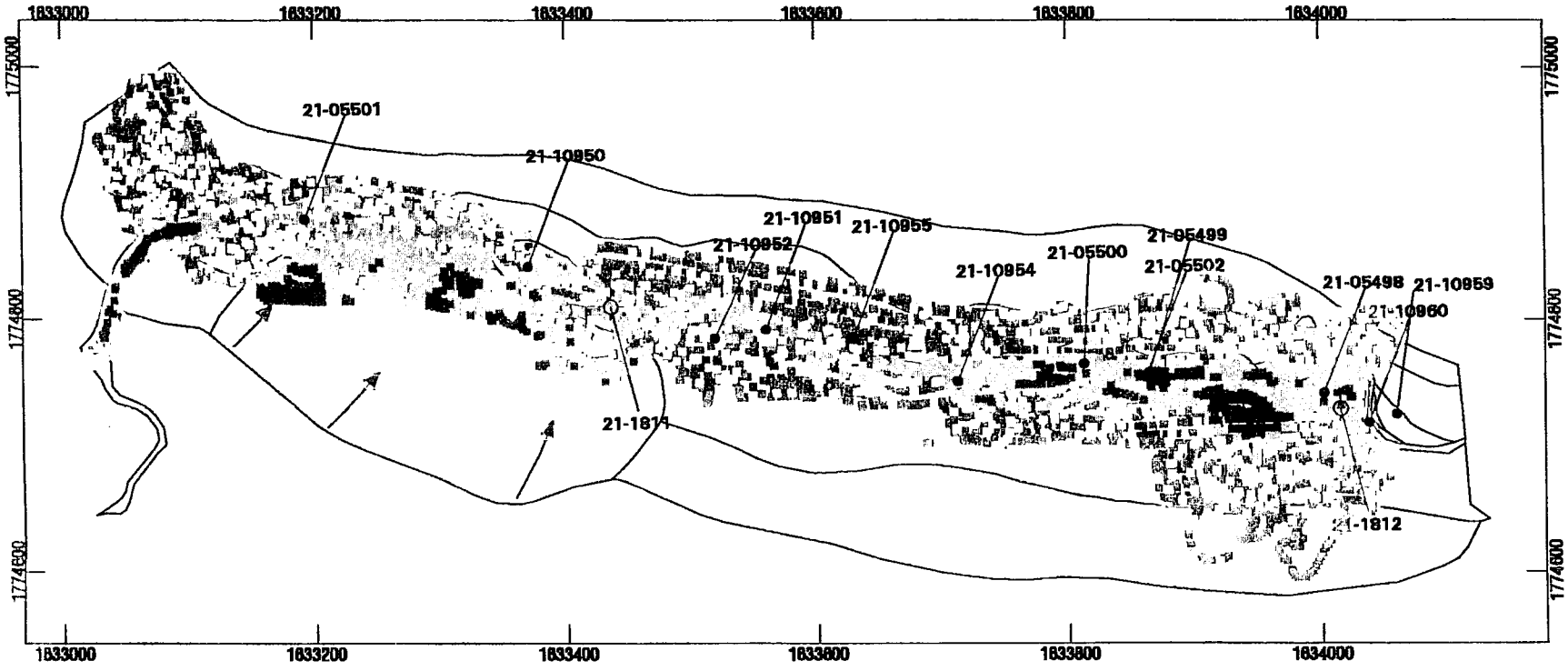
The initial geomorphic mapping in reaches DP-2, -3, and -4 was supplemented by fixed-point, gross gamma radiation data. Levels of gamma radiation, largely related to cesium-137, were found to be high enough throughout DP-2 through DP-4 to provide excellent definition of horizontal and vertical variations in cesium concentration. Therefore, investigations in DP-2 through DP-4 relied heavily on fixed-point gamma radiation measurements. The methods and results for all the field instruments are presented in Section B-3.0. A gross gamma radiation walkover survey was conducted in reach DP-2 to supplement mapping results and refine geomorphic unit boundaries. Figure 2.2-1 shows the results of the survey.

2.2.4 Sediment Sampling and Preliminary Data Evaluation

Sediment sampling in this investigation followed a phased approach that included a combination of sampling for "full-suite" and "limited-suite" analyses. Preliminary data evaluation between phases helped identify uncertainties and focus subsequent sample collection and analysis for key contaminants that were thought to drive the risk evaluation. The primary goals and other information about each sampling event are summarized in Table B-4.0-1 in Appendix B.

Full-suite analyses were obtained in the first sampling phase on samples from all reaches, after the initial fixed-point radiological survey, with the goal of identifying all analytes that were present above background values and determining the primary risk drivers. Initially, only one full-suite sample was collected from DP-1 and DP-3. In reach DP-3, a deposit with relatively high gross gamma radiation was sampled to determine if the contaminants were similar to those identified in DP-2 and DP-4. In reach DP-1, a single fine-grained deposit was sampled since no radiological contamination was identified from preliminary radiological screening in the reach. For all reaches except DP-1, specific sample sites and sample depths included intervals with the highest field radiological measurements in each reach as well as intervals with relatively low radiation. Sample sites also included representative fine-grained and coarse-grained sediment deposits from all important geomorphic units. The full-suite analyses included a series of inorganic chemicals, organic chemicals, and radionuclides (see Section 3.1 and Appendix C of this report).

The second sampling phase was the primary characterization phase for the DP-1 subreaches, since limited data existed for those subreaches. The second sampling phase in DP-2, -3, and -4 included some full-suite analyses, but primarily focused on a limited suite of contaminants that were considered primary potential risk drivers. The second sampling phase also was designed to define the horizontal and vertical extent of contamination and variations in contaminant levels. Organic and inorganic constituents were considered key contaminants in DP-1 subreaches. Cesium-137 and other radiological constituents were considered key contaminants in DP-2, -3, and -4. Specific sample sites in each sampling event were selected to reduce uncertainties in the horizontal and vertical extent of contamination, the average and range of contaminant concentrations in each unit, the inventory of key contaminants, and controls on their distribution (e.g., effects of sediment age and sediment particle size).



ChemRad Gamma Values (cpm)
- < 4500
- 4500 - 4999
- 5000 - 5499
- 5500 - 5999
- 6000 - 6999
- 7000 - 10999
- >= 11000

New PMC Survey
Well/Hole
Geomorphic Unit Boundary

0 100 200 300
FEET

1983 North American Datum
Projection and Grid Ticks:
New Mexico State Plane Coordinate System,
Central Zone (Transverse Mercator)

Notice: Information on this map is provisional and has not been checked for accuracy.

Produced by Marcia Jones

FIMAD G107914 13 Jul 99

Figure 2.2-1. Gross gamma survey results in reach DP-2

To most effectively reduce the uncertainty in contaminant inventory in each reach, a stratified random sample allocation process was applied (using calculations based on equation 5.10 in Gilbert 1987, 56179). To evaluate uncertainty in this sample allocation process, Monte Carlo calculations were performed using the Crystal Ball version 4 add-in to Microsoft Excel software. These calculations used available data on the area, thickness, and radionuclide concentration in each geomorphic unit and sediment facies to help determine the number of samples to be collected from each unit and each facies. For example, a unit with a relatively large volume of post-1942 sediment, high radionuclide concentrations, and/or high variability in radionuclide concentration would be assigned more samples than a similar unit with small volume, low concentrations, and/or low variability in radionuclide concentration.

2.3 Results

2.3.1 Reach DP-1

2.3.1.1 Physical Characteristics

Reach DP-1 is in a part of upper DP Canyon where the canyon floor is narrow. The area that has been impacted by post-1942 floods averages approximately 4–7 m wide in DP-1 West, DP-1 Central, and DP-1 East. The areal distribution of the geomorphic units is shown on Figures 1.3-1, 2.3-1, and 2.3-2. Topographic relations are illustrated in the cross sections of Figures 2.3-3 and 2.3-4. Physical characteristics of the geomorphic units in DP-1 are summarized in Table 2.3-1. Data on particle size and unit thickness are presented in Tables B-1.0-1, B-2.0-1, and B-2.0-5 in Appendix B.

The active channel, c1, averages 2.2 m wide in the DP-1 subreaches and has a bedrock channel with discontinuous deposits of coarse sand and gravel. The active channel typically is bordered by pre-1942 bedrock and colluvial units, or abandoned post-1942 channel or floodplain units (c2, c3, f1) that average approximately 1.2–5.2 m in width and average 0.4–1.8 m in height above the channel. The c2 and c3 units are usually capped by an average of approximately 0.2–0.62 m of relatively fine-grained sediments dominated by medium sand. In each subreach, unit c3 has surfaces that are higher above the channel than c2, although the c2 and c3 units may have ages that overlap within and between subreaches. The f1 unit averages 1.3–1.8 m in height above the active channel and is capped by an average of 0.42–0.52 m of overbank sediments dominated by fine sand.

2.3.1.2 Radiological Characteristics

No radiological measurements were taken in DP-1 subreaches because no significant radiological sources were anticipated.

2.3.1.3 Geomorphic History

An important geomorphic process in DP-1 subreaches includes high-intensity flooding that results in deposition of coarse-grained sediment outside the present active channel. Lateral channel migration likely has been minimal due to the migration constraints resulting from bedrock exposures throughout the subreaches. Since 1942, DP-1 subreaches likely have experienced some incision of the bedrock channel due in part to the enhanced storm-water runoff resulting from development in the Los Alamos townsite. High intensity flooding and vertical incision are evidenced by coarse-grained deposits that occur significantly above the elevation of the present active channel. These coarse sediments also could have been deposited behind temporary flood-related debris or boulder dams.

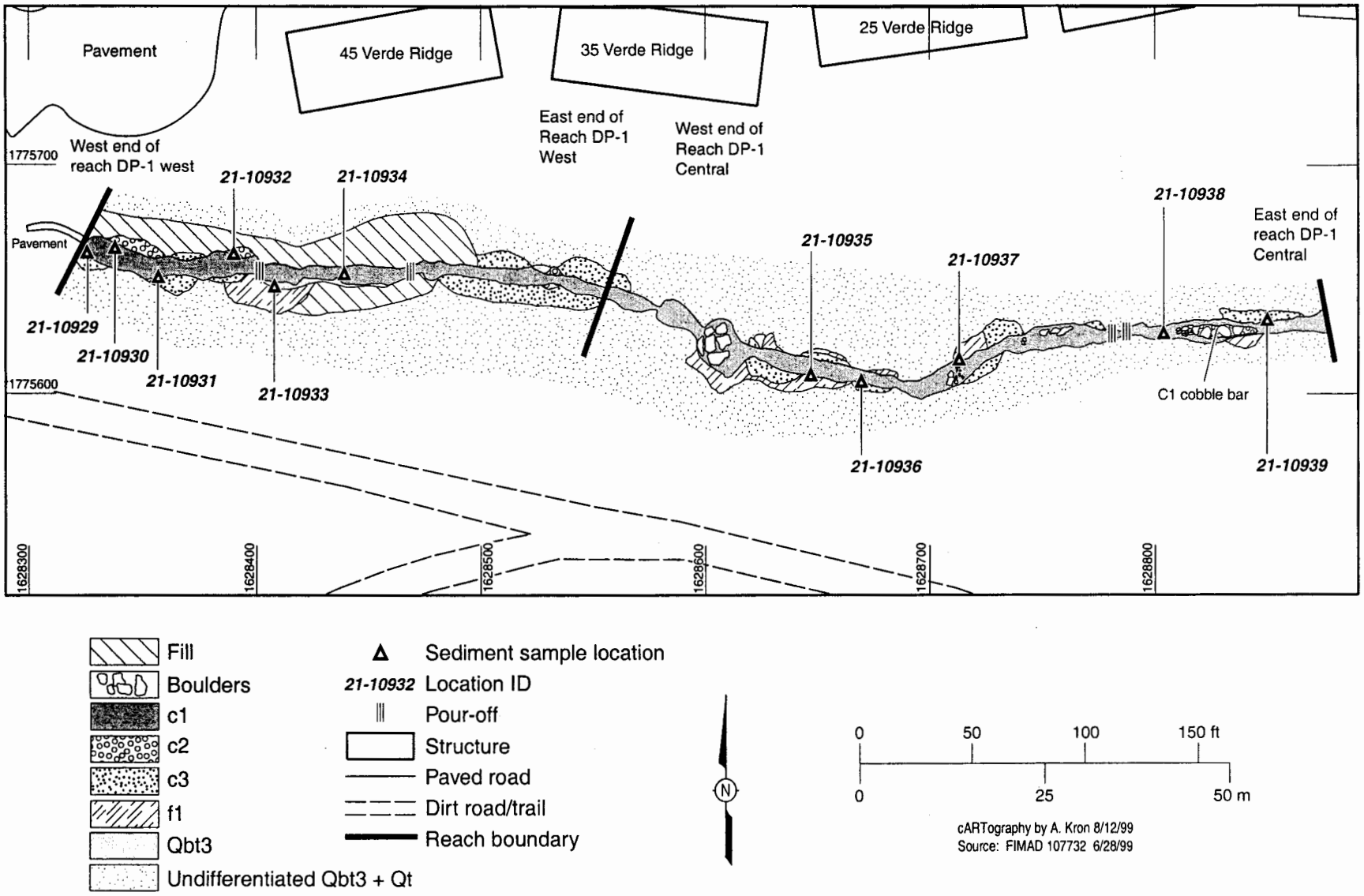


Figure 2.3-1. Reach DP-1 West and Central geomorphology and sediment sample locations

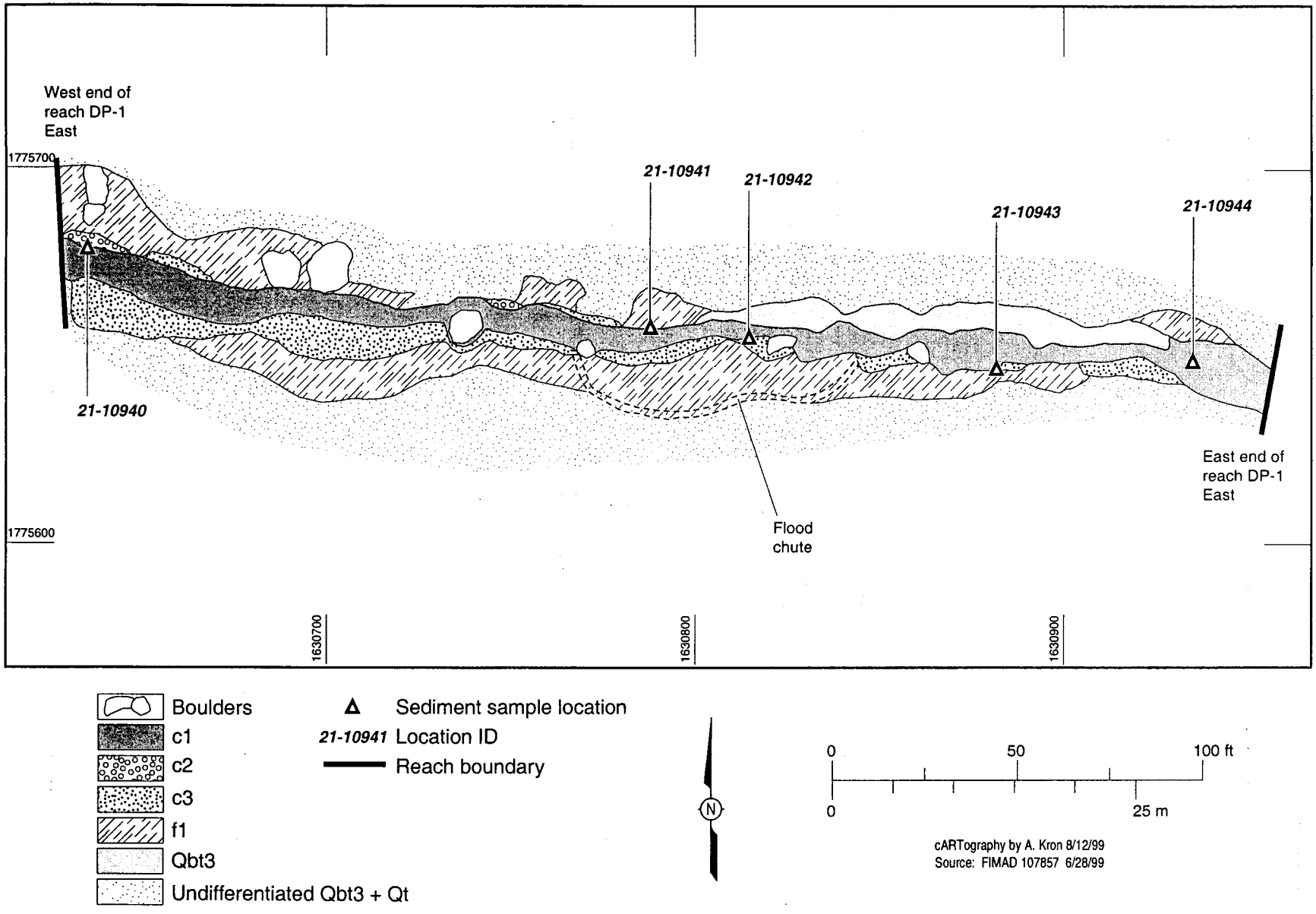


Figure 2.3-2. Reach DP-1 East geomorphology and sediment sample locations

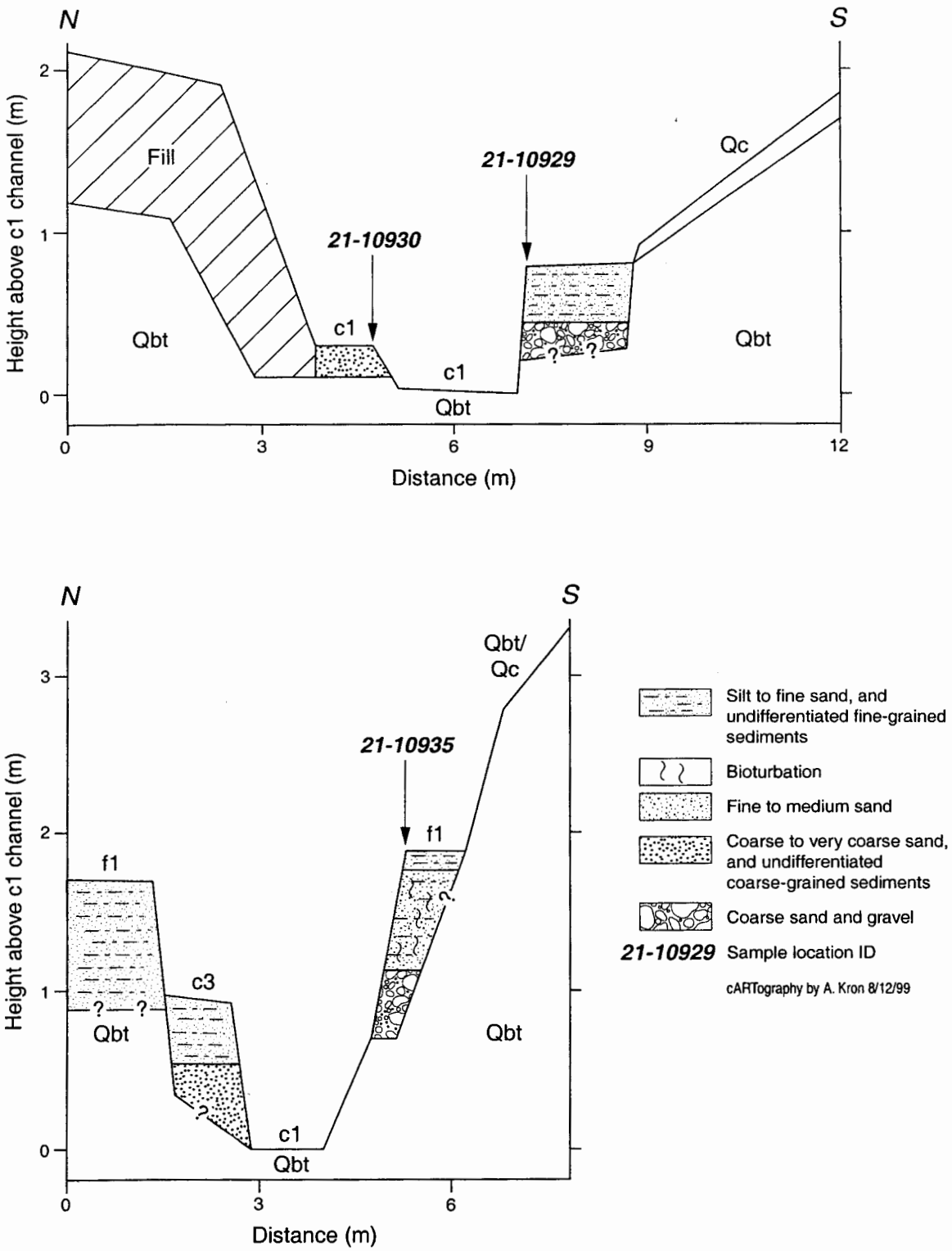


Figure 2.3-3. Reach DP-1 West (top) and Reach DP-1 Central (bottom) cross sections

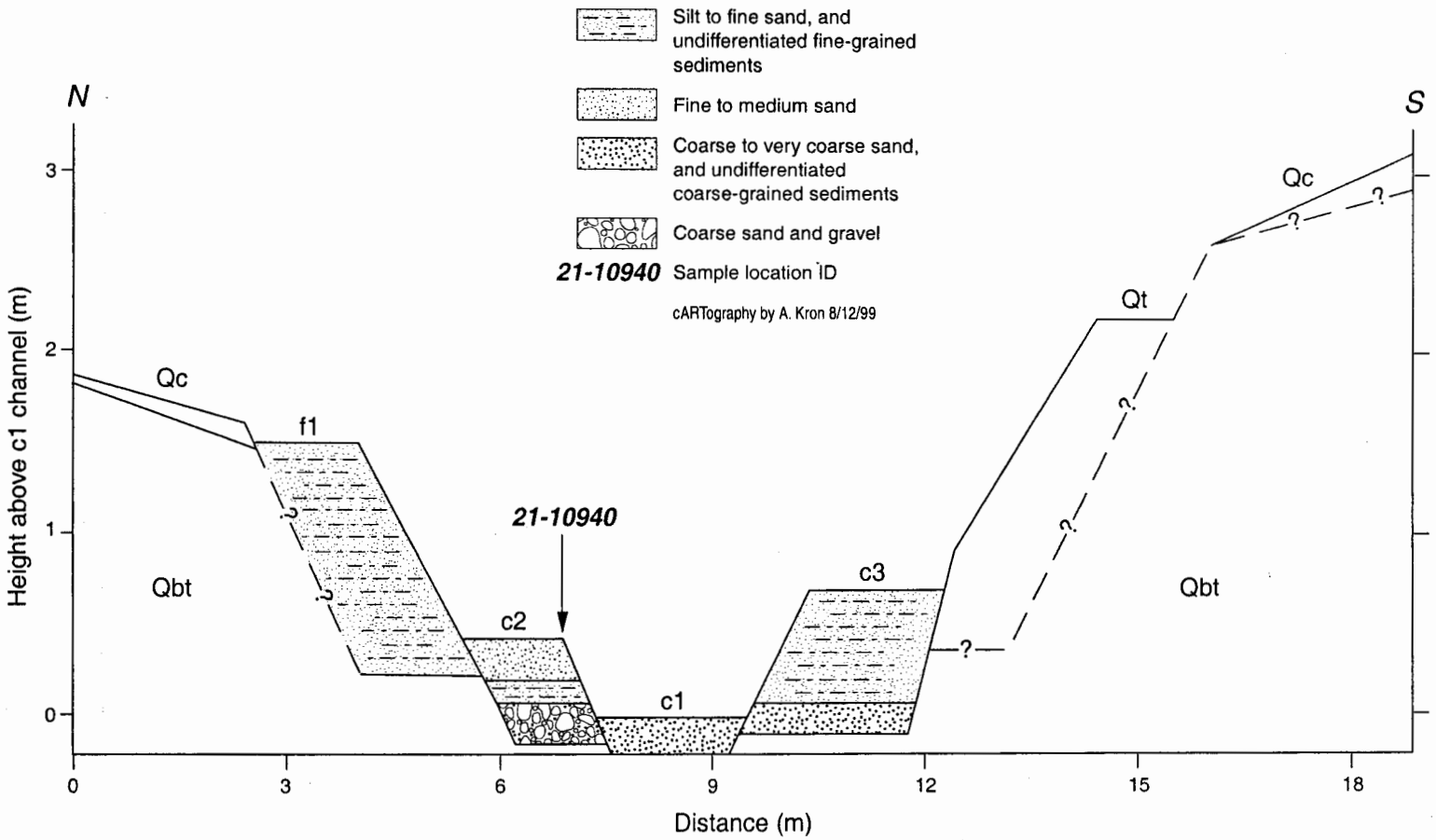


Figure 2.3-4. Reach DP-1 East cross section

Table 2.3-1
Geomorphic Mapping Units in Reach DP-1 Subreaches

Subreach	Unit	Estimated Average Unit Height Above Channel (m)	Unit Area (m^2)	Average Unit Width[a] (m)	Sediment Facies	Estimated Average Thickness (m)	Typical Median Particle Size Class (<2 mm fraction)	Notes
DP-1 West	c1	0	155	2.2	Coarse	0.25	cs	Active channel
	c2	0.43	17	0.3	Fine	0.2	fs	Younger abandoned post-1942 channel
					Coarse	0.35	"cs"[b]	
	c3	0.63	108	1.5	Fine	0.58	fs	Older abandoned post-1942 channel
					Coarse	0.25	"cs"	
	f1	1.28	35	2.3	Fine	0.45	csi	Active floodplain
DP-1 Central	c1	0	219	2.2	Coarse	0.25	cs	Active channel
	c3	1.17	64	0.63	Fine	0.27	fs	Older abandoned post-1942 channel
					Coarse	0.33	cs	
	f1	1.75	56	0.6	Fine	0.52	csi	Active floodplain
DP-1 East	c1	0	224	2.2	Coarse	0.25	cs	Active channel
	c2	0.38	69	0.7	Fine	0.33	fs	Younger abandoned post-1942 channel
					Coarse	0.09	cs	
	c3	1.06	124	1.2	Fine	0.62	vfs	Older abandoned post-1942 channel
					Coarse	0.21	cs	
	f1	1.42	335	3.3	Fine	0.42	csi	Active floodplain

[a] Unit area divided by subreach length.

[b] Quotes mean not sampled for particle size, so c3 coarse reach DP-1 Central data used for median particle size class.

Due to the narrow nature of the subreaches, all fine- and coarse-grained sediments are stored relatively close to the active channel. The f1 units are farther away from the active channel, although they sometimes border the active channel. The sediments contained within the c2 and c3 units are somewhat more susceptible to remobilization by lateral bank erosion during floods. Approximately half the post-1942 sediments in the different subreaches are stored in f units.

2.3.2 Reach DP-2

2.3.2.1 Physical Characteristics

Reach DP-2 is in a relatively wide part of upper DP Canyon where the canyon floor is much wider than other DP Canyon reaches. The area that has been impacted by post-1942 floods averages approximately 15 m wide. The areal distribution of the geomorphic units is shown on Figures 1.3-1 and 2.3-5. Topographic relations are illustrated in the cross sections of Figure 2.3-6. Physical characteristics of the geomorphic units in DP-2 are summarized in Table 2.3-2. Data on particle size and unit thickness are presented in Tables B-1.0-1, B-2.0-2, and B-2.0-6 in Appendix B.

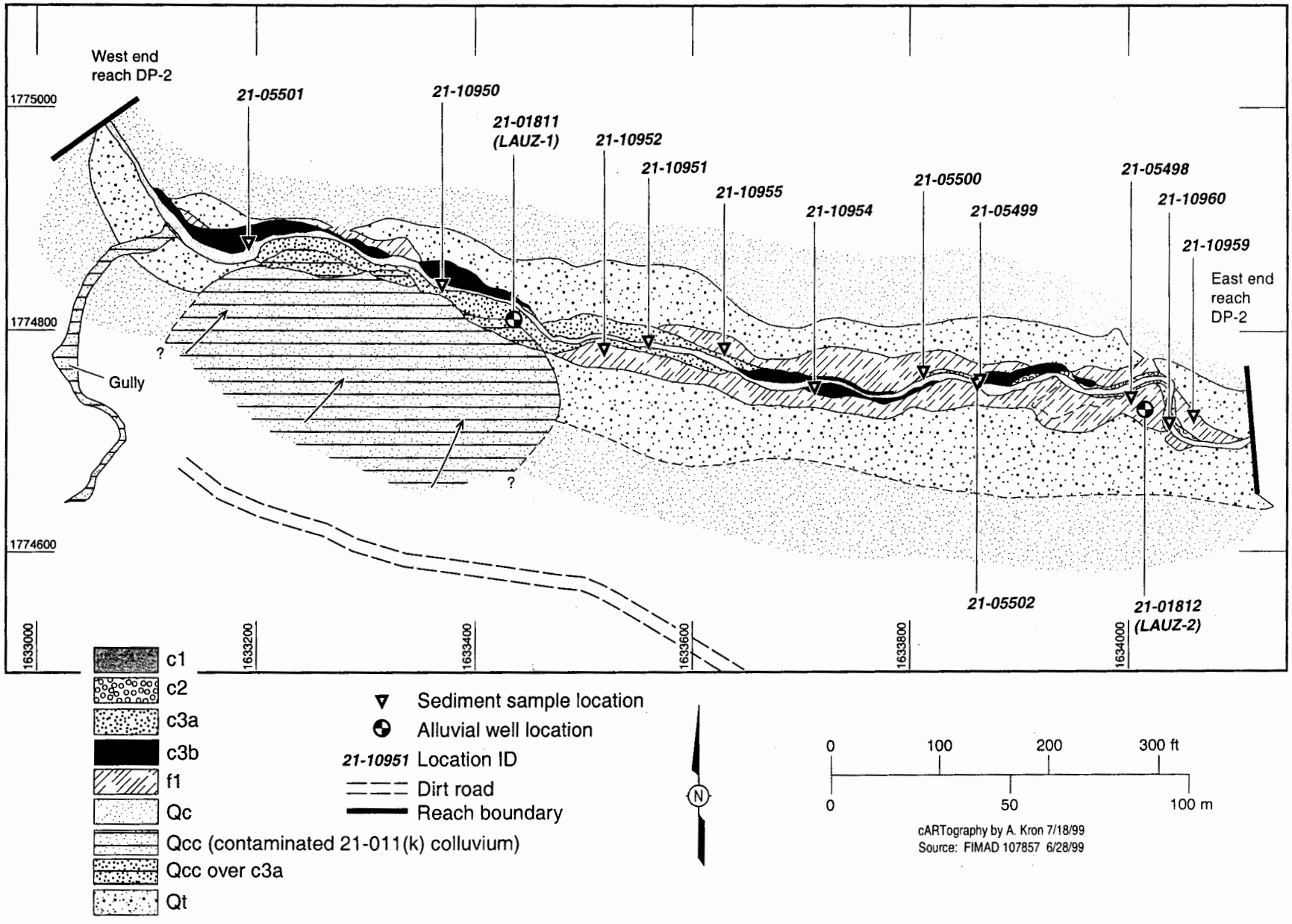


Figure 2.3-5. Reach DP-2 geomorphology and sediment sample locations

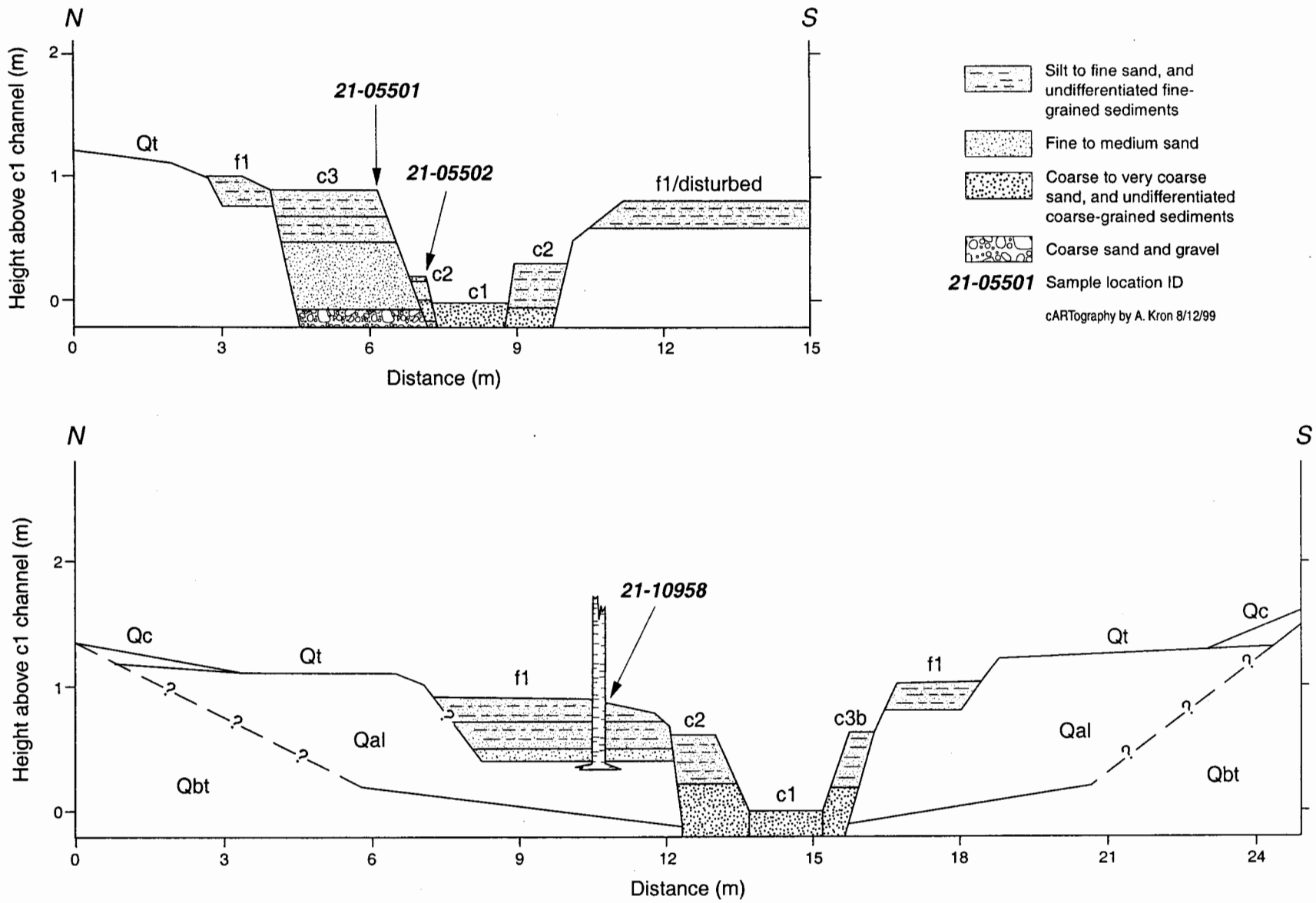


Figure 2.3-6. Reach DP-2 cross sections

Table 2.3-2
Geomorphic Mapping Units in Reach DP-2

Unit	Estimated Average Unit Height Above Channel (m)	Unit Area (m^2)	Average Unit Width* (m)	Sediment Facies	Estimated Average Thickness (m)	Typical Median Particle Size Class (<2 mm fraction)	Notes
c1	0	606	1.9	Coarse	0.5	cs	Active channel
c2	0.4	102	0.3	Fine	0.37	fs	Younger abandoned post-1942 channel
				Coarse	0.5	ms	
c3a	0.73	627	2.0	Fine	0.53	vfs	Older abandoned post-1942 channel
				Coarse	0.5	cs	
c3b	0.80	528	1.7	Fine	0.42	vfs	Older abandoned post-1942 channel
				Coarse	0.5	cs	
f1	1.14	1917	6.1	Fine	0.43	csi	Active floodplain
				Coarse		fs	

* Unit area divided by subreach length.

The active channel, c1, averages 1.9 m wide; its bed is composed of coarse sand and gravel. The active channel usually is bordered by abandoned post-1942 channel units (c2, c3a, c3b) that average approximately 4.0 m in combined width and have average heights of 0.4–0.8 m above the channel. Abandoned channel units dominate the western portion of DP-2. The eastern portion of the reach is dominated by f1 units with only thin discontinuous abandoned channel units preserved along the active channel. The c3b units within reach DP-2 are distinguished from c3a units by the higher levels of gamma radiation. The c2 units are inset into all other abandoned channel and floodplain units. Active floodplains (f1) in DP-2 average approximately 6 m wide. The f1 units average 1.1 m in height above the active channel and are capped by an average if 0.43 m of fine-grained sediment dominated by fine sand. Dead, standing ponderosa pine trunks rooted into pre-1943 alluvium are buried by up to 50–60 cm of fine-grained flood deposits within the f1 units.

An important colluvial unit exists along the south side of the channel in the western portion of reach DP-2. These thin colluvial deposits (estimated thickness of less than 1 m) are contaminated from historical discharge of contaminated effluent from PRS 21-011(k). This unit overlies portions of relatively uncontaminated c3a units along the south side of the active channel. Detailed characterization of the colluvial unit was not conducted for this investigation.

Reach DP-2 receives frequent floods. Apparently all post-1942 geomorphic units are inundated with flood water with moderate frequency, due to high storm-water discharges generated in the Los Alamos townsite that are routed to DP Canyon by storm drains. The lateral extent of flood water is evidenced by a clear demarcation of domestic grasses against native grasses, which also delineates the extent of the post-1942 deposits.

2.3.2.2 Radiological Characteristics

The gross gamma radiation walkover survey and fixed-point radiation measurements in reach DP-2 indicated that levels of gamma-emitting radionuclides were high enough to support mapping the horizontal extent of the gamma radiation in sediment deposits (Figure 2.2-1). Therefore, these measurements were used both to refine the preliminary geomorphic map and to subdivide areas in DP-2

(c3a, c3b) on the basis of variations in gross gamma radiation. In addition, fixed-point gamma radiation measurements were used to examine vertical variations in gamma-emitting radionuclides within the geomorphic units and to select specific sample layers. Section B-3.0 in Appendix B presents the fixed-point gamma radiation data, including depth profiles of gamma radiation in a series of stratigraphic sections through the c2, c3a, and c3b units (Figure B-3.2-2). Reach DP-2 field radiation measurements are presented in Section B-3.2.1 in Appendix B.

Gross gamma radiation walkover measurements in DP-2 indicated that overall the most extensive and highest levels of gamma radiation occur in the eastern portion of the reach (Figure 2.2-1). Gross gamma measurements with 1-sec count times and an unshielded probe typically were 6000–7000 cpm in the c3a units, and 7000–11,000 cpm in the c3b units. Gross gamma walkover measurements in the f1 units typically were 7000 cpm to greater than 11,000 cpm.

Fixed-point gamma radiation measurements in reach DP-2 were taken from vertical exposures along the stream banks and from hand-dug holes in floodplain units, and were used to define vertical variations in gross gamma radiation. These measurements used 1-min count times and a shielded probe. The shielded probe focuses the measurements on a specific sediment layer of interest better than the unshielded probe used for the walkover survey, although the measurements are still affected by gamma radiation derived from nearby layers. Measurements with the shielded probe also were made near the soil surface instead of at a height of approximately 0.3 m. Therefore, the fixed-point and walkover measurements cannot be directly compared, although they show the same relative differences in gamma radiation.

The fixed-point gamma radiation measurements show that in most units the highest levels of radiation occur in the subsurface. In reach DP-2, the highest gross gamma radiation measurements occur in fine- or coarse-grained sediment. The relations of variations in radionuclide concentration and sediment particle size are discussed further in Section 3.3.3.1.

2.3.2.3 Geomorphic History

Post-1942 geomorphic processes within reach DP-2 include lateral migration of the active channel within an area that averages approximately 3.3 m wide and the occasional overtopping of pre-1943 terraces during floods. Aerial photographs of reach DP-2 show that changes in channel position have occurred primarily in the western half of the reach and the channel position has remained relatively stable in the eastern half of the reach. The channel units generally record deposition of coarse channel deposits with subsequent deposition of finer-grained overbank deposits on the coarse-grained channel deposits. The stream bed elevation appears to have been relatively stable during this period. It was located within 0.5 m of its current elevation, as indicated by the height of buried channel deposits in the c2, c3a, and c3b units relative to the present channel deposits.

C3 units are predominant in the western portion of reach DP-2, and f units are predominant in the eastern portion of the reach. Radiological and sample analytical data indicate that the c3 units in the western portion of the reach are comprised of sediment with relatively low levels of radiological contamination inferred to be derived in large part from upstream of PRS 21-011(k). These fine-grained sediments are inferred to be derived from the DP-1 area and do not contain significant radiological contamination. Due to the frequency of high-magnitude floods in DP-2 that typically have a flood stage equivalent to the height of the c3 terraces, high potential exists for erosion of c3 deposits and/or deposition of sediments on c3 terrace surfaces. Older sediments at depth within the c3 units are protected from erosion because they are below the elevation of the active channel bed. Based on the suite of contaminants and their concentrations, much of the fine-grained sediment on the floodplains in the eastern portion of reach DP-2 may be derived largely from erosion of the c3 units in the western portion of the reach with subsequent

deposition of the fine-grained fraction onto downstream floodplains. Information on the age of sediments in DP-2 was derived primarily by assessing contaminant concentration and isotope ratios.

2.3.3 Reach DP-3

2.3.3.1 Physical Characteristics

Reach DP-3 is in a part of DP Canyon where the canyon floor is generally very narrow and deeply incised into surrounding bedrock units. The area that has been impacted by post-1942 floods averages approximately 4.5 m wide. The areal distribution of the geomorphic units is shown on Figures 1.3-1 and 2.3-7. Topographic relations are shown in the cross sections of Figure 2.3-8. Physical characteristics of the geomorphic units in DP-3 are summarized in Table 2.3-3. Data on particle size and unit thickness are presented in Tables B1-1, B2-3, and B2-7 in Appendix B.

The active channel (c1) averages 2.4 m wide in reach DP-3 and has a bed composed of bedrock with discontinuous coarse sand and gravel. The active channel is discontinuously bounded by abandoned post-1942 channel units (c2, c3a, and c3b) that average approximately 0.9 m in combined width and have average heights of 0.6–0.9 m above the channel. The c2, c3a, and c3b units usually are capped by an average of approximately 0.3–0.65 m of relatively fine-grained sediments.

In reach DP-3, the f1 unit has an average width of 0.8 m and an average height of approximately 1.6 m. It is capped by an average of approximately 0.7 m of typically fine-grained sediment. The f2 unit averages approximately 0.4 m wide. Field gamma radiation measurements are only slightly above background ranges on the f2 unit. This unit is considered to represent a post-1942 floodplain on the basis of fixed-point gross gamma measurements and laboratory analyses.

2.3.3.2 Radiological Characteristics

The fixed-point gamma radiation measurements in reach DP-3 were taken from vertical exposures in the stream banks and were used to subdivide the post-1942 abandoned channel units, define vertical variations in gross gamma radiation, and select sample sites. Abandoned channel units with maximum gross gamma radiation less than or equal to 10,000 cpm were assigned a c2 designation. Those with 10,001–20,000 cpm gross gamma radiation were assigned a c3a designation. Those with greater than 20,000 cpm gross gamma radiation were assigned a c3b designation. Floodplain units with maximum gross gamma radiation less than 7000 cpm were assigned an f2 designation, and those with greater than 7000 cpm were assigned an f1 designation. The results of the fixed-point measurements made in DP-3 are presented in Table B-3.2-2 in Appendix B. Gamma radiation depth profiles are presented in Figure B-3.2-4.

The fixed-point gamma radiation measurements in DP-3 show that in most units the highest levels of radiation occur in the subsurface. These subsurface layers generally correspond to the finest-grained sediment within individual stratigraphic sections. The relations of variations in radionuclide concentration and sediment particle size are discussed further in Section 3.3.3.2.

2.3.3.3 Geomorphic History

Since 1942 the stream channel in reach DP-3 has experienced little or no lateral migration due to bedrock control along both sides of the channel. It is possible that some vertical incision has occurred due to increased storm-water runoff resulting from development in the Los Alamos townsite, but incision may be limited by the relatively resistant nature of the Qbt2 bedrock. High-intensity flooding within DP-3 has resulted in deposition of coarse-grained sediments outside the presently active channel. Additionally, some channel aggradation has occurred up-channel of boulder and debris dams that exist within the channel.

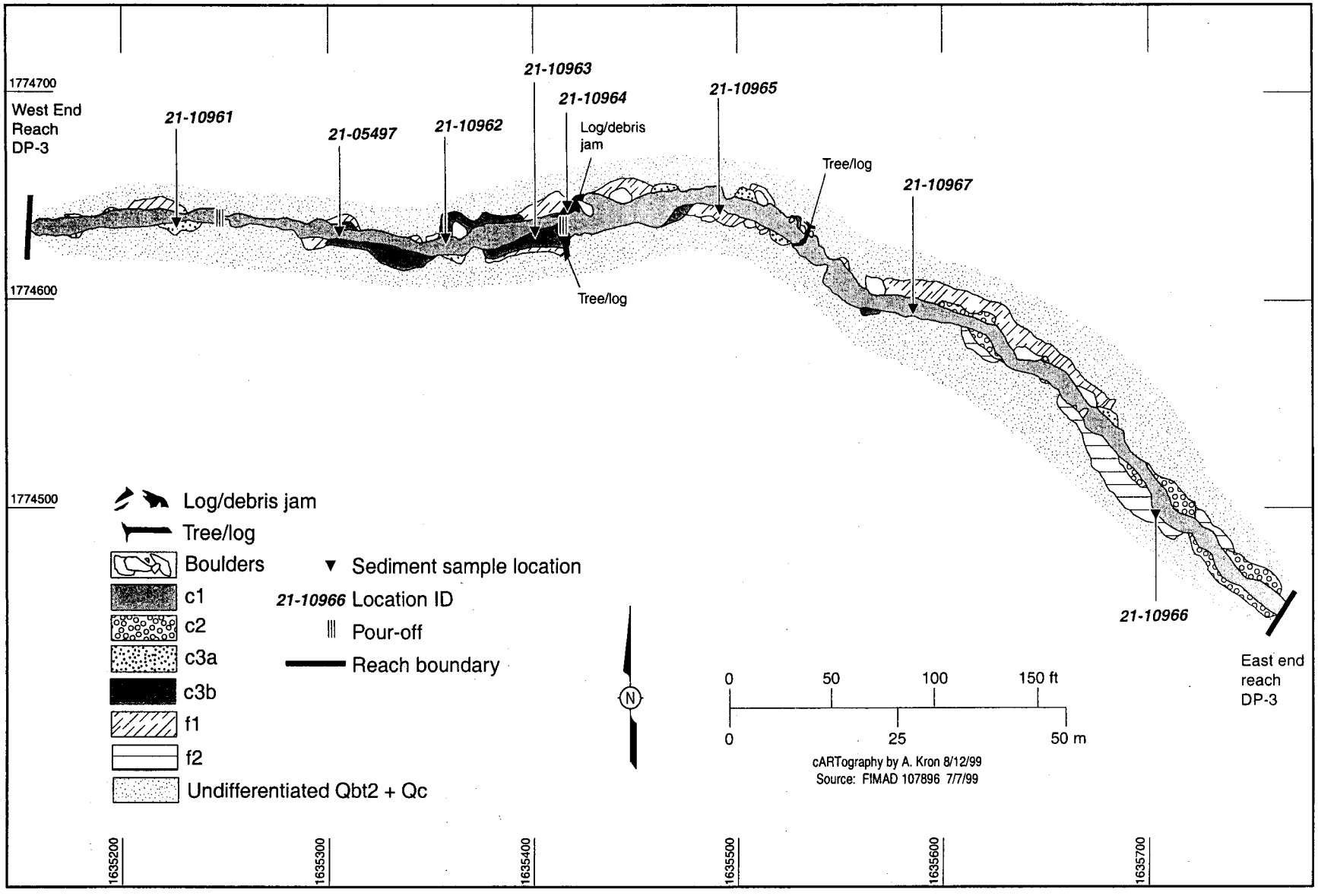
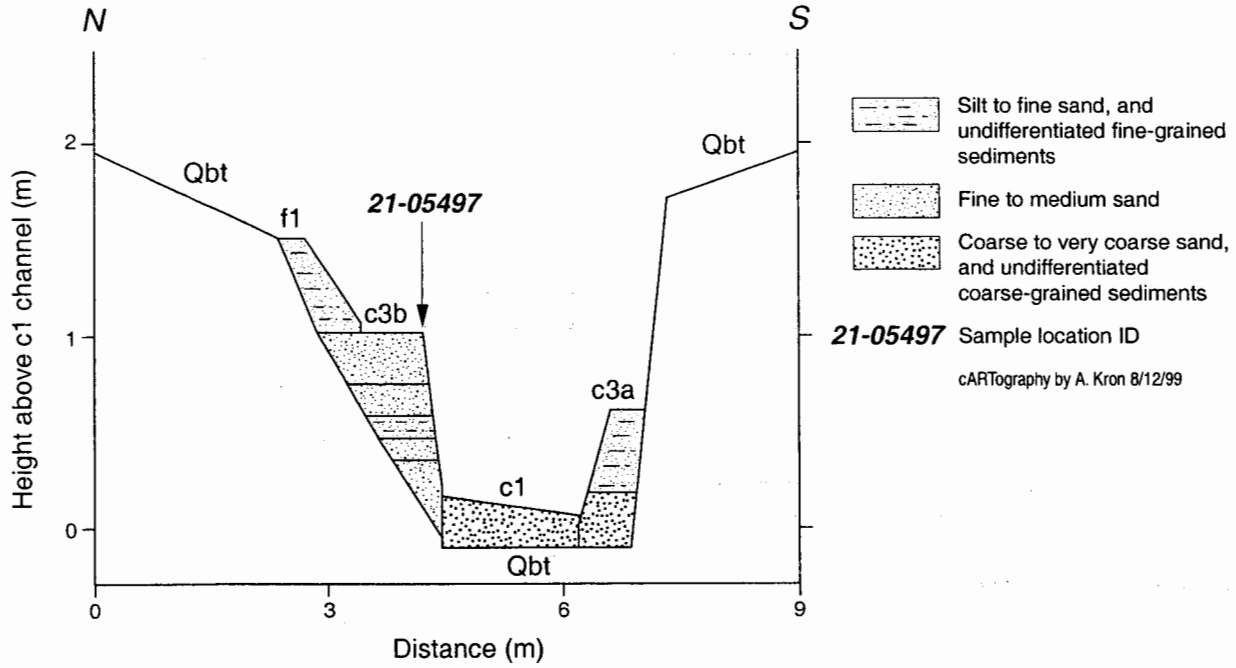


Figure 2.3-7. Reach DP-3 geomorphology and sediment sample locations



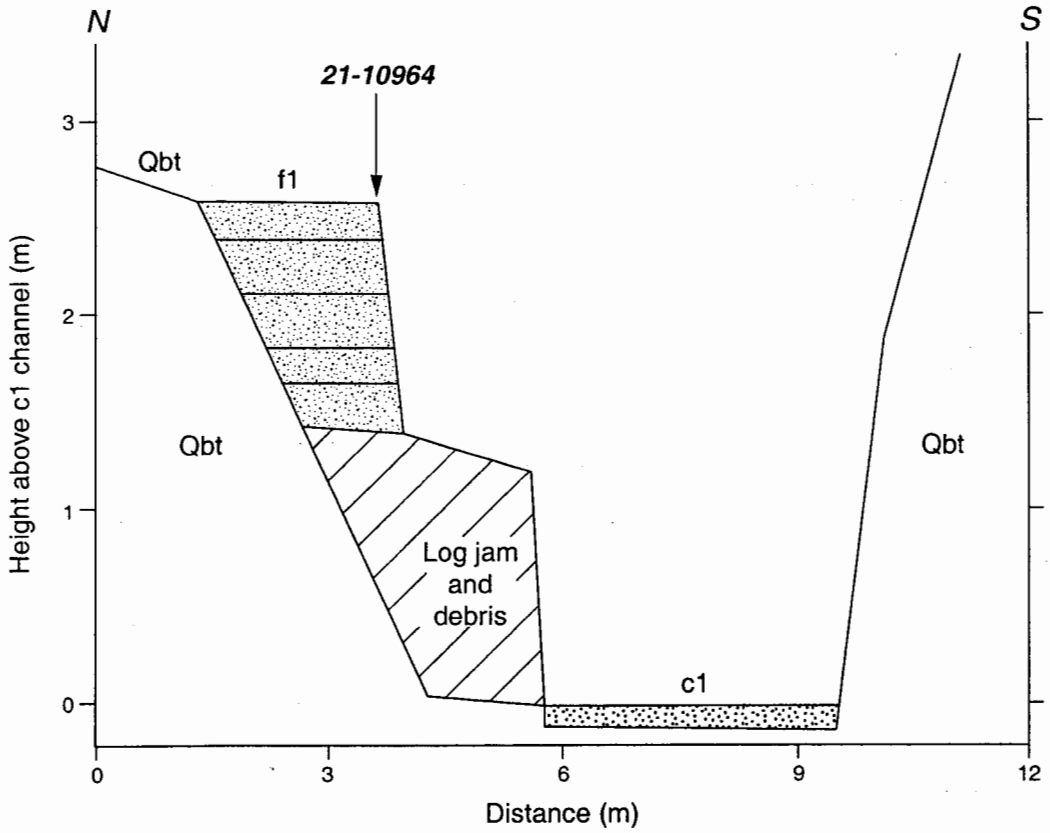


Figure 2.3-8. Reach DP-3 cross sections

Table 2.3-3
Geomorphic Mapping Units in Reach DP-3

Unit	Estimated Average Unit Height Above Channel (m)	Unit Area (m^2)	Average Unit Width[a] (m)	Sediment Facies	Estimated Average Thickness (m)	Typical Median Particle Size Class (<2 mm fraction)	Notes
c1	0	506	2.4	Coarse	0.25	cs	Active channel
c2	0.60	75	0.4	Fine	0.37	"fs"[b]	
				Coarse	0.25	"vcs"	Sand and gravel bars adjacent to active channel
c3a	0.74	28	0.1	Fine	0.45	fs	Younger abandoned post-1942 channel
				Coarse	0.25	vcs	
c3b	0.87	81	0.4	Fine	0.65	vfs	Older abandoned post-1942 channel
				Coarse	0.25	cs	
f1	1.64	168	0.8	Fine	0.7	vfs	Active floodplain
f2	0.88	87	0.4	Fine	0.72	csi	Potentially active floodplain

[a] Unit area divided by subreach length.

[b] Quotes mean not sampled for particle size, so c3a data used for median particle size class.

No inset relations exist between channel units in DP-3. The heights of channel and floodplain deposits and terraces appear random and do not indicate a clear incision chronology that would have been recorded by older terraces occurring at the highest elevations relative to the active channel. This implies that the deposits composing the different channel units are of variable age.

2.3.4 Reach DP-4

2.3.4.1 Physical Characteristics

Like reach DP-3, reach DP-4 is in a part of DP Canyon where the canyon floor is generally very narrow and deeply incised into surrounding bedrock units. The area that has been impacted by post-1942 floods averages approximately 5.6 m wide. The areal distribution of the geomorphic units is shown on Figures 1.3-1 and 2.3-9, and topographic relations are illustrated in the channel cross sections (Figure 2.3-10). Physical characteristics of the geomorphic units in DP-4 are summarized in Table 2.3-4. Data on particle size and unit thickness are presented in Tables B-1.0-1, B-2.0-4, and Figure B-2.0-8 in Appendix B.

The active channel, c1, averages 3.7 m wide in reach DP-4 and has a boulder-strewn bed with discontinuous deposits of coarse sand and gravel. The active channel is discontinuously bounded by abandoned post-1942 channel units (c2a, c2b) that average approximately 0.8 m in width and 0.6–1.5 m in height above the channel. The c2a and c2b units usually are capped by an average of approximately 0.22–0.33 m of relatively fine-grained overbank sediments. Floodplain units comprise a significant portion of the post-1942 deposits in DP-4. The f1 unit has an average width of 1.3 m, has an average height of approximately 0.5 m, and is capped by an average of approximately 0.22 m of typically fine-grained sediment. Average heights of channel and floodplain units in DP-4 incorporate highly variable terrace heights measuring up to approximately 3.0 m above the active channel.

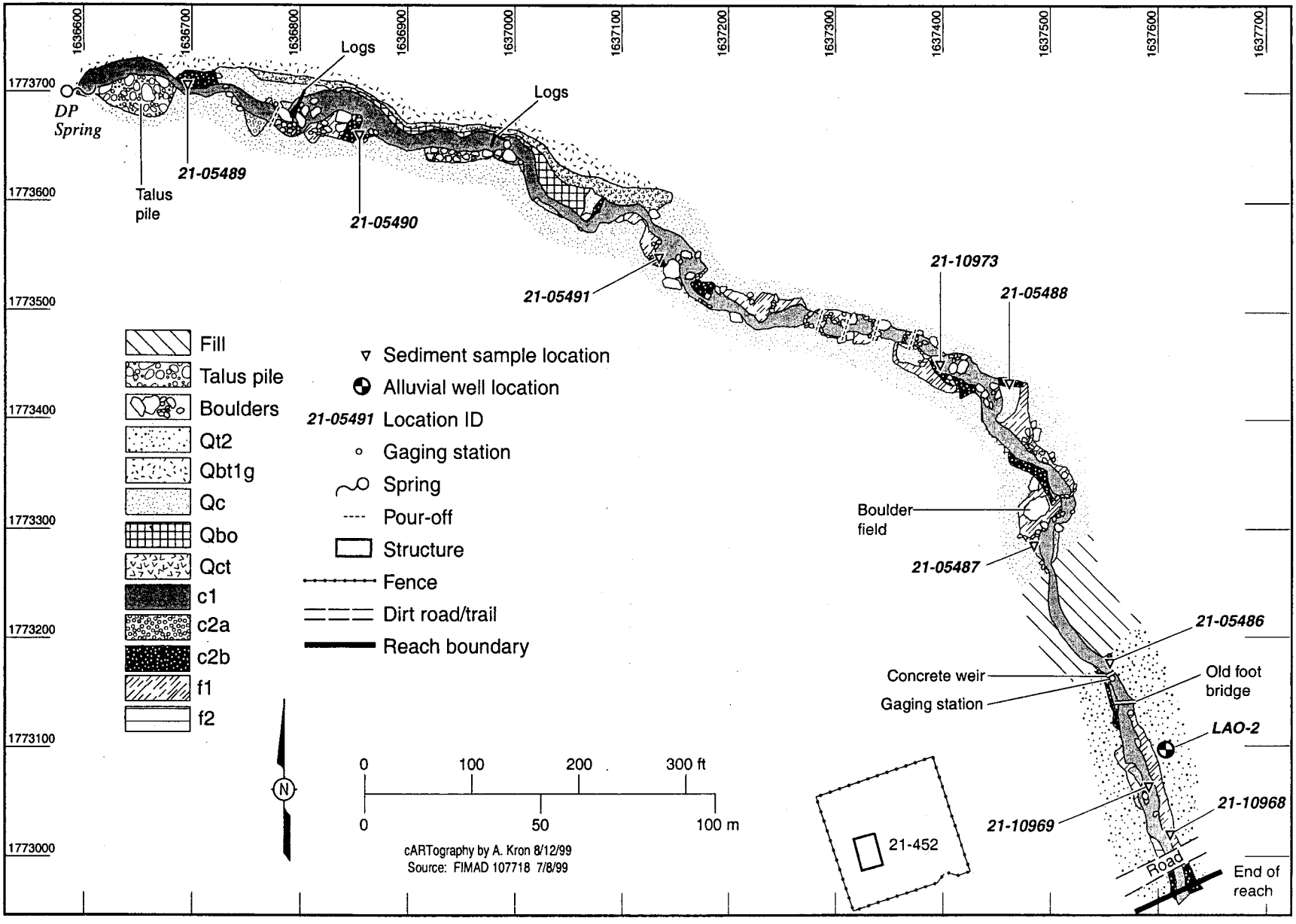
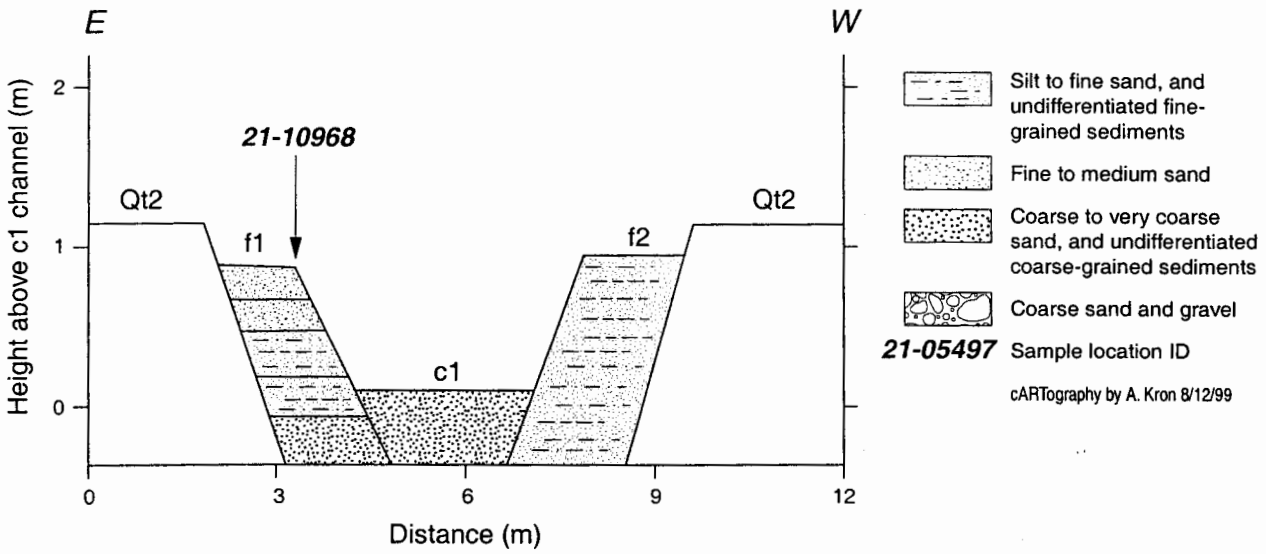


Figure 2.3-9. Reach DP-4 geomorphology and sediment sample locations



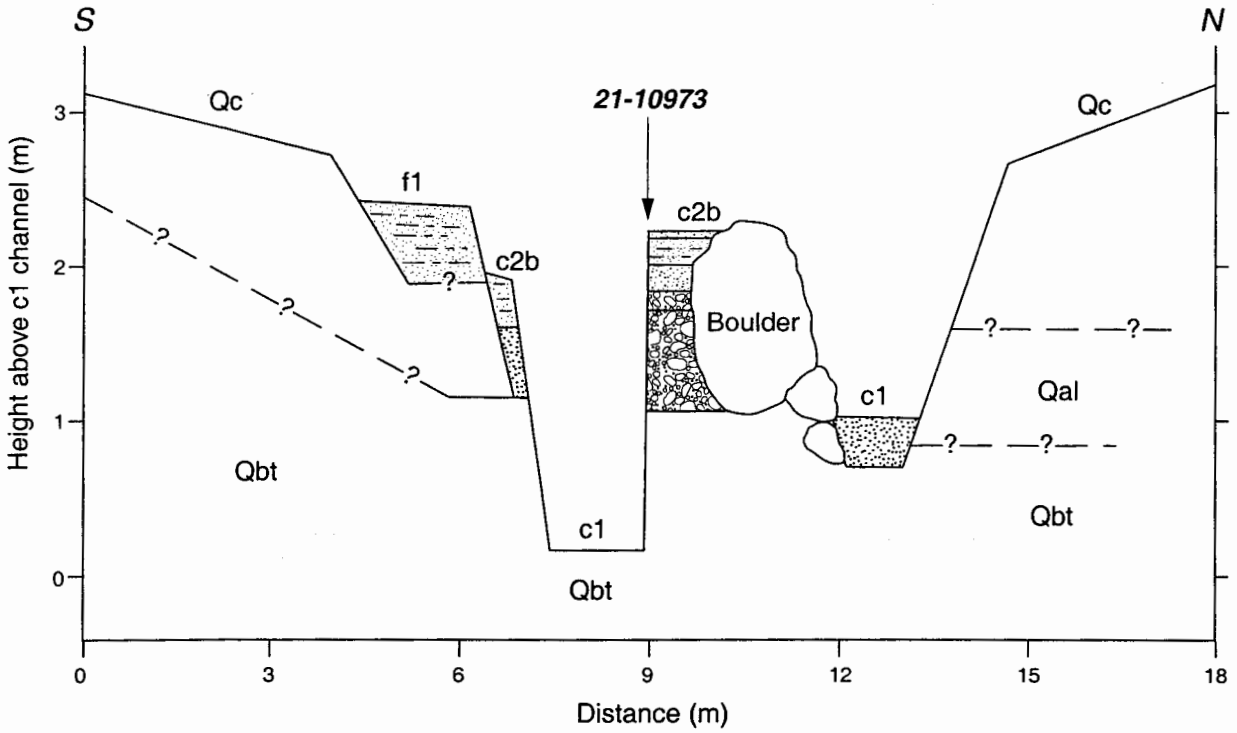


Figure 2.3-10. Reach DP-4 cross sections

Table 2.3-4
Geomorphic Mapping Units in Reach DP-4

Unit	Estimated Average Unit Height Above Channel (m)	Unit Area (m^2)	Average Unit Width[a] (m)	Sediment Facies	Estimated Average Thickness (m)	Typical Median Particle Size Class (<2 mm fraction)	Notes
c1	0	1697	3.7	Channel	0.5	vcs	Active channel
c2a	0.61	78	0.2	Fine	0.33	fs	Less contaminated abandoned post-1942 channel
				Coarse	0.5	"cs"[b]	
c2b	1.5	252	0.6	Fine	0.22	fs	More contaminated abandoned post-1942 channel
				Coarse	0.5	cs	
f1	0.5	586	1.3	Fine	0.22	fs	Active floodplain

[a] Unit area divided by subreach length.

[b] Quotes mean not sampled for particle size, so c2b coarse data used for median particle size class.

2.3.4.2 Radiological Characteristics

The fixed-point gamma radiation measurements in DP-4 were taken from vertical exposures in the stream banks (Figure B-3.0-5). These measurements were used to subdivide the post-1942 abandoned channel units, define vertical variations in gross gamma radiation, and select sample sites. Abandoned channel units with relatively low gross gamma radiation and low cesium-137 concentrations (based on analytical results) were assigned a c2a designation. Those with relatively high gross gamma radiation and higher cesium-137 concentrations were assigned a c2b designation. The results of the fixed-point measurements in DP-4 are presented in Table B-3.2-3. Gamma radiation depth profiles are presented in Figure B-3.2-6.

The fixed-point gamma radiation measurements in DP-4 show that in most units the highest radiation levels generally correspond to the finest-grained sediment within individual stratigraphic sections. The relations of variations in radionuclide concentration and sediment particle size are discussed further in Section 3.3.3.3.

2.3.4.3 Geomorphic History

Since 1942 the stream channel in DP-4, like DP-3, has experienced little or no lateral migration due to bedrock walls and large boulders that limit channel migration. Some vertical incision may have occurred in DP-4 due to intensification of storm-water runoff since development in the Los Alamos townsite, but the magnitude of incision is unknown. No consistent inset relations are observed between channel units and tree-ring age estimates have not been conducted. As in DP-3, high-intensity flooding has resulted in deposition of coarse-grained sediments outside the presently active channel and behind boulder and debris dams. The heights of channel and floodplain deposits and terraces appear random and do not indicate a clear incision chronology that would have been recorded by older terraces occurring at the highest elevations relative to the active channel. This implies that the deposits composing the different channel units are of variable age. Flood deposits are found locally in channels and swales located several meters away from the active channel and up to 3 m above the active channel. For example, flood deposits occur over a large area in the eastern third of the reach, and are locally separated from the

active channel by a high area composed of pre-1943 alluvium and colluvium. These deposits appear to record deposition of predominantly suspended-load sediments during a single flood or series of floods that surged out of the channel and over the ridge, and drained through an extensive brushy swale before reentering the main channel. Ratios of various radioisotope concentrations indicate a pre-1961 age for these sediments (Reneau 1999, 63138) and probably relate these flood deposits to the relatively high contaminant-concentration flood deposits found in the c3 unit of LA-2 East (discussed in Section 3.4.2.2).

3.0 ANALYTICAL RESULTS AND DATA REVIEW

3.1 Data Review

Sediment samples were collected in DP Canyon for site characterization. The canyon was divided into four reaches: DP-1, DP-2, DP-3, and DP-4. Geomorphic mapping and radiological screening were performed in reaches DP-2, DP-3, and DP-4. Sample sites were chosen based on geomorphic characteristics and radiological screening. The first group of samples was collected in August and October 1997. The second group of samples was collected in November 1998. New sites as well as sites from the previous sampling event were sampled in the second sampling round. Sample suites for these samples were based on radiological screening, geomorphic characteristics, and results from the first set of samples.

Sediment samples collected in DP Canyon included samples for full-suite, limited-suite, and key-contaminant analyses. The samples were collected following the technical approach presented in Chapter 5 of the Los Alamos/Pueblo Canyons work plan (LANL 1995, 50290). This data review considers the physical context for sample collection as well as the specific results obtained. Sediment samples were collected to represent specific geomorphic units and sediment facies; the variability within and among these geomorphic units and sediment facies is a key assessment variable. The number of samples varies among classes of analytes. The number of samples analyzed for organic chemicals, inorganic chemicals (target analyte list [TAL] metals), and radionuclides is presented in Table 3.1-1.

Table 3.1-1
Number of Samples Analyzed by Suite

Analytical Suite	Sediment Sample	Water Sample	Total
PCBs	21	9	30
Pesticides and PCBs	25	13	38
SVOCs	55	21	76
Total petroleum hydrocarbon-diesel range organics	41	11	52
VOCs	6	18	24
Inorganic chemicals	47	32	79
Soil physical parameters[a]	93	n/a[b]	93
Water quality parameters[c]	n/a	8	8
Gamma spectroscopy radionuclides	82	24	106
Tritium	26	12	38
Isotopic plutonium	64	24	88
Isotopic uranium	24	24	48
Strontium-90	70	24	94

[a] Soil physical parameters include particle size distribution analysis, organic matter content, and pH (32 samples were analyzed for pH).

[b] n/a = not applicable.

[c] Water quality parameters include bicarbonate, bromide, chloride, fluoride, iodide, sulfate, ammonia expressed as nitrogen (N), nitrate+nitrite as N, nitrate as N, nitrite as N, phosphorous, orthophosphate, total silica, and total organic carbon.

Water samples collected in DP Canyon included samples for full-suite analyses. The samples, from storm water, DP Canyon alluvial groundwater, and DP Spring, were collected to help revise the conceptual site model and provide contaminant concentration data for screening assessments. The number of samples analyzed for organic chemicals, inorganic chemicals (TAL metals), radionuclides, and water quality parameters is presented in Table 3.1-1.

The objective of this data review is to determine which analytes should be retained for further assessment and which analytes should be eliminated before human-health and ecological risk calculations. Analytes that are retained are considered chemicals of potential concern (COPCs). Because the assessment includes sediment and water samples, the COPC list will be developed separately for each medium. Considerations in these assessments include the magnitude of contaminant concentrations relative to background values (or detection limits for organic chemicals), the correlation between contaminant concentrations between and within reaches, and potential quality control (QC) problems with the laboratory analyses.

3.1.1 Inorganic Chemical Comparison with Background for Sediment Data

Inorganic chemicals on the TAL were analyzed in 47 sediment samples collected from DP Canyon. Inorganic chemical sample results were compared with the sediment background values that are presented in "Inorganic and Radionuclide Background Data for Soils, Canyon Sediments, and Bandelier Tuff at Los Alamos National Laboratory" (Ryti et al. 1998, 58093).

As detailed in Appendix C of this report, the QC problems associated with this sediment data set were caused by high or low recoveries in the matrix-spike samples. Matrix-spike samples are used to assess the quality of the sample digestion, extraction, and analysis procedures. A low recovery suggests either incomplete recovery of an analyte in these procedures or sample heterogeneity. A high recovery indicates either sample heterogeneity or matrix interference. One reason for inconsistencies in the recoveries is the heterogeneous nature of many of the sediment samples.

The matrix-spike recovery for antimony was low in request number (RN) 3619. Antimony was not detected in the nine sediment samples analyzed for this request number. The detection limit for these samples should be regarded as estimated and biased low (UJ-) based on the low antimony matrix-spike recovery. For RN 4961, 17 sediment samples were analyzed for TAL metals. The matrix-spike recovery for antimony was low, and the matrix-spike recovery for lead was high. Antimony was not detected in the 17 sediment samples analyzed for this request number. The detection limit for these samples should be regarded as estimated and biased low (UJ-), based on the low antimony matrix-spike recovery. Lead was detected in all 17 samples; lead results should be regarded as estimated and biased high (J+). For RN 4977, three sediment samples were analyzed for TAL metals; the three nondetected antimony results were qualified as estimated and biased low (UJ-) because the matrix-spike recovery for antimony was low. For RN 4983, three sediment samples were analyzed for TAL metals; in one sample, antimony was not detected. This result was qualified as estimated and biased low (UJ-) because the matrix-spike recovery for antimony was low. In the two samples in which antimony was detected, the results should be regarded as estimated and biased low (J-). For RN 4997, five sediment samples were analyzed for antimony. Antimony was not detected; the reporting limits for these samples should be regarded as estimated and biased low (UJ-). For RN 5004, two sediment samples were analyzed for antimony. Antimony was not detected; the reporting limits for these samples should be regarded as estimated and biased low (UJ-).

With the exception of four samples analyzed under RN 3468 by RECRA LabNet in 1997, the analytical methods for the inorganic chemicals are comparable to those used to generate Environmental

Restoration Project background data. These four samples were analyzed by a radial view inductively coupled plasma emission spectroscopy (ICPES). This method results in detection limits for some analytes above those typically found in background soils.

Of the 23 TAL metals, all except thallium were detected in at least one DP Canyon sediment sample. Tables 3.1-2, 3.1-3, 3.1-4, and 3.1-5 present the concentration range and frequency of results above the background value for the 22 detected inorganic chemicals and the 1 nondetected inorganic chemical (thallium) for the DP Canyon reaches.

Table 3.1-2
Frequency of Detected Inorganic Chemicals in Reach DP-1 Sediment Samples

Analyte	Number of Analyses	Number of Detects	Concentration Range (mg/kg)[a]	Maximum Detect (mg/kg)	Background Value (mg/kg)	Frequency of Detects above Background Value[b]
Aluminum	18	18	754 to 5460	5460	15400	0/18
Antimony	18	0	[0.56] to [1.2]	ND[c]	0.83	0/0, 4/18 DL[d]>BV[e]
Arsenic	18	18	0.66 to 3	3	3.98	0/18
Barium	18	18	21 to 135	135	127	1/18
Beryllium	18	18	0.11 to 0.66	0.66	1.31	0/18
Cadmium	18	16	[0.04] to 0.67	0.67	0.4	4/16, 0/2 DL>BV
Calcium	18	18	795 to 12000	12000	4420	5/18
Chromium, total	18	18	1.3 to 20.4	20.4	10.5	9/18
Cobalt	18	18	1 to 4.2	4.2	4.73	0/18
Copper	18	18	5.4 to 15	15	11.2	6/18
Iron	18	18	2910 to 8460	8460	13800	0/18
Lead	18	18	9.4 to 207	207	19.7	15/18
Magnesium	18	18	256 to 1420	1420	2370	0/18
Manganese	18	18	94.8 to 321	321	543	0/18
Mercury	18	14	[0.01] to 0.25	0.25	0.1	4/14, 0/4 DL>BV
Nickel	18	18	1.5 to 8.7	8.7	9.38	0/18
Potassium	18	18	198 to 1290	1290	2690	0/18
Selenium	18	4	[0.355] to 1.1	1.1	0.3	4/4, 14/14 DL>BV
Silver	18	2	[0.16] to 0.37	0.37	1	0/2, 0/16 DL>BV
Sodium	18	18	38.6 to 169	169	1470	0/18
Thallium	18	0	[0.355] to [0.81]	ND	0.73	0/0, 6/18 DL>BV
Vanadium	18	18	4.3 to 17.2	17.2	19.7	0/18
Zinc	18	18	29.6 to 166	166	60.2	11/18

[a] Values in square brackets indicate nondetected results.

[b] Value is the ratio of the number of detected values exceeding the background value to the number of analyses.

[c] ND = not detected.

[d] DL = detection limit.

[e] BV = background value.

Table 3.1-3
Frequency of Detected Inorganic Chemicals in Reach DP-2 Sediment Samples

Analyte	Number of Analyses	Number of Detects	Concentration Range (mg/kg)[a]	Maximum Detect (mg/kg)	Background Value (mg/kg)	Frequency of Detects above Background Value[b]
Aluminum	12	12	639 to 7660	7660	15400	0/12
Antimony	12	2	[0.524] to [7.9]	1.4	0.83	2/2, 6/10 DL[c]>BV[d]
Arsenic	12	12	1.1 to 3	3	3.98	0/12
Barium	12	12	14 to 112	112	127	0/12
Beryllium	12	12	0.21 to 0.64	0.64	1.31	0/12
Cadmium	12	3	[0.05] to [0.69]	0.25	0.4	0/3, 4/9 DL>BV
Calcium	12	12	419 to 5200	5200	4420	3/12
Chromium, total	12	12	1.8 to 9.8	9.8	10.5	0/12
Cobalt	12	12	2.1 to 4.71	4.71	4.73	0/12
Copper	12	12	1.3 to 14.4	14.4	11.2	3/12
Iron	12	12	3440 to 9880	9880	13800	0/12
Lead	12	12	6.8 to 76.5	76.5	19.7	9/12
Magnesium	12	12	221 to 1430	1430	2370	0/12
Manganese	12	12	161 to 738	738	543	1/12
Mercury	12	8	[0.01] to 0.09	0.09	0.1	0/8, 0/4 DL>BV
Nickel	12	12	2.5 to 7	7	9.38	0/12
Potassium	12	12	213 to 1480	1480	2690	0/12
Selenium	12	4	[0.315] to 1.3	1.3	0.3	4/4, 8/8 DL>BV
Silver	12	5	[0.105] to 0.95	0.95	1	0/5, 0/7 DL>BV
Sodium	12	12	49.5 to 266	266	1470	0/12
Thallium	12	0	[0.19] to [0.88]	ND[e]	0.73	0/0, 6/12 DL>BV
Vanadium	12	12	3.7 to 14.9	14.9	19.7	0/12
Zinc	12	12	21.3 to 71.7	71.7	60.2	6/12

[a] Values in square brackets indicate nondetected results.

[b] Value is the ratio of the number of detected values exceeding the background value to the number of analyses.

[c] DL = detection limit.

[d] BV = background value.

[e] ND = not detected.

Table 3.1-4
Frequency of Detected Inorganic Chemicals in Reach DP-3 Sediment Samples

Analyte	Number of Analyses	Number of Detects	Concentration Range (mg/kg)[a]	Maximum Detect (mg/kg)	Background Value (mg/kg)	Frequency of Detects above Background Value[b]
Aluminum	7	7	769 to 5040	5040	15400	0/7
Antimony	7	0	[0.52] to [1.1]	ND[c]	0.83	0/0, 1/7 DL[d]>BV[e]
Arsenic	7	6	[0.66] to 2.6	2.6	3.98	0/6, 0/1 DL>BV
Barium	7	7	15.7 to 86.5	86.5	127	0/7
Beryllium	7	7	0.19 to 0.63	0.63	1.31	0/7
Cadmium	7	3	[0.04] to 0.402	0.402	0.4	1/3, 0/4 DL>BV
Calcium	7	7	509 to 4130	4130	4420	0/7
Chromium, total	7	7	1.2 to 18.3	18.3	10.5	1/7
Cobalt	7	7	1.3 to 4.8	4.8	4.73	1/7
Copper	7	7	2.8 to 8	8	11.2	0/7
Iron	7	7	2880 to 8610	8610	13800	0/7
Lead	7	7	4.9 to 80.1	80.1	19.7	4/7
Magnesium	7	7	187 to 1150	1150	2370	0/7
Manganese	7	7	83.7 to 343	343	543	0/7
Mercury	7	2	[0.01] to 0.07	0.07	0.1	0/2, 0/5 DL>BV
Nickel	7	7	1.4 to 5.6	5.6	9.38	0/7
Potassium	7	7	212 to 1500	1500	2690	0/7
Selenium	7	1	[0.312] to 0.71	0.71	0.3	1/1, 6/6 DL>BV
Silver	7	2	[0.17] to 0.24	0.24	1	0/2, 0/5 DL>BV
Sodium	7	7	34.2 to 254	254	1470	0/7
Thallium	7	0	[0.312] to [0.78]	ND	0.73	0/0, 2/7 DL>BV
Vanadium	7	7	4 to 15.5	15.5	19.7	0/7
Zinc	7	7	9.5 to 53	53	60.2	0/7

[a] Values in square brackets indicate nondetected results.

[b] Value is the ratio of the number of detected values exceeding the background value to the number of analyses.

[c] ND = not detected.

[d] DL = detection limit.

[e] BV = background value.

Table 3.1-5
Frequency of Detected Inorganic Chemicals in Reach DP-4 Sediment Samples

Analyte	Number of Analyses	Number of Detects	Concentration Range (mg/kg)[a]	Maximum Detect (mg/kg)	Background Value (mg/kg)	Frequency of Detects above Background Value[b]
Aluminum	10	10	586 to 5460	5460	15400	0/10
Antimony	10	0	[0.55] to [0.81]	ND[c]	0.83	0/0, 0/10 DL[d]>BV[e]
Arsenic	10	9	[0.61] to 2.5	2.5	3.98	0/9, 0/1 DL>BV
Barium	10	10	10.5 to 126	126	127	0/10
Beryllium	10	10	0.2 to 0.73	0.73	1.31	0/10
Cadmium	10	0	[0.04] to [0.1]	ND	0.4	0/0, 0/10 DL>BV
Calcium	10	10	282 to 3350	3350	4420	0/10
Chromium, total	10	10	0.88 to 5.9	5.9	10.5	0/10
Cobalt	10	10	0.94 to 3	3	4.73	0/10
Copper	10	10	3.8 to 36.1	36.1	11.2	5/10
Iron	10	10	1970 to 7600	7600	13800	0/10
Lead	10	10	5.9 to 57.7	57.7	19.7	8/10
Magnesium	10	10	137 to 990	990	2370	0/10
Manganese	10	10	93.2 to 277	277	543	0/10
Mercury	10	4	[0.01] to 0.05	0.05	0.1	0/4, 0/6 DL>BV
Nickel	10	10	0.91 to 5.1	5.1	9.38	0/10
Potassium	10	10	166 to 1030	1030	2690	0/10
Selenium	10	0	[0.53] to [0.64]	ND	0.3	0/0, 10/10 DL>BV
Silver	10	0	[0.16] to [0.29]	ND	1	0/0, 0/10 DL>BV
Sodium	10	10	20.2 to 87.5	87.5	1470	0/10
Thallium	10	0	[0.48] to [0.63]	ND	0.73	0/0, 0/10 DL>BV
Vanadium	10	10	2.2 to 11.5	11.5	19.7	0/10
Zinc	10	10	17.3 to 53.4	53.4	60.2	0/10

[a] Values in square brackets indicate nondetected results.

[b] Value is the ratio of the number of detected values exceeding the background value to the number of analyses.

[c] ND = not detected.

[d] DL = detection limit.

[e] BV = background value.

For the 1997 DP sediment data, all TAL metals were reported below background values for the Laboratory's canyon sediments except antimony, cadmium, selenium, and zinc. Antimony detection limits were reported above the background value in the four sediments that RECRA LabNet analyzed under RN 3468. These four antimony samples had reporting limits of approximately 8 mg/kg compared with the background value of 0.83 mg/kg. The background value for cadmium is 0.4 mg/kg. Again for the four samples analyzed by radial view ICPES under RN 3468, the reporting limit exceeded the cadmium background value, but the reporting limits were all below 0.7 mg/kg. The 0.3 mg/kg background value for selenium was exceeded across the sediment data (both 1997 and 1998 samples), but no selenium reporting limits exceeded 0.64 mg/kg.

For the 1998 DP sediment data, all TAL metals except selenium and thallium had reporting limits less than Laboratory sediment background values. Reporting limits for selenium in the 1998 sediment data ranged from 0.53–0.74 mg/kg, compared with the background value of 0.3 mg/kg. Some thallium reporting limits exceeded the background value of 0.73 mg/kg, but no thallium reporting limits exceeded 0.88 mg/kg.

Ten inorganic chemicals (aluminum, arsenic, beryllium, iron, magnesium, nickel, potassium, silver, sodium, and vanadium) were measured above the detection limit and below the background value. Thus, these 10 inorganic chemicals will not be retained for further assessment in this report. Additional discussion and graphical data presentations for these chemicals can be found in Appendix E of this report.

Statistical and graphical data evaluation approaches led to the elimination of three inorganic chemicals because they did not differ from background. These inorganic chemicals, which have at least one result greater than background value, included barium, manganese, and thallium and will not be retained for further assessment in this report. Additional discussion and graphical data presentations for these chemicals can be found in Appendix E.

Ten other inorganic chemicals were shown to be elevated above background values by a statistical and graphical background comparison and are retained as sediment COPCs. Statistical analyses and graphs that support this evaluation are provided in Appendix E. These inorganic chemicals retained as sediment COPCs include antimony, cadmium, calcium, total chromium, cobalt, copper, lead, mercury, selenium, and zinc. It is worth noting that lead had QC indicators of positive bias, which could suggest that this chemical could have been erroneously identified as a sediment COPC. However, all sample results are used as reported without any adjustment for possible analytical bias; therefore, lead will be retained for further assessment.

In summary, the inorganic chemical data review yielded 10 analytes to be carried forward as sediment COPCs (see Table 3.1-6). A complete presentation of the data for the detected inorganic chemicals, which includes inorganic chemicals identified as sediment COPCs, is provided in Appendix D of this report. These analytes are inferred to potentially record releases from one or more sites in the DP Canyon watershed. The concentrations of the chemicals eliminated as sediment COPCs were well within the background concentration range, with the exceptions noted above, and those chemicals are justifiably eliminated from further assessment.

3.1.2 Radionuclide Comparison with Background/Fallout Radionuclide Concentrations for Sediment Data

Eighty-five sediment samples from DP Canyon were analyzed for radionuclides; the analytical suites for these samples are presented in Table 3.1-1. The analytical methods used for these analyses are presented in Appendix D. These analyses were compared with the sediment background values that are presented in "Inorganic and Radionuclide Background Data for Soils, Canyon Sediments, and Bandelier Tuff at Los Alamos National Laboratory" (Ryti et al. 1998, 58093). The analytical methods used for the DP Canyon radionuclide analyses are comparable to those used for the Laboratory background data.

The detected radionuclides include isotopes associated with worldwide fallout: tritium; strontium-90; cesium-137; plutonium-238; plutonium-239,240; and americium-241. Because the sediment sampling in DP Canyon focused on post-1942 sediments that were therefore impacted by atmospheric fallout, fallout values are assumed to apply to the entire depth profile of sediments sampled in DP Canyon.

Table 3.1-6
Results of Inorganic Chemical Data Review

Analyte	Result	Rationale
Aluminum	Eliminated	Eliminated as a sediment COPC because no values exceeded the background value.
Antimony	Retained	Retained as sediment COPC because of detected sample results in reach DP-2 and detection limits in reach DP-1 above the background value.
Arsenic	Eliminated	Eliminated as a sediment COPC because no values exceeded the background value.
Barium	Eliminated	Eliminated as a sediment COPC by statistical and graphical methods as presented in Appendix E.
Beryllium	Eliminated	Eliminated as a sediment COPC because no values exceeded the background value.
Cadmium	Retained	Retained as a sediment COPC because of detected values above the background value in reach DP-1 and detection limits above the background value in reach DP-2.
Calcium	Retained	Retained as a sediment COPC of detected values above the background value in reaches DP-1 and DP-2.
Chromium, total	Retained	Retained as a sediment COPC because of detected values above the background value in reaches DP-1 and DP-3.
Cobalt	Retained	Retained as a sediment COPC by statistical and graphical methods as presented in Appendix E.
Copper	Retained	Retained as a sediment COPC because of detected values above the background value in reaches DP-1, DP-2, and DP-4.
Iron	Eliminated	Eliminated as a sediment COPC because no values exceeded the background value
Lead	Retained	Retained as a sediment COPC because of detected values above the background value in reaches DP-1, DP-2, DP-3, and DP-4.
Magnesium	Eliminated	Eliminated as a sediment COPC because no values exceeded the background value.
Manganese	Eliminated	Eliminated as a sediment COPC based on the information discussed in Appendix E
Mercury	Retained	Retained as a sediment COPC because of detected values above the background value in reach DP-1.
Nickel	Eliminated	Eliminated as a sediment COPC because no values exceeded the background value.
Potassium	Eliminated	Eliminated as a sediment COPC because no values exceeded the background value
Selenium	Retained	Retained as a sediment COPC because of detected values above the background value in reaches DP-1 and DP-2 and detection limits above the background value in reaches DP-1, DP-2, DP-3, and DP-4.
Silver	Eliminated	Eliminated as a sediment COPC because no values exceeded the background value.
Sodium	Eliminated	Eliminated as a sediment COPC because no values exceeded the background value.
Thallium	Eliminated	Eliminated as a sediment COPC based on the information discussed in Appendix E.
Vanadium	Eliminated	Eliminated as a sediment COPC because no values exceeded the background value.
Zinc	Retained	Retained as a sediment COPC because of detected values above the background value in reaches DP-1 and DP-2.

As described in Appendix C, detection status was determined by quantitation limits agreed upon in contracts with the analytical laboratories, minimum detectable activities determined by the analytical laboratories, or the 1-sigma total propagated uncertainty (TPU). Detection status was used as the preliminary data evaluation step for isotopic uranium by alpha spectroscopy, isotopic plutonium by alpha spectroscopy, tritium by liquid scintillation, and strontium-90 by beta scintillation.

Gamma spectroscopy measured concentrations of 42 radionuclides with varying certainty and applicability to Laboratory releases. The summary of detection frequency and concentration ranges for all gamma spectroscopy radionuclides is provided in Appendix D. According to Laboratory ER Project guidance, the eight gamma spectroscopy radionuclides that should be retained and evaluated in data review are americium-241, cesium-134, cesium-137, cobalt-60, europium-152, ruthenium-106, sodium-22, and uranium-235. This list represents radionuclides that are potential historical contaminants, have half-lives greater than 1 yr, and are reliably measured by gamma spectroscopy. Among these eight gamma spectroscopy radionuclides, only americium-241 and cesium-137 were detected in DP Canyon sediment samples and will be carried forward to the background comparison.

As discussed in Appendix C, except for the three gamma spectroscopy results rejected (R) because of spectral interference, no other QC problems were associated the sediment data for this report. The americium-241 result for sample CA21-98-0053 (RN 4964) and the uranium-235 results for CA-98-0069 (RN 4964) and CA21-98-0112 (RN 5001) were qualified as rejected because of spectral interference. These rejected sample results are excluded from data summaries and statistical analyses.

Nine radionuclides were detected in the sediment samples. Tables 3.1-7, 3.1-8, 3.1-9, and 3.1-10 present the concentration range and frequency of results above the background value for these radionuclides in DP Canyon reaches DP-1, DP-2, DP-3, and DP-4, respectively. A complete presentation of the data for these radionuclides and other detected gamma spectroscopy radionuclides is located in Appendix D.

Table 3.1-7
Frequency of Detected Radionuclides in Reach DP-1 Sediment Samples

Analyte	Number of Analyses	Number of Detects	Concentration Range (pCi/g)[a]	Maximum Detect (pCi/g)	Background Value/Fallout Value (pCi/g)	Frequency of Detects above Background Value/Fallout Value[b]
Americium-241	5[c]	0	[-0.18] to [0.4]	ND[d]	DL[e]	0/0
Cesium-137	6	4	[0.101] to 0.62	0.62	0.9	0/4
Plutonium-238	6	0	[-0.0109] to [0.0049]	ND	0.006	0/0
Plutonium-239	6	6	0.039 to 0.075	0.075	0.068	2/6
Strontium-90	6	0	[-0.15] to [0.27]	0.27	1.04	0/0
Tritium	6	3	[0.05] to 0.13	0.13	0.093	1/3
Uranium-234	6	6	0.575 to 1.84	1.84	2.59	0/6
Uranium-235	6	6	0.021 to 0.105	0.105	0.2	0/6
Uranium-238	6	6	0.63 to 2.04	2.04	2.29	0/6

[a] Values in square brackets indicate nondetected results.

[b] Value is the ratio of the number of detected values exceeding the background value/fallout value to the number of analyses.

[c] One sample result for americium-241 was rejected and is not included in this table.

[d] ND = not detected.

[e] DL = detection limit.

Table 3.1-8
Frequency of Detected Radionuclides in Reach DP-2 Sediment Samples

Analyte	Number of Analyses	Number of Detects	Concentration Range (pCi/g)[a]	Maximum Detect (pCi/g)	Background Value/Fallout Value (pCi/g)	Frequency of Detects above Background Value/Fallout Value[b]
Americium-241	36	26	[-0.19] to 29.8	29.8	DL[c]	26/26
Cesium-137	36	36	0.219 to 442	442	0.9	33/36
Plutonium-238	24	19	[0.0127] to 1.286	1.286	0.006	19/19
Plutonium-239	24	20	0.0272 to 11.11	11.11	0.068	19/20
Strontium-90	35	28	[0.11] to 32.8	32.8	1.04	26/28
Tritium	7	5	0.04 to 3	3	0.093	5/5
Uranium-234	8	8	0.505 to 1.46	1.46	2.59	0/8
Uranium-235	8	7	0.021 to 0.103	0.103	0.2	0/7
Uranium-238	8	8	0.394 to 0.989	0.989	2.29	0/8

[a] Values in square brackets indicate nondetected results.

[b] Value is the ratio of the number of detected values exceeding the background value/fallout value to the number of analyses.

[c] DL = detection limit.

Table 3.1-9
Frequency of Detected Radionuclides in Reach DP-3 Sediment Samples

Analyte	Number of Analyses	Number of Detects	Concentration Range (pCi/g)[a]	Maximum Detect (pCi/g)	Background Value/Fallout Value (pCi/g)	Frequency of Detects above Background Value/Fallout Value[b]
Americium-241	21	14	[-0.35] to 71	71	DL[c]	14/14
Cesium-137	21	19	[0.021] to 192	192	0.9	19/19
Plutonium-238	13	9	[0.0071] to 2.79	2.79	0.006	9/9
Plutonium-239	13	13	0.084 to 11.2	11.2	0.068	13/13
Strontium-90	10	9	[0.39] to 17.1	17.1	1.04	9/9
Tritium	4	2	[0.05] to 0.13	0.13	0.093	2/2
Uranium-234	1	1	1.71 to 1.71	1.71	2.59	0/1
Uranium-235	1	1	0.067 to 0.067	0.067	0.2	0/1
Uranium-238	1	1	0.441 to 0.441	0.441	2.29	0/1

[a] Values in square brackets indicate nondetected results.

[b] Value is the ratio of the number of detected values exceeding the background value/fallout value to the number of analyses.

[c] DL = detection limit.

Table 3.1-10
Frequency of Detected Radionuclides in Reach DP-4 Sediment Samples

Analyte	Number of Analyses	Number of Detects	Concentration Range (pCi/g)[a]	Maximum Detect (pCi/g)	Background Value/Fallout Value (pCi/g)	Frequency of Detects above Background Value/Fallout Value[b]
Americium-241	19	13	[0.06] to 32.7	32.7	DL[c]	13/13
Cesium-137	19	19	1.11 to 149	149	0.9	19/19
Plutonium-238	21	19	[0.0139] to 1.34	1.34	0.006	19/19
Plutonium-239	21	21	0.054 to 48.3	48.3	0.068	20/21
Strontium-90	19	19	0.09 to 31.1	31.1	1.04	15/19
Tritium	9	6	[0.01] to 0.09	0.09	0.093	0/6
Uranium-234	9	9	0.576 to 1.72	1.72	2.59	0/9
Uranium-235	9	8	[0.0094] to 0.092	0.092	0.2	0/8
Uranium-238	9	9	0.544 to 1.243	1.243	2.29	0/9

[a] Values in square brackets indicate nondetected results.

[b] Value is the ratio of the number of detected values exceeding the background value/fallout value to the number of analyses.

[c] DL = detection limit.

During implementation of the DP Canyon sampling and analysis plan (SAP), investigators decided to analyze for americium-241 by gamma spectroscopy. Detection limits for americium-241 by gamma spectroscopy are greater than by alpha spectroscopy (1 pCi/g versus 0.1 pCi/g). This decision to use gamma spectroscopy means that the DP Canyon americium-241 data are not comparable to the Laboratory background data that are based on alpha spectroscopy. Thus, the detection limit was used as a nominal background value for americium-241; however, this does not affect the usability of the americium-241 data, as most sample results for americium-241 are detects (53 of 82 americium-241 results are detects). Detects were noted in all reaches except reach DP-1, where the maximum detection limit is 0.4 pCi/g (Table 3.1-7). Nondetect values in reach DP-1 will be used in the site assessments. Six of the other eight radionuclides were retained as sediment COPCs because these analytes were determined to be greater than background by using the graphical and statistical approaches provided in Appendix E. These radionuclides included cesium-137, plutonium-238, plutonium-239,240, uranium-234, strontium-90, and tritium. Two radionuclides (uranium-235 and uranium-238) were eliminated because no values exceeded the background values.

In summary, the radionuclide data review yielded seven analytes to be carried forward as sediment COPCs (see Table 3.1-11) based on comparison of sample results with background values and on the statistical and graphical data evaluations presented in Appendix E.

3.1.3 Evaluation of Organic Chemicals Detected in Sediment

Sediment samples from DP Canyon were analyzed for semivolatile organic compounds (SVOCs), by the US Environmental Protection Agency (EPA) SW-846 Method 8270, volatile organic compounds (VOCs) by EPA Method 8260, total petroleum hydrocarbons-diesel range organics (TPH-DROs) by EPA Method 8015M, organochlorine pesticides by EPA Method 8081 and polychlorinated biphenyls (PCBs) by EPA Method 8082. A total of 55 sediment samples were analyzed for SVOCs; 6 for VOCs; 41 for TPH-DROs; 25 for pesticides/PCB; and 21 for PCBs only. Thirty-three organic compounds were detected in these samples.

Table 3.1-11
Results of Radionuclide Data Review

Analyte	Result	Rationale
Americium-241	Retained	Retained as a sediment COPC because this radionuclide was detected in reaches DP-2, DP-3, and DP-4. In addition, the detection limits of results in reach DP-1 are greater than the background value.
Cesium-137	Retained	Retained as a sediment COPC because detected sample results were greater than the background value in reaches DP-2, DP-3, and DP-4.
Plutonium-238	Retained	Retained as a sediment COPC because detected sample results were greater than the background value in reaches DP-2, DP-3, and DP-4.
Plutonium-239,240	Retained	Retained as a sediment COPC because detected sample results were greater than the background value in reaches DP-1, DP-2, DP-3, and DP-4.
Uranium-234	Retained	Retained as a sediment COPC because the isotopic ratio of uranium-234 to uranium-238 for the reach DP-3 sample suggested the presence enriched uranium.
Uranium-235	Eliminated	Eliminated as a sediment COPC because no values exceeded the background value.
Uranium-238	Eliminated	Eliminated as a sediment COPC because no values exceeded the background value.
Strontium-90	Retained	Retained as a sediment COPC because detected sample results were greater than the background value in reaches DP-2, DP-3, and DP-4.
Tritium	Retained	Retained as a sediment COPC because detected sample results were greater than the background value in reaches DP-1, DP-2, and DP-3.

The data quality evaluation of the DP sediment data is presented in Appendix C. Some organic data were qualified because of internal standards and surrogate recoveries outside of acceptance criteria. Other organic analytes identified in Appendix C were qualified as nondetected (U) because these analytes were detected in the method blank. Some SVOC and pesticide/PCB samples also were diluted because of matrix interference; therefore, the detection limits for these samples were elevated. Table C-5.0-3 in Appendix C summarizes the sample-specific qualifiers for these data. None of the data qualifications affect the usability or defensibility of the data.

As noted in Appendix C, many of the reported detected organic compounds were detected at concentrations less than the estimated quantitation limit (EQL). These results should be regarded as estimated (J) because of the greater quantitative uncertainty associated with results below the EQL. The greater sensitivity of the analytical method (lower detection limit) for some samples reflects differences in potential interferences from the matrix or absence of other organic chemicals. All organic chemicals that were detected in at least one sample are retained for further assessment, regardless of whether such reported detections are less than the EQL.

Tables 3.1-12, 3-1.13, 3.1-14, and 3.1-15 present the concentration range and frequency of detects for these analytes. A complete presentation of the data for these detected organic chemicals is in Appendix D.

In summary, 33 organic chemicals were retained as sediment COPCs because they were positively detected in at least one sample, as presented in Table 3.1-16.

Table 3.1-12
Frequency of Detected Organic Chemicals in Reach DP-1 Sediment Samples

Analyte	Number of Analyses	Number of Detects	Concentration Range (mg/kg)[a]	Maximum Detect (mg/kg)	EQL (mg/kg)	Frequency of Detects[b]
Acenaphthene	20	1	[0.088] to [4.2]	0.24	0.33	1/20
Anthracene	20	4	0.069 to [4.2]	0.62	0.33	4/20
Aroclor-1260	11	5	0.022 to 1	1	0.033	5/11
Benz(a)anthracene	20	14	0.039 to [3.9]	3	0.33	14/20
Benzo(a)pyrene	20	9	0.26 to [3.9]	3.2	0.33	9/20
Benzo(b)fluoranthene	20	12	0.25 to [3.9]	3.8	0.33	12/20
Benzo(g,h,i)perylene	20	2	0.27 to 5	5	0.33	2/20
Benzo(k)fluoranthene	20	6	0.083 to [4.1]	1.4	0.33	6/20
Bis(2-ethylhexyl)phthalate	20	15	0.049 to [4.2]	1.7	0.33	15/20
Butylbenzylphthalate	20	4	0.28 to [4.2]	0.5	0.33	4/20
Carbazole	20	3	0.045 to [4.2]	0.5	0.33	3/20
α-Chlordane	5	4	0.00894 to 0.25	0.25	0.0017	4/5
γ-Chlordane	4	3	0.011 to 0.18	0.18	0.0017	3/4
Chrysene	20	14	0.041 to [3.9]	3.3	0.33	14/20
4,4'-DDT	5	2	0.0207 to 0.12	0.12	0.0033	2/5
Dibenz(a,h)anthracene	20	1	[0.35] to [4.2]	0.98	0.33	1/20
Fluoranthene	20	12	0.036 to 4.4	4.4	0.33	12/20
Fluorene	20	1	0.047 to [4.2]	0.047	0.33	1/20
Heptachlor Epoxide	4	1	[0.02] to 0.11	0.11	0.0017	1/4
Indeno(1,2,3-cd)pyrene	20	5	0.21 to [4.2]	3.8	0.33	5/20
2-Methylnaphthalene	20	2	0.031 to [4.2]	0.046	0.33	2/20
Naphthalene	20	3	0.11 to [4.2]	0.62	0.33	3/20
Organics, diesel range	19	19	57 to 680	680	4	19/19
Phenanthrene	20	17	0.03 to [3.6]	3.2	0.33	17/20
Pyrene	20	19	0.051 to 12	12	0.33	19/20

[a] Values in square brackets indicate nondetected results.

[b] Value is the ratio of the number of detected values to the number of analyses.

Table 3.1-13
Frequency of Detected Organic Chemicals in Reach DP-2 Sediment Samples

Analyte	Number of Analyses	Number of Detects	Concentration Range (mg/kg)[a]	Maximum Detect (mg/kg)	EQL (mg/kg)	Frequency of Detects[b]
Acetone	4	1	0.006 to [0.024]	0.006	0.02	1/4
Anthracene	10	2	0.048 to [2]	0.11	0.33	2/10
Aroclor-1260	10	4	[0.042] to [0.19]	0.175	0.033	4/10
Benz(a)anthracene	10	9	0.13 to [0.84]	0.77	0.33	9/10
Benzo(a)pyrene	10	8	0.15 to [2]	0.72	0.33	8/10
Benzo(b)fluoranthene	10	8	0.14 to 1	1	0.33	8/10
Benzo(g,h,i)perylene	10	5	0.15 to [2]	0.7	0.33	5/10
Benzo(k)fluoranthene	10	7	0.084 to [2]	0.4	0.33	7/10
Bis(2-ethylhexyl)phthalate	10	7	0.075 to [2]	0.92	0.33	7/10
Carbazole	10	1	0.13 to [2]	0.13	0.33	1/10
α-Chlordane	10	6	[0.0021] to 0.031	0.031	0.0017	6/10
γ-Chlordane	10	6	[0.0021] to 0.0338	0.0338	0.0017	6/10
Chrysene	10	9	0.16 to [0.84]	0.83	0.33	9/10
4,4'-DDT	10	7	0.0037 to 0.119	0.119	0.0033	7/10
Di-n-octylphthalate	10	1	0.16 to [2]	0.16	0.33	1/10
Fluoranthene	10	8	[0.22] to 1.4	1.4	0.33	8/10
Fluorene	10	1	0.066 to [2]	0.066	0.33	1/10
Indeno(1,2,3-cd)pyrene	10	4	0.18 to [2]	0.62	0.33	4/10
Naphthalene	10	1	0.071 to [2]	0.071	0.33	1/10
Organics, diesel range	7	7	47 to 260	260	4	7/7
Phenanthrene	10	8	[0.24] to [0.84]	0.79	0.33	8/10
Pyrene	10	9	0.34 to 2.5	2.5	0.33	9/10
Toluene	4	1	0.002 to [0.008]	0.002	0.005	1/4

[a] Values in square brackets indicate nondetected results.

[b] Value is the ratio of the number of detected values to the number of analyses.

Table 3.1-14
Frequency of Detected Organic Chemicals in Reach DP-3 Sediment Samples

Analyte	Number of Analyses	Number of Detects	Concentration Range (mg/kg)[a]	Maximum Detect (mg/kg)	EQL (mg/kg)	Frequency of Detects[b]
Aroclor-1260	7	2	[0.037] to [0.16]	0.091	0.033	2/7
Benz(a)anthracene	7	3	0.026 to [4.1]	0.66	0.33	3/7
Benzo(a)pyrene	7	2	[0.35] to [4.1]	0.72	0.33	2/7
Benzo(b)fluoranthene	7	4	0.037 to 1.3	1.3	0.33	4/7
Benzoic acid	7	1	0.38 to [20]	0.38	3.3	1/7
Bis(2-ethylhexyl)phthalate	7	3	0.16 to [4.1]	0.95	0.33	3/7
Butylbenzylphthalate	7	1	0.062 to [4.1]	0.062	0.33	1/7
α-Chlordane	7	2	[0.0018] to 0.011	0.011	0.0017	2/7
γ-Chlordane	7	2	[0.0018] to 0.00898	0.00898	0.0017	2/7
Chrysene	7	3	0.033 to [4.1]	0.66	0.33	3/7
4,4'-DDT	7	4	[0.0037] to 0.056	0.056	0.0033	4/7
Di-n-butylphthalate	7	1	[0.35] to [4.1]	2.1	0.33	1/7
Fluoranthene	7	5	0.046 to 1.5	1.5	0.33	5/7
Indeno(1,2,3-cd)pyrene	7	1	0.24 to [4.1]	0.24	0.33	1/7
Organics, diesel range	6	6	34 to 87	87	4	6/6
Phenanthrene	7	3	0.027 to [4.1]	0.8	0.33	3/7
Pyrene	7	5	0.097 to 1.6	1.6	0.33	5/7
2,4,6-Trichlorophenol	7	1	[0.35] to 9.3	9.3	0.33	1/7

[a] Values in square brackets indicate nondetected results.

[b] Value is the ratio of the number of detected values to the number of analyses.

Table 3.1-15
Frequency of Detected Organic Chemicals in Reach DP-4 Sediment Samples

Analyte	Number of Analyses	Number of Detects	Concentration Range (mg/kg)[a]	Maximum Detect (mg/kg)	EQL (mg/kg)	Frequency of Detects[b]
Anthracene	18	1	0.066 to [4]	0.066	0.33	1/18
Aroclor-1260	18	2	[0.034] to [0.15]	0.041	0.033	2/18
Benz(a)anthracene	18	3	0.031 to [4]	0.29	0.33	3/18
Benzo(a)pyrene	18	3	0.03 to [4]	0.35	0.33	3/18
Benzo(b)fluoranthene	18	4	0.035 to [4]	0.62	0.33	4/18
Benzo(g,h,i)perylene	18	2	0.16 to [4]	0.33	0.33	2/18
Benzo(k)fluoranthene	9	1	0.059 to [1.8]	0.059	0.33	1/9
Bis(2-ethylhexyl)phthalate	18	3	0.034 to [4]	0.073	0.33	3/18
Butylbenzylphthalate	18	1	0.17 to [4]	0.17	0.33	1/18
α-Chlordane	9	7	[0.0017] to 0.024	0.024	0.0017	7/9
γ-Chlordane	9	7	[0.0017] to 0.017	0.017	0.0017	7/9
Chrysene	18	3	0.03 to [4]	0.37	0.33	3/18
4,4'-DDE	9	3	0.0022 to [0.015]	0.0042	0.0033	3/9
4,4'-DDT	9	8	[0.0034] to 0.045	0.045	0.0033	8/9
Dimethyl phthalate	18	1	0.076 to [4]	0.076	0.33	1/18
Fluoranthene	18	4	0.034 to [4]	0.51	0.33	4/18
Indeno(1,2,3-cd)pyrene	18	2	0.13 to [4]	0.28	0.33	2/18
Organics, diesel range	9	9	31 to 82	82	4	9/9
Phenanthrene	18	3	0.091 to [4]	0.34	0.33	3/18
Pyrene	18	5	0.06 to [4]	1.1	0.33	5/18

[a] Values in square brackets indicate nondetected results.

[b] Value is the ratio of the number of detected values to the number of analyses.

Table 3.1-16
Results of Organic Chemical Data Review

Analyte	Result	Rationale
Organics, diesel range	Retained	Detected in all reaches.
Aroclor-1260	Retained	Detected in all reaches.
α-Chlordane	Retained	Detected in all reaches.
γ-Chlordane	Retained	Detected in all reaches.
4,4'-DDE	Retained	Detected in reach DP-4.
4,4'-DDT	Retained	Detected in all reaches.
Heptachlor Epoxide	Retained	Detected in reach DP-1.
Acenaphthene	Retained	Detected in reach DP-1.
Anthracene	Retained	Detected in reaches DP-1, DP-2, and DP-4.
Benz(a)anthracene	Retained	Detected in all reaches.
Benzo(a)pyrene	Retained	Detected in all reaches.
Benzo(b)fluoranthene	Retained	Detected in all reaches.
Benzo(g,h,i)perylene	Retained	Detected in reaches DP-1, DP-2, and DP-4.
Benzo(k)fluoranthene	Retained	Detected in reaches DP-1, DP-2, and DP-4.
Benzoic acid	Retained	Detected in reach DP-3.
Bis(2-ethylhexyl) phthalate	Retained	Detected in all reaches.
Butylbenzylphthalate	Retained	Detected in reaches DP-1, DP-3, and DP-4.
Carbazole	Retained	Detected in reaches DP-1 and DP-2.
Chrysene	Retained	Detected in all reaches.
Dibenz(a,h)anthracene	Retained	Detected in reach DP-1.
Dimethyl phthalate	Retained	Detected in reach DP-4.
Di-n-butylphthalate	Retained	Detected in reach DP-3.
Di-n-octylphthalate	Retained	Detected in reach DP-2.
Fluoranthene	Retained	Detected in all reaches.
Fluorene	Retained	Detected in reaches DP-1 and DP-2.
Indeno(1,2,3-cd)pyrene	Retained	Detected in all reaches.
2-Methylnaphthalene	Retained	Detected in reach DP-1.
Naphthalene	Retained	Detected in reaches DP-1 and DP-2.
Phenanthrene	Retained	Detected in all reaches.
Pyrene	Retained	Detected in all reaches.
2,4,6-Trichlorophenol	Retained	Detected in reach DP-3.
Acetone	Retained	Detected in reach DP-2 and not analyzed in reach DP-4.
Toluene	Retained	Detected in reach DP-2 and not analyzed in reach DP-4.

3.1.4 Evaluation of Sediment Physical Parameter Data

Particle size distribution analysis and organic matter content were measured for 93 DP Canyon sediment samples. The results of these analyses are presented in Appendix B of this report, and the quality of these data is discussed in Appendix C. In summary, the quality of these data is good, as shown by the similarity

of the laboratory duplicate sample results. Sediment pH was measured on 32 of these samples; the pH range was between 6.3 and 7.7, which suggests that these sediments have neutral acid-base chemistry.

3.1.5 Evaluation of Inorganic Chemicals Detected in Water

TAL metals were analyzed in 32 water samples collected from DP Canyon. Eight samples were also analyzed for boron, lithium, molybdenum, strontium, and uranium. Inorganic chemical sample results were compared with sample results for alluvial well LAO-B, which is the only alluvial background well for the Laboratory. The data for LAO-B include samples collected between June 1994 and May 1995 but do not include the recently collected data (1997 and 1998) to characterize Laboratory background groundwater concentrations of inorganic chemicals and radionuclides. Formal statistical tests were not used for background comparisons; instead, a weight-of-evidence approach was used to retain or eliminate inorganic chemicals as water COPCs. Details on this evaluation process are provided in Appendix E. Sample results for storm water collected in DP Canyon are reported for comparison with alluvial groundwater concentrations. Analytes detected only in storm water are not retained as water COPCs, because the ephemeral nature of storm water makes it irrelevant to chronic human and ecological exposures. Storm water data will be discussed in terms of the nature and sources of contamination (Section 3.2). Preparation of the DP Canyon water samples included field-filtering through a 0.4-micron filter. Data review considers both filtered and unfiltered sample results; filtered and unfiltered results are presented in separate tables. Information on the difference or similarity of the filtered and unfiltered sample results increases understanding of the potential mechanisms of contaminant transport.

As detailed in Appendix C, the QC problems associated with this water data set were caused by high or low recoveries in the matrix-spike samples and detection of inorganic chemicals in the method blank. Matrix-spike samples were used to assess the quality of the sample digestion, extraction, and analysis procedures. A low recovery suggests that there was either incomplete recovery of an analyte in these procedures or sample heterogeneity. A high recovery indicates matrix interference. Blank contamination is a QC indicator of possible positive bias in sample results. Thus, reported concentrations for samples with blank contamination could overestimate the actual environmental concentrations. Inorganic chemicals that were detected at less than 5 times the concentration of the result in the method preparation blank were qualified as nondetected (U), as summarized in Table C-5.0-2 in Appendix C.

Matrix-spike recoveries for aluminum and lead were low in RN 3609. In RN 3616, the aluminum matrix-spike recovery was high. The selenium matrix-spike recovery was low in RN 4253. The samples that were qualified as a result of these matrix-spike recoveries are summarized in Table C-5.0-2 in Appendix C.

Magnesium was qualified as nondetected (U) in RN 3977 and zinc as nondetected (U) in RNs 4253 and 4256 because these results were less than 5 times the concentration for these analytes in the preparation blank.

3.1.5.1 Sampling of Alluvial Groundwater and DP Spring

Two alluvial wells in DP Canyon, (LAUZ-1 and LAUZ-2) and DP Spring were sampled quarterly for four quarters. The first-quarter samples were collected on August 20, 1997, at LAUZ-1 and LAUZ-2 and on August 21, 1997, at DP Spring. A filtered and unfiltered sample was collected at each well and at the spring. Two additional samples were collected at DP Spring on October 15, 1997, to confirm the VOC found in the August 21 samples.

The second-quarter samples were collected on December 4, 1997, at LAUZ-1 and LAUZ-2. A filtered and unfiltered sample was collected at each well. No samples were collected at DP Spring this quarter

because the spring was frozen. Two duplicate samples were collected at LAUZ-1 for both filtered and unfiltered samples.

The third-quarter samples were collected on May 5, 1998, at LAUZ-1 and LAUZ-2 and on May 6, 1998, at DP Spring. A filtered and unfiltered sample was collected at each well and at the spring.

The fourth-quarter samples were collected on September 17, 1998, at LAUZ-1 and LAUZ-2, and on September 16, 1998, at DP Spring. A filtered and an unfiltered sample were collected at each well and at the spring. These samples were analyzed for boron, lithium, molybdenum, strontium, and uranium in addition to the other analyses. Three additional samples were collected at each well and the spring on October 7, 1998, and October 23, 1998, for analysis of SVOCs and pesticides/PCBs because holding times were missed on the first set of samples.

Field water-quality parameters were collected for all samples. These field parameters include pH, conductivity, turbidity, dissolved oxygen, and temperature. The field parameter results are presented in Section 3.1-7.

Tables 3.1-17 through 3.1-20 present the concentration range and frequency of detected results for inorganic chemicals detected at LAUZ-1, LAUZ-2, and DP Spring for the unfiltered and filtered samples.

Table 3.1-17
Frequency of Detected Inorganic Chemicals in Unfiltered Alluvial Water Samples

Analyte	Number of Analyses	Number of Detects	Concentration Range (μg/L)[a]	Maximum Detect (μg/L)	EQL (μg/L)	Frequency of Detects[b]
Aluminum	9	7	[100] to 1600	1600	200	7/9
Arsenic	9	2	[2.4] to 8	8	10	2/9
Barium	9	9	90 to 200	200	200	9/9
Boron	2	2	59 to 64.6	64.6	100	2/2
Calcium	9	9	42000 to 95000	95000	5000	9/9
Cobalt	9	1	[0.5] to [20]	0.81	50	1/9
Iron	9	9	103 to 6700	6700	100	9/9
Lead	9	5	1 to 6	6	3	5/9
Lithium	2	2	8.5 to 9	9	10	2/2
Magnesium	9	9	2670 to 6500	6500	5000	9/9
Manganese	9	6	30 to 870	870	15	6/9
Nickel	9	2	2.3 to [40]	2.9	40	2/9
Potassium	9	9	9000 to 17000	17000	5000	9/9
Sodium	9	9	38300 to 100000	100000	5000	9/9
Strontium	2	2	171 to 251	251	10	2/2
Thallium	9	2	[5] to 6.8	6.8	10	2/9
Vanadium	9	2	0.6 to [10]	2.5	50	2/9
Zinc	9	5	1.7 to 130	130	20	5/9

[a] Values in square brackets indicate nondetected results.

[b] Value is the ratio of the number of detected values to the number of analyses.

Table 3.1-18
Frequency of Detected Inorganic Chemicals in Filtered Alluvial Water Samples

Analyte	Number of Analyses	Number of Detects	Concentration Range (µg/L)[a]	Maximum Detect (µg/L)	EQL (µg/L)	Frequency of Detects[b]
Aluminum	9	3	27.1 to 300	300	200	3/9
Arsenic	9	1	[2.4] to [4]	3.3	10	1/9
Barium	9	9	90 to 210	210	200	9/9
Boron	2	2	53.6 to 67	67	100	2/2
Calcium	9	9	36700 to 110000	110000	5000	9/9
Cobalt	9	1	[0.5] to [20]	0.8	50	1/9
Copper	9	2	0.9 to [20]	2.5	25	2/9
Iron	9	7	[40] to 1050	1050	100	7/9
Lead	9	2	1 to 5	5	3	2/9
Lithium	2	2	9 to 10	10	10	2/2
Magnesium	9	9	2500 to 6900	6900	5000	9/9
Manganese	9	5	[10] to [830]	760	15	5/9
Molybdenum	2	1	[2.6] to 5.4	5.4	10	1/2
Nickel	9	2	2.2 to [40]	2.8	40	2/9
Potassium	9	9	9000 to 17700	17700	5000	9/9
Sodium	9	8	37800 to 110000	110000	5000	8/9
Strontium	2	2	169 to 249	249	10	2/2
Thallium	9	2	3 to [5]	3.5	10	2/9
Vanadium	9	2	0.53 to [10]	2.3	50	2/9
Zinc	9	6	1.7 to 20	20	20	6/9

[a] Values in square brackets indicate nondetected results.

[b] Value is the ratio of the number of detected values to the number of analyses.

Table 3.1-19
Frequency of Detected Inorganic Chemicals in Unfiltered Samples from DP Spring

Analyte	Number of Analyses	Number of Detects	Concentration Range (µg/L)[a]	Maximum Detect (µg/L)	EQL (µg/L)	Frequency of Detects[b]
Aluminum	3	3	100 to 2600	2600	200	3/3
Barium	3	3	49 to 80	80	200	3/3
Boron	1	1	41.1 to 41.1	41.1	100	1/1
Calcium	3	3	15000 to 30000	30000	5000	3/3
Copper	3	1	2.5 to [20]	2.5	25	1/3
Iron	3	3	180 to 1300	1300	100	3/3
Lead	3	1	[1] to 4	4	3	1/3
Lithium	1	1	13.5 to 13.5	13.5	10	1/1
Magnesium	3	3	1600 to 3200	3200	5000	3/3
Manganese	3	1	[10] to 17.6	17.6	15	1/3
Molybdenum	1	1	3.4 to 3.4	3.4	10	1/1
Nickel	3	1	2.7 to [40]	2.7	40	1/3
Potassium	3	3	9000 to 15000	15000	5000	3/3
Sodium	3	3	32000 to 54000	54000	5000	3/3
Strontium	1	1	114 to 114	114	10	1/1
Thallium	3	1	4.7 to [5]	4.7	10	1/3
Vanadium	3	1	4.1 to [10]	4.1	50	1/3
Zinc	3	2	5.1 to 50	50	20	2/3

[a] Values in square brackets indicate nondetected results.

[b] Value is the ratio of the number of detected values to the number of analyses.

Table 3.1-20
Frequency of Detected Inorganic Chemicals in Filtered Samples from DP Spring

Analyte	Number of Analyses	Number of Detects	Concentration Range (µg/L)[a]	Maximum Detect (µg/L)	EQL (µg/L)	Frequency of Detects[b]
Aluminum	3	2	[100] to 2100	2100	200	2/3
Barium	3	3	40 to 80	80	200	3/3
Boron	1	1	46.6 to 46.6	46.6	100	1/1
Calcium	3	3	15000 to 30000	30000	5000	3/3
Copper	3	1	2.1 to [20]	2.1	25	1/3
Iron	3	2	[40] to 940	940	100	2/3
Lead	3	1	[1] to 3	3	3	1/3
Lithium	1	1	12.1 to 12.1	12.1	10	1/1
Magnesium	3	3	1600 to 3100	3100	5000	3/3
Manganese	3	1	0.97 to [10]	0.97	15	1/3
Molybdenum	1	1	3.2 to 3.2	3.2	10	1/1
Nickel	3	1	1.4 to [40]	1.4	40	1/3
Potassium	3	3	9000 to 14000	14000	5000	3/3
Sodium	3	3	33000 to 50000	50000	5000	3/3
Strontium	1	1	112 to 112	112	10	1/1
Vanadium	3	1	3.6 to [10]	3.6	50	1/3
Zinc	3	2	2 to 70	70	20	2/3

[a] Values in square brackets indicate nondetected results.

[b] Value is the ratio of the number of detected values to the number of analyses.

3.1.5.2 Sampling of Surface Water during Storm Events

Storm water stations were sampled in DP Canyon on two separate storm events. Results from storm water sample analyses will increase the understanding of contaminant transport, but these storm water data were not used to identify water COPCs for the site assessments. Two storm water stations owned by the Laboratory's Water Quality and Hydrology Group (ESH-18) were used to sample the events. Station 1 is located near the culvert behind the Knights of Columbus Hall on DP Road. Station 2 is located east of the DP Road commercial area, downstream of Station 1. These locations were selected to represent surface water as it entered the canyon, and surface water quality before entering the alluvial deposit in reach DP-2. ESH-18 collected the samples from the storm water stations and then transferred them to the ER Project to be filtered and transferred to sample bottles. The first storm event was sampled on August 22, 1997. Field notes suggest that both filtered and unfiltered samples were collected; however, based on field information obtained from the Facility for Information Management, Analysis, and Display (FIMAD) data tables and also based on the concentrations reported for analytes like aluminum and iron, both samples actually were not filtered. The second storm event was sampled on October 26, 1998. A filtered and an unfiltered sample were collected from each station. Samples for the evaluation of field water quality parameters were not collected for these events.

Tables 3.1-21 and 3.1-22 present the concentration range and frequency of results for inorganic chemicals detected in unfiltered and filtered samples from storm water Stations 1 and 2.

Table 3.1-21
Frequency of Detected Inorganic Chemicals in Unfiltered Storm Water Samples

Analyte	Number of Analyses	Number of Detects	Concentration Range (µg/L)[a]	Maximum Detect (µg/L)	EQL (µg/L)	Frequency of Detects[b]
Aluminum	6	6	2340 to 8100	8100	200	6/6
Antimony	6	1	[2.7] to 5.3	5.3	60	1/6
Arsenic	6	3	[2.6] to 5.7	5.7	10	3/6
Barium	6	6	64.8 to 185	185	200	6/6
Beryllium	6	3	[0.3] to 0.89	0.89	5	3/6
Cadmium	6	1	[0.2] to [0.4]	0.34	5	1/6
Calcium	6	6	21200 to 33300	33300	5000	6/6
Chromium, total	6	6	5.8 to 15.3	15.3	10	6/6
Cobalt	6	6	2 to 4.8	4.8	50	6/6
Copper	6	6	22.1 to 49.5	49.5	25	6/6
Iron	6	6	2060 to 7760	7760	100	6/6
Lead	6	6	17.7 to 64.2	64.2	3	6/6
Magnesium	6	6	1760 to 2800	2800	5000	6/6
Manganese	6	6	102 to 450	450	15	6/6
Mercury	6	2	0.03 to 0.06	0.06	0.2	2/6
Nickel	6	6	5.5 to 11.2	11.2	40	6/6
Potassium	6	6	3030 to 4290	4290	5000	6/6
Selenium	6	1	[2.6] to 3	3	5	1/6
Sodium	6	6	4900 to 7340	7340	5000	6/6
Thallium	6	5	2.7 to 5.1	5.1	10	5/6
Vanadium	6	6	7.1 to 15.6	15.6	50	6/6
Zinc	6	6	245 to 358	358	20	6/6

[a] Values in square brackets indicate nondetected results.

[b] Value is the ratio of the number of detected values to the number of analyses.

Table 3.1-22
Frequency of Detected Inorganic Chemicals in Filtered Storm Water Samples

Analyte	Number of Analyses	Number of Detects	Concentration Range (µg/L)[a]	Maximum Detect (µg/L)	EQL (µg/L)	Frequency of Detects[b]
Aluminum	2	2	71.1 to 74.2	74.2	200	2/2
Arsenic	2	1	[3] to 6.3	6.3	10	1/2
Barium	2	2	10.4 to 23.1	23.1	200	2/2
Boron	2	2	33.1 to 39.3	39.3	100	2/2
Calcium	2	2	4970 to 13800	13800	5000	2/2
Chromium, total	2	2	0.63 to 1.2	1.2	10	2/2
Copper	2	2	2.6 to 4.8	4.8	25	2/2
Iron	2	2	92 to 105	105	100	2/2
Lithium	2	1	[1] to 3.9	3.9	10	1/2
Magnesium	2	2	328 to 671	671	5000	2/2
Manganese	2	2	1.7 to 15.8	15.8	15	2/2
Nickel	2	2	1.2 to 1.8	1.8	40	2/2
Potassium	2	2	1130 to 1880	1880	5000	2/2
Sodium	2	2	1230 to 3520	3520	5000	2/2
Strontium	2	2	17 to 41.4	41.4	10	2/2
Thallium	2	1	[3.1] to 6.9	6.9	10	1/2
Vanadium	2	2	1.6 to 1.7	1.7	50	2/2
Zinc	2	2	31.1 to 32.1	32.1	20	2/2

[a] Values in square brackets indicate nondetected results.

[b] Value is the ratio of the number of detected values to the number of analyses.

Six inorganic chemicals (antimony, beryllium, cadmium, total chromium, mercury, and selenium) were detected in storm water samples but were not detected in alluvial groundwater or DP Spring samples. Thus, these six inorganic chemicals will not be retained as water COPCs. Additional discussion and graphical data presentations for these chemicals can be found in Appendix E. Ten other inorganic chemicals were detected in alluvial groundwater and DP Spring water at concentrations similar to those observed at LAO-B. These inorganic chemicals, including aluminum, cobalt, copper, lead, molybdenum, nickel, strontium, thallium, vanadium, and zinc, will not be retained for further assessment. Additional discussion and graphical data presentations for these 18 chemicals eliminated from further assessment can be found in Appendix E.

Nine organic chemicals were measured at concentrations greater than those observed at well LAO-B, and are thus retained for further assessment. These chemicals include barium, boron, calcium, iron, lithium, magnesium, manganese, potassium, and sodium. Additional discussion and graphical data presentations for these nine chemicals eliminated from further assessment can be found in Appendix E.

In summary, the inorganic chemical data review yielded nine analytes to be carried forward as water COPCs (see Table 3.1-23). A complete presentation of the data for the inorganic chemicals identified as water COPCs and other detected inorganic chemicals is provided in Appendix D. These analytes are

inferred to potentially record releases from one or more sites in the DP Canyon watershed. The concentrations of the chemicals eliminated as water COPCs were similar to the preliminary alluvial background concentration (well LAO-B), and these chemicals were therefore excluded from further assessment.

Table 3.1-23
Results of Inorganic Chemical Data Review

Analyte	Result	Rationale
Aluminum	Eliminated	Concentrations in alluvial water and DP Spring are similar to LAO-B (alluvial background water well); see discussion in Appendix E.
Antimony	Eliminated	Not detected in alluvial water and DP Spring samples.
Arsenic	Eliminated	Based on concentration range of detected and nondetected sample results; see discussion in Appendix E.
Barium	Retained	Concentrations in alluvial water and DP Spring are greater than LAO-B.
Beryllium	Eliminated	Not detected in alluvial water and DP Spring samples.
Boron	Retained	Concentrations in alluvial water and DP Spring are greater than LAO-B.
Cadmium	Eliminated	Not detected in alluvial water and DP Spring samples.
Calcium	Retained	Concentrations in alluvial water and DP Spring are greater than LAO-B.
Chromium, total	Eliminated	Not detected in alluvial water and DP Spring samples.
Cobalt	Eliminated	Based on concentration range of detected and nondetected sample results; see discussion in Appendix E.
Copper	Eliminated	Detected concentrations in alluvial water and DP Spring are less than LAO-B; see discussion in Appendix E.
Iron	Retained	Concentrations in alluvial water are greater than LAO-B.
Lead	Eliminated	Detected concentrations in alluvial water and DP Spring are less than LAO-B; see discussion in Appendix E.
Lithium	Retained	Concentrations in alluvial water and DP Spring are greater than LAO-B.
Magnesium	Retained	Concentrations in alluvial water and DP Spring are greater than LAO-B.
Manganese	Retained	Concentrations in alluvial water are greater than LAO-B.
Mercury	Eliminated	Not detected in alluvial water and DP Spring samples.
Molybdenum	Eliminated	Concentration range of detected and non-detected sample results are less than LAO-B.
Nickel	Eliminated	Based on concentration range of detected and nondetected sample results; see discussion in Appendix E.
Potassium	Retained	Concentrations in alluvial water are greater than LAO-B.
Selenium	Eliminated	Not detected in alluvial water and DP Spring samples.
Sodium	Retained	Concentrations in alluvial water and DP Spring are greater than LAO-B.
Strontium	Eliminated	Concentration range of detected and nondetected sample results are less than LAO-B.
Thallium	Eliminated	Based on concentration range of detected and nondetected sample results; see discussion in Appendix E.
Vanadium	Eliminated	Concentration range of detected sample results are less than LAO-B.
Zinc	Eliminated	Most detected sample results are less than LAO-B.

3.1.6 Evaluation of Radionuclides Detected in Water

Twenty-four water samples were analyzed for radionuclides in DP Canyon; the analytical suites for these samples are presented in Table 3.1-1. Radionuclide analyses were requested only for the alluvial groundwater and DP Spring samples. The analytical methods used for these analyses are presented in Appendix D. No radionuclide data for the 1994 and 1995 samples were collected from alluvial well LAO-B, thus no informal background comparisons can be made. The only background information considered relevant to the review of the radionuclide data is the concentration ratio expected between uranium-234 and uranium-238, which is discussed in more detail below. Thus, the main effort in radionuclide data review is to evaluate the detection status of the radionuclides.

As described in Appendix C, detection status was determined by quantitation limits agreed upon in contracts with the analytical laboratories, minimum detectable activities determined by the analytical laboratories, or the 1-sigma TPU. Detection status was used as the preliminary data evaluation step for isotopic uranium by alpha spectroscopy, isotopic plutonium by alpha spectroscopy, tritium by liquid scintillation, and strontium-90 by beta scintillation. As discussed in Section 3.1.2, the gamma spectroscopy analytes evaluated in this report are americium-241, cesium-134, cesium-137, cobalt-60, europium-152, ruthenium-106, sodium-22, and uranium-235. None of these gamma spectroscopy analytes were detected in water samples. Other gamma spectroscopy analytes detected in water are referred to Appendix D.

As discussed in Appendix C, the only QC problem for the DP radionuclide water data set is the laboratory control sample recovery for strontium-90 in RN 3978. The six strontium-90 results in RN 3978 should be regarded as estimated and biased low (J-) because the recovery for stontium-90 in the laboratory control sample was low. Because no QC problems were associated with nondetected radionuclide, data quality problems did not interfere with the ability to detect radionuclides. The only problem relating to detection limits was the somewhat elevated range of minimal detectable activities reported for tritium. These tritium detection limits were not low enough to measure tritium to meteoric concentration values reported by other studies (e.g., Goff and Werner [LANL 1996, 63895]), but were sensitive enough to yield one detected tritium sample result.

Six radionuclides were detected in the alluvial groundwater water samples. Tables 3.1-24 and 3.1-25 present the concentration range and frequency of detected results for unfiltered and filtered alluvial groundwater samples (LAUZ-1 and LAUZ-2). Tables 3.1-26 and 3.1-27 present the concentration range and frequency of detects for DP Spring water samples. Note that tritium analysis was performed only on the unfiltered samples. A complete presentation of the data for these detected radionuclides is provided in Appendix D.

Five radionuclides (plutonium-239,240, strontium-90, tritium, uranium-234, and uranium-235) were detected in alluvial groundwater or DP Spring. These radionuclides have been documented as historical constituents in potential release site (PRS) 21-011(k) effluent. Thus, these five radionuclides were retained for further evaluation. Uranium-238 was detected, but was not retained as a water COPC, based on the preliminary review of radionuclide background concentrations, and the expected concentrations of uranium-238, based on secular equilibrium. More information on these radionuclides is presented in the statistical plots and text in Appendix E.

In summary, the radionuclide data review yielded five analytes to be retained as water COPCs (see Table 3.1-28) based on the detection status, knowledge of historical releases from the PRS 21-011(k) outfall, and the statistical graphics presented in Appendix E.

Table 3.1-24
Frequency of Detected Radionuclides in Unfiltered Alluvial Water

Analyte	Number of Analyses	Number of Detects	Concentration Range (pCi/L)[a]	Maximum Detect (pCi/L)	EQL (pCi/L)	Frequency of Detects[b]
Plutonium-239, 240	9	3	[-0.018] to 0.25	0.25	0.1	3/9
Strontium-90	9	9	68.51 to 195.72	195.72	1	9/9
Tritium	9	1	[3.38] to 280	280	250	1/9
Uranium-234	9	9	0.49 to 1.32	1.32	0.1	9/9
Uranium-235	9	1	[0] to [0.18]	0.057	0.1	1/9
Uranium-238	9	5	[0.058] to 0.239	0.239	0.1	5/9

[a] Values in square brackets indicate nondetected results.

[b] Value is the ratio of the number of detected values to the number of analyses.

Table 3.1-25
Frequency of Detected Radionuclides in Filtered Alluvial Water

Analyte	Number of Analyses	Number of Detects	Concentration Range (pCi/L)[a]	Maximum Detect (pCi/L)	EQL (pCi/L)	Frequency of Detects[b]
Strontium-90	9	9	77.99 to 207.83	207.83	1	9/9
Uranium-234	9	9	0.403 to 1.73	1.73	0.1	9/9
Uranium-238	9	4	[0.039] to 0.42	0.42	0.1	4/9

[a] Values in square brackets indicate nondetected results.

[b] Value is the ratio of the number of detected values to the number of analyses.

Table 3.1-26
Frequency of Detected Radionuclides in Unfiltered Samples from DP Spring

Analyte	Number of Analyses	Number of Detects	Concentration Range (pCi/L)[a]	Maximum Detect (pCi/L)	EQL (pCi/L)	Frequency of Detects[b]
Plutonium-239, 240	3	1	[0.007] to 0.071	0.071	0.1	1/3
Strontium-90	3	3	40.7 to 111	111	1	3/3
Uranium-234	3	3	0.415 to 0.561	0.561	0.1	3/3
Uranium-238	3	2	[0.047] to 0.098	0.098	0.1	2/3

[a] Values in square brackets indicate nondetected results.

[b] Value is the ratio of the number of detected values to the number of analyses.

Table 3.1-27
Frequency of Detected Radionuclides in Filtered Samples from DP Spring

Analyte	Number of Analyses	Number of Detects	Concentration Range (pCi/L)[a]	Maximum Detect (pCi/L)	EQL (pCi/L)	Frequency of Detects[b]
Strontium-90	3	3	38.9 to 119	119	1	3/3
Uranium-234	3	3	0.373 to 0.636	0.636	0.1	3/3
Uranium-238	3	2	[0.04] to 0.094	0.094	0.1	2/3

[a] Values in square brackets indicate nondetected results.

[b] Value is the ratio of the number of detected values to the number of analyses.

Table 3.1-28
Results of Radionuclide Data Review for Water Samples

Analyte	Result	Rationale
Plutonium-239,240	Retained	Known presence in PRS 21-011(k) releases; observed spatial concentration trend from alluvial groundwater to DP Spring
Strontium-90	Retained	Known presence in PRS 21-011(k) releases; observed spatial concentration trend from alluvial groundwater to DP Spring
Tritium	Retained	Known presence in PRS 21-011(k) releases; detection in alluvial groundwater
Uranium-234	Retained	Known presence in PRS 21-011(k) releases; observed spatial concentration trend from alluvial groundwater to DP Spring
Uranium-235	Retained	Known presence in PRS 21-011(k) releases; concentrations of uranium-235 are consistent with enriched uranium
Uranium-238	Eliminated	Uranium is known to have released, but concentrations of uranium-238 are consistent with preliminary radionuclide background data

3.1.7 Evaluation of Organic Chemicals Detected in Water

Water samples from DP Canyon were analyzed for SVOCs by EPA SW-846 Method 8270, VOCs by EPA Method 8260, TPH-DROs by EPA Method 8015M, organochlorine pesticides by EPA Method 8081, and PCBs by EPA Method 8082. A total of 21 samples were analyzed for SVOCs, 18 for VOCs, 11 for TPH-DROs, 13 for pesticides/PCBs, and 22 for PCBs only. Water samples submitted for organic chemical analysis were from the storm water sampling stations, alluvial groundwater, and DP Spring. A total of 12 organic compounds were detected in these water samples. No background concentrations were expected for organic chemicals in water; thus background data were not used to identify water COPCs. The objective of organic chemical data review is to identify all detected organic chemicals in alluvial groundwater and DP Spring. As discussed for the inorganic chemicals, the storm water sample data will be compared with alluvial groundwater concentrations. Thus, organic chemicals detected in storm water only were eliminated as COPCs.

The data quality evaluation of the DP Canyon water data is presented in Appendix C. Organic data were qualified because of internal standards and surrogate recoveries outside of acceptance criteria. Other organic analytes were qualified as nondetected (U) because these analytes were detected in the method blank. Table C-5.0-3 in Appendix C summarizes the sample-specific qualifiers for these data. None of the data qualifications affect the usability or defensibility of the data.

Tables 3.1-29 and 3.1-30 present the concentration range and frequency of detects for organic analytes in the DP Canyon alluvial groundwater and DP Spring. A complete presentation of the data for these detected organic chemicals is in Appendix D. Statistical plots and text discussing these organic analytes are in Appendix E.

Table 3.1-29
Frequency of Detected Organic Compounds in Filtered Alluvial Water

Analyte	Number of Analyses	Number of Detects	Concentration Range (µg/L)	Maximum Detect (µg/L)	EQL (µg/L)	Frequency of Detects*
Bis(2-ethylhexyl)phthalate	2	2	22 to 36	36	10	2/2

* Value is the ratio of the number of detected values to the number of analyses.

Table 3.1-30
Frequency of Detected Organic Compounds in Unfiltered Samples from DP Spring

Analyte	Number of Analyses	Number of Detects	Concentration Range (µg/L)[a]	Maximum Detect (µg/L)	EQL (µg/L)	Frequency of Detects[b]
1,2-Dichloroethane	4	1	[5] to 7.6	7.6	5	1/4

[a] Values in square brackets indicate nondetected results.

[b] Value is the ratio of the number of detected values to the number of analyses.

Tables 3.1-31 and 3.1-32 present the concentration range and frequency of detects for organic analytes in the DP Canyon storm water. A complete presentation of the data for these detected organic chemicals is in Appendix D. Statistical plots and text discussing these analytes are in Appendix E.

In summary, two organic chemicals, bis(2-ethylhexyl)phthalate and 1,2-dichloroethane, were retained as water COPCs because they were positively detected in one sample from alluvial groundwater or DP Spring, as shown in Table 3.1-33.

3.1.8 Evaluation of Water Quality Parameters

Water quality parameters provide information on the general physical properties of DP Canyon waters. The parameters include field physical measurements (e.g., temperature and pH), and analytical laboratory chemical measurements. The analytical laboratory water quality measurements include major anions and cations (bromide, chloride, fluoride, iodide, sulfate, ammonia expressed as nitrogen [N], nitrate and nitrite as N, nitrate as N, phosphorous, and orthophosphate as phosphorous), total silica, and total organic carbon.

Water quality information was collected to support geochemical assessments of the data; thus, these data are not relevant to the site assessments (Chapter 5). However, because some water quality parameters have New Mexico Water Quality Control Commission (WQCC) standards, the WQCC standards for these parameters are discussed.

Table 3.1-31
Frequency of Detected Organic Compounds in Unfiltered Storm Water

Analyte	Number of Analyses	Number of Detects	Concentration Range (µg/L)[a]	Maximum Detect (µg/L)	EQL (µg/L)	Frequency of Detects[b]
Acetone	4	1	[20] to 38	38	20	1/4
Benzo(b)fluoranthene	6	3	1.1 to [22]	1.6	10	3/6
Bis(2-ethylhexyl)phthalate	6	5	4 to [10]	9	10	5/6
2-Butanone	4	2	[5.8] to [20]	8.3	20	2/4
Chrysene	6	1	1.1 to [22]	1.1	10	1/6
Di-n-butylphthalate	6	1	4.1 to [14]	4.1	10	1/6
Di-n-octylphthalate	6	3	1 to [22]	1.5	10	3/6
Fluoranthene	6	2	1.2 to [22]	1.7	10	2/6
Phenanthrene	6	1	1 to [22]	1	10	1/6
Pyrene	6	3	1.1 to [22]	1.7	10	3/6

[a] Values in square brackets indicate nondetected results.

[b] Value is the ratio of the number of detected values to the number of analyses.

Table 3.1-32
Frequency of Detected Organic Compounds in Filtered Storm Water

Analyte	Number of Analyses	Number of Detects	Concentration Range (µg/L)	Maximum Detect (µg/L)	EQL (µg/L)	Frequency of Detects*
Benzoic acid	1	1	6.3 to 6.3	6.3	50	1/1

* Value is the ratio of the number of detected values to the number of analyses.

Table 3.1-33
Results of Organic Chemical Data Review for Water Samples

Analyte	Result	Rationale
Acetone	Eliminated	Detected in storm water samples only.
Benzo(b)fluoranthene	Eliminated	Detected in storm water samples only.
Benzoic acid	Eliminated	Detected in storm water samples only.
Bis(2-ethylhexyl)phthalate	Retained	Detected in an alluvial groundwater sample.
2-Butanone	Eliminated	Detected in storm water samples only.
Chrysene	Eliminated	Detected in storm water samples only.
1,2-Dichloroethane	Retained	Detected in a DP Spring sample.
Di-n-butylphthalate	Eliminated	Detected in storm water samples only.
Di-n-octylphthalate	Eliminated	Detected in storm water samples only.
Fluoranthene	Eliminated	Detected in storm water samples only.
Phenanthrene	Eliminated	Detected in storm water samples only.
Pyrene	Eliminated	Detected in storm water samples only.

Table 3.1-34 lists all field-measured water quality parameters. The following physical measurements were made for both alluvial groundwater and DP Spring water: pH, specific conductance, temperature, dissolved oxygen, and turbidity. These physical water measurements will assist in geochemical modeling of the DP Canyon alluvial aquifer. The static water level was measured for the alluvial groundwater wells and is also presented in Table 3.1-34.

For analytical laboratory-measured water quality analytes, one filtered and one unfiltered sample were taken at LAUZ-1, LAUZ-2, and DP Spring in the fall of 1998. Two filtered storm water samples from Stations 1 and 2 were also analyzed for water quality parameters in the fall of 1998. As seen in Appendix C, no data qualifiers were applied to the analytical laboratory-measured water quality parameters for these eight samples.

Tables 3.1-35 through 3.1-38 present the concentration range and frequency of detects for water quality parameters in the alluvial water and DP Spring. A complete presentation of the data for these detected water quality parameters is in Appendix D. Table 3.1-39 summarizes this information for the two filtered storm water samples. As can be noted by reviewing Tables 3.1-35 through 3.1-39, none of the detected results exceed the minimum WQCC standards for the analyte. The result closest to a standard is the detected fluoride result for DP Spring. None of these water quality parameters are retained as water COPCs.

Table 3.1-34
Field-Measured Water Quality Parameters

Location ID	Sample ID	Unfiltered/ Filtered	Collection Date	Field Parameters					
				pH	Specific Conductance (ms/cm)[a]	Temp. (°C)	DO[b] (mg/L)	Turbidity (NTU)[c]	Static Water Level (ft)
1st Quarter									
LAUZ-1	0121-97-1396	U[d]	8/20/97	7.17	0.245	18.2	10.6	5	5.05
LAUZ-1	0121-97-1397	U	8/20/97	7.17	0.245	18.2	10.6	5	5.05
LAUZ-2	0121-97-1398	U	8/20/97	7.41	0.42	19.1	14.71	1	6.16
LAUZ-2	0121-97-1399	U	8/20/97	7.41	0.42	19.1	14.71	1	6.16
DP Spring	0121-97-1400	U	8/21/97	7.85	0.219	11.6	13.57	NA[e]	NA
DP Spring	0121-97-1401	U	8/21/97	7.85	0.219	11.6	13.57	NA	NA
2nd Quarter									
LAUZ-1	0121-97-1424	U	12/4/97	7.11	0.802	5.5	12.73	1	4.87
LAUZ-1	0121-97-1426	U, Dup 1424	12/4/97	7.11	0.802	5.5	12.73	1	4.87
LAUZ-1	0121-97-1428	F[f]	12/4/97	7.11	0.802	5.5	12.73	1	4.87
LAUZ-1	0121-97-1430	F, Dup 1428	12/4/97	7.11	0.802	5.5	12.73	1	4.87
LAUZ-2	0121-97-1425	U	12/4/97	7.43	0.545	7.3	13.8	3	6.67
LAUZ-2	0121-97-1429	F	12/4/97	7.43	0.545	7.3	13.8	3	6.67
DP Spring	No sample	NA	NA	NA	NA	NA	NA	NA	NA
DP Spring	No sample	NA	NA	NA	NA	NA	NA	NA	NA
3rd Quarter									
LAUZ-1	CA21-98-0001	U	5/5/98	7.16	0.726	7.6	17.41	0	6.35
LAUZ-1	CA21-98-0002	F	5/5/98	7.16	0.726	7.6	17.41	0	6.35
LAUZ-2	CA21-98-0003	U	5/5/98	7.92	0.701	8.2	19.92	4	6.52
LAUZ-2	CA21-98-0004	F	5/5/98	7.92	0.701	8.2	19.92	4	6.52
DP Spring	CA21-98-0005	U	5/6/98	6.18	0.486	12	11.29	NA	NA
DP Spring	CA21-98-0006	F	5/6/98	NA	NA	NA	NA	NA	NA
4th Quarter									
LAUZ-1	CA21-98-0007	F	9/17/98	7.27	0.337	17.6	13.66	3.0	5.96
LAUZ-1	CA21-98-0008	U	9/17/98	7.27	0.337	17.6	13.66	3.0	5.96
LAUZ-2	CA21-98-0009	F	9/17/98	7.33	0.462	17.7	13.01	2.0	6.17
LAUZ-2	CA21-98-0010	F	9/17/98	7.33	0.462	17.7	13.01	2.0	6.17
DP Spring	CA21-98-0011	U	9/16/98	8.16	0.308	16.7	11.34	NA	NA
DP Spring	CA21-98-0012	F	9/16/98	8.16	0.308	16.7	11.34	NA	NA
DP Spring	CA21-98-0043	U	10/6/98	7.84	0.219	12.4	12.52	NA	NA
LAUZ-2	CA21-98-0042	U	10/7/98	6.75	0.422	16	12.23	3.3	6.12
LAUZ-1	CA21-98-0041	U	10/20/98	6.7	0.246	13.8	9.71	4.0	6.4

[a] ms/cm = milliseconds per centimeter.
[b] DO = dissolved oxygen.
[c] NTU = nephelometric turbidity unit.
[d] U = unfiltered.
[e] NA = not analyzed at DP Spring.
[f] F = filtered.

Table 3.1-35
Frequency of Detected Water Quality Parameters in Unfiltered Alluvial Water

Analyte	Number of Analyses	Number of Detects	Concentration Range (mg/L)[a]	Maximum Detect (mg/L)	EQL (mg/L)	Frequency of Detects[b]	Minimum WQCC Standard (mg/L)
Bicarbonate by alkalinity titration	2	2	160 to 220	220	5	2/2	N.A.[c]
Carbon, total organic	2	2	6.5 to 7.8	7.8	1	2/2	N.A.
Chloride	2	2	27 to 63	63	0.2	2/2	250
Fluoride	2	2	0.77 to 1.3	1.3	0.1	2/2	1.6
Nitrogen, Nitrate+Nitrite (expressed as N)	2	2	0.05 to 0.23	0.23	0.05	2/2	10[d]
Phosphorus, total (expressed as P)	2	1	[0.1] to 0.11	0.11	0.1	1/2	N.A.
Sulfate	2	2	1.5 to 7.9	7.9	1	2/2	600

[a] Values in square brackets indicate nondetected results.

[b] Value is the ratio of the number of detected values to the number of analyses.

[c] N.A. = not available.

[d] This value is for nitrate (NO_3) expressed as N.

Table 3.1-36
Frequency of Detected Water Quality Parameters in Filtered Alluvial Water

Analyte	Number of Analyses	Number of Detects	Concentration Range (mg/L)[a]	Maximum Detect (mg/L)	EQL (mg/L)	Frequency of Detects[b]	Minimum WQCC Standard (mg/L)
Bicarbonate by alkalinity titration	2	2	180 to 190	190	5	2/2	N.A.[c]
Carbon, total organic	2	2	6.7 to 7.7	7.7	1	2/2	N.A.
Chloride	2	2	27 to 63	63	0.2	2/2	250
Fluoride	2	2	0.82 to 1.3	1.3	0.1	2/2	1.6
Nitrogen, Nitrate+Nitrite (expressed as N)	2	1	[0.05] to 0.25	0.25	0.05	1/2	10[d]
Phosphorus, total (expressed as P)	2	1	[0.1] to 0.14	0.14	0.1	1/2	N.A.
Sulfate	2	2	1.5 to 7.6	7.6	1	2/2	600

[a] Values in square brackets indicate nondetected results.

[b] Value is the ratio of the number of detected values to the number of analyses.

[c] N.A. = not available.

[d] This value is for nitrate (NO_3) expressed as N.

Table 3.1-37
Frequency of Detected Water Quality Parameters in Unfiltered Samples from DP Spring

Analyte	Number of Analyses	Number of Detects	Concentration Range (mg/L)	Maximum Detect (mg/L)	EQL (mg/L)	Frequency of Detects[a]	Minimum WQCC Standard (mg/L)
Bicarbonate by alkalinity titration	1	1	87 to 87	87	5	1/1	N.A.[b]
Carbon, total organic	1	1	4 to 4	4	1	1/1	N.A.
Chloride	1	1	35 to 35	35	0.2	1/1	250
Fluoride	1	1	1.1 to 1.1	1.1	0.1	1/1	1.6
Nitrogen, nitrate+nitrite (expressed as N)	1	1	0.31 to 0.31	0.31	0.05	1/1	10[c]
Phosphorus, total (expressed as P)	1	1	0.12 to 0.12	0.12	0.1	1/1	N.A.
Sulfate	1	1	6.6 to 6.6	6.6	1	1/1	600

[a] Value is the ratio of the number of detected values to the number of analyses.

[b] N.A. = not available.

[c] This value is for nitrate (NO_3) expressed as N.

Table 3.1-38
Frequency of Detected Water Quality Parameters in Filtered Samples from DP Spring

Analyte	Number of Analyses	Number of Detects	Concentration Range (mg/L)	Maximum Detect (mg/L)	EQL (mg/L)	Frequency of Detects[a]	Minimum WQCC Standard (mg/L)
Bicarbonate by alkalinity titration	1	1	91 to 91	91	5	1/1	N.A.[b]
Carbon, total organic	1	1	3.8 to 3.8	3.8	1	1/1	N.A.
Chloride	1	1	34 to 34	34	0.2	1/1	250
Fluoride	1	1	1.1 to 1.1	1.1	0.1	1/1	1.6
Nitrogen, nitrate+nitrite (expressed as N)	1	1	0.28 to 0.28	0.28	0.05	1/1	10[c]
Phosphorus, total (expressed as P)	1	1	0.12 to 0.12	0.12	0.1	1/1	N.A.
Sulfate	1	1	6.6 to 6.6	6.6	1	1/1	600

[a] Value is the ratio of the number of detected values to the number of analyses.

[b] N.A. = not available.

[c] This value is for nitrate (NO_3) expressed as N.

Table 3.1-39
Frequency of Detected Water Quality Parameters in Filtered Storm Water Samples

Analyte	Number of Analyses	Number of Detects	Concentration Range (mg/L)	Maximum Detect (mg/L)	EQL (mg/L)	Frequency of Detects[a]	Minimum WQCC Standard (mg/L)
Bicarbonate by alkalinity titration	2	2	15 to 39	39	5	2/2	N.A.[b]
Chloride	2	2	0.85 to 2.5	2.5	0.2	2/2	250
Nitrogen, nitrate (expressed as NO_3)	2	2	0.23 to 0.23	0.23	0.05	2/2	10[c]
Silica, total	2	2	1.7 to 2.6	2.6	0.05	2/2	N.A.
Sulfate	2	2	2.9 to 4.9	4.9	1	2/2	600

[a] Value is the ratio of the number of detected values to the number of analyses.

[b] N.A. = not available.

[c] This value is for nitrate (NO_3) expressed as N.

3.2 Nature and Sources of Contamination in Sediment and Alluvial Groundwater

Contamination in DP Canyon sediments and alluvial groundwater ("alluvial groundwater" as used here includes samples collected from DP Spring) was investigated using a combination of full-suite and limited-suite analyses; statistical analyses of the analytical data; and detailed geomorphic mapping and physical characterization of post-1942 sediments. The nature, characteristics, and probable sources of COPCs identified in Section 3.1 are discussed in this section; evidence for the possible collocation of contaminants is also included. These COPCs include 8 radionuclides, 19 inorganic chemicals, and 34 organic chemicals. Identifying the sources of contaminants is an important part of the conceptual model that describes their distribution; evidence pertaining to the sources of each COPC is discussed in this section. Available data indicate that the primary sources for most of these COPCs are discharges from the PRS 21-011(k) outfall and non-Laboratory sources (urban runoff) located in the Los Alamos townsite. As discussed in Section 1.3.2, other potential sources of contamination include PRS 21-029 and the TA-73 septic tanks. Americium-241, cesium-137, plutonium-238, plutonium-239,240 and strontium-90, are viewed as key radionuclides for DP Canyon. Additional information on how COPCs are identified is presented in Appendix E, and detailed discussions of americium-241; cesium-137; plutonium-239,240; and strontium-90 are presented in Section 3.3.

Table 3.2-1 shows that calcium is the only inorganic COPC in both sediment and alluvial groundwater. Thus, there is almost no overlap in the inorganic chemicals identified in alluvial groundwater and sediment. Table 3.2-1 also shows that all these inorganic COPCs in sediment, and many other inorganic chemicals not identified as COPCs, were detected in storm water. In contrast, eight radionuclide COPCs were detected in either sediment or alluvial groundwater. Four of these radionuclides are common to both media. Only one radionuclide, uranium-235, is a COPC in alluvial groundwater but not in sediment. Lastly, the organic chemicals show the greatest disparity in COPCs listed, mainly because only 2 of 35 total organic COPCs were identified as COPCs in alluvial groundwater (see Table 3.2-2). The organic chemical summary tables for DP Canyon water samples (Tables 3.1-29–3.1-32) show that more organic chemicals were detected in storm water, primarily in the unfiltered storm water samples. The highest concentrations of many inorganic chemicals were also noted in unfiltered storm water samples. The observation of inorganic and organic chemicals in unfiltered storm water suggests that these analytes are associated with sediment particles carried in suspension during storms.

Several graphical methods are used in this section to present variations in the COPCs within and between reaches. For all COPCs, summary figures are presented that show the normalized maximum value of COPCs relative to background values (or, in the case of organic chemicals, the estimated quantitation limit [EQL]); values below 1.0 on these figures indicate results below background values. To highlight the pattern of COPCs between reaches, the chemicals are ordered within each group (organic chemicals and inorganic chemicals) from highest to lowest for reach DP-1. Reach DP-2 data were used to order the radionuclides. Thus, the normalized values for DP-1 organic chemicals and inorganic chemicals follow a decreasing trend by chemical; the normalized values for DP-2 radionuclides also follow a decreasing trend. Where values for other reaches follow a decreasing trend, a positive correlation in maximum values between reaches is suggested. Note that the "maximum" results for some COPCs are actually for samples with concentrations reported below detection limits, but they are considered in this report to provide conservative estimates of potential levels of contamination. Other summary figures show only detected values because these results more accurately portray the known contaminant levels. The normalized plots include data and COPCs identified in reach LA-2 to provide information on the contribution of DP Canyon contaminants into Los Alamos Canyon sediments (Reneau et al. 1998, 59160).

Table 3.2-1
Inorganic and Radionuclide COPCs by Media

Analyte	COPC Detected in Sediment	COPC Detected in Alluvial Groundwater	COPC Detected in Storm Water[a]
Inorganics			
Aluminum	—[b]	—	Yes
Antimony	Yes	—	Yes
Arsenic	—	—	Yes
Barium	—	Yes	Yes
Beryllium	—	—	Yes
Boron	NA[c]	Yes	Yes
Cadmium	Yes	—	Yes
Calcium	Yes	Yes	Yes
Chromium, total	Yes	—	Yes
Cobalt	Yes	—	Yes
Copper	Yes	—	Yes
Iron	—	Yes	Yes
Lead	Yes	—	Yes
Lithium	NA	Yes	Yes
Magnesium	—	Yes	Yes
Manganese	—	Yes	Yes
Mercury	Yes	—	Yes
Molybdenum	NA	—	No
Nickel	—	—	Yes
Potassium	—	Yes	Yes
Selenium	Yes	—	Yes
Silver	—	—	No
Sodium	—	Yes	Yes
Strontium	NA	—	Yes
Thallium	—	—	No
Vanadium	—	—	Yes
Zinc	Yes	—	Yes
Radionuclides			
Americium-241	Yes	—	NA
Cesium-137	Yes	—	NA
Plutonium-238	Yes	—	NA
Plutonium-239,240	Yes	Yes	NA
Strontium-90	Yes	Yes	NA
Tritium	Yes	Yes	NA
Uranium-234	Yes	Yes	NA
Uranium-235	—	Yes	NA
Uranium-238	—	—	NA

[a] Filtered or unfiltered samples.
[b] A dash in the table means the analyte is not a COPC.
[c] NA = not analyzed.

Table 3.2-2
Organic COPCs by Media

Analyte	COPC Detected in Sediment	COPC Detected in Alluvial Groundwater	COPC Detected in Storm Water[a]
PAHs			
Acenaphthene	Yes	—[b]	No
Anthracene	Yes	—	No
Benz(a)anthracene	Yes	—	No
Benzo(a)pyrene	Yes	—	No
Benzo(b)fluoranthene	Yes	—	Yes
Benzo(g,h,i)perylene	Yes	—	No
Benzo(k)fluoranthene	Yes	—	No
Carbazole	Yes	—	No
Chrysene	Yes	—	Yes
Dibenz(a,h)anthracene	Yes	—	No
Fluoranthene	Yes	—	Yes
Fluorene	Yes	—	No
Indeno(1,2,3-cd)pyrene	Yes	—	No
2-Methylnaphthalene	Yes	—	No
Naphthalene	Yes	—	No
Phenanthrene	Yes	—	Yes
Pyrene	Yes	—	Yes
PCBs/Pesticides			
Aroclor-1260	Yes	—	No
α-Chlordane	Yes	—	No
γ-Chlordane	Yes	—	No
4,4'-DDE	Yes	—	No
4,4'-DDT	Yes	—	No
Heptachlor Epoxide	Yes	—	No
SVOCs			
Benzoic acid	Yes	—	Yes
Bis(2-ethylhexyl)phthalate	Yes	Yes	Yes
Butylbenzylphthalate	Yes	—	No
Dimethyl phthalate	Yes	—	No
Di-n-butylphthalate	Yes	—	Yes
Di-n-octylphthalate	Yes	—	Yes
TPH-DRO	Yes	—	No
2,4,6-Trichlorophenol	Yes	—	No
VOCs			
Acetone	Yes	—	Yes
2-Butanone	—	—	Yes
1,2-Dichloroethane	—	Yes	No
Toluene	Yes	—	No

[a] Filtered or unfiltered samples.
[b] A dash in the table means the analyte is not a COPC.

Other graphical methods used to present data on COPCs in the DP Canyon sediment samples include plots of analyte concentration versus distance downstream from the culvert at the head of DP Canyon for representative COPCs. For some inorganic and organic COPCs, these plots distinguish results reported above and below detection limits to allow better interpretation of the data and uncertainties associated with elevated detection limits for some analytes. Finally, scatter plots are used to show the relation between results from different alluvial groundwater sampling locations or the relation between concentrations in sediment and storm water.

The upper Los Alamos Canyon sediment investigation, which was conducted in 1996 and 1997, included one sample collected from reach DP-4. The information for this sample was included in data review and statistical analyses of the upper Los Alamos Canyon sediment data (Reneau et al. 1998, 59160). The sample identification (ID) number is 04LA-96-0140; results from this sample will be used to supplement the information collected in the current investigation.

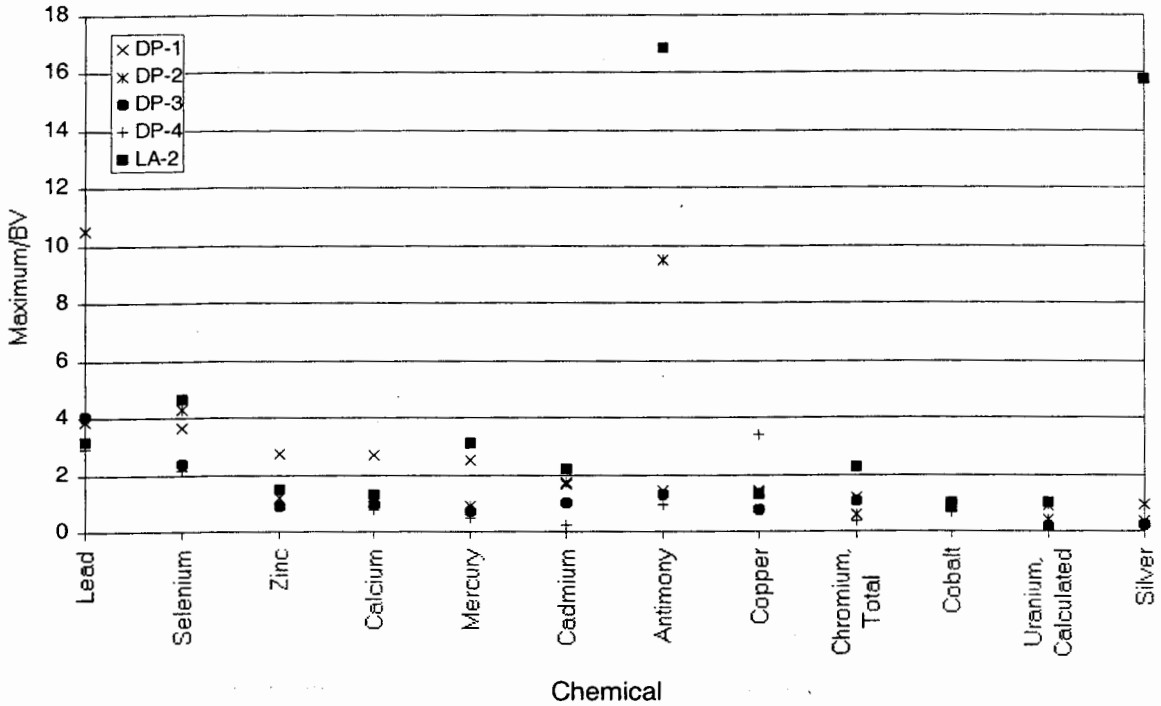
3.2.1 Inorganic COPCs in Sediment

Twelve inorganic chemicals are discussed in this section, including analytes identified as COPCs in either DP Canyon or in upper Los Alamos Canyon. Ten inorganic chemicals were identified as DP Canyon COPCs in Section 3.1.1: antimony, cadmium, calcium, total chromium, cobalt, copper, lead, mercury, selenium, and zinc. In addition, two other inorganic chemicals were identified as COPCs in upper Los Alamos Canyon: total uranium and silver (Reneau et al. 1998, 59160). Analyses for these chemicals are discussed here as they pertain to understanding the sources of uranium and silver in Los Alamos Canyon. The nature, distribution, and possible sources for each of these 12 inorganic COPCs were evaluated using statistical analyses (see Appendix E) as well as the specific geographic and geomorphic settings in which these analytes were detected above background values.

The upper Los Alamos Canyon sediment investigation included collecting one sample from reach DP-4. The analytical suites and results for sample 04LA-96-0140 are consistent with the other results for DP Canyon sediments. One exception was that total uranium analysis was requested from 04LA-96-0140 and for no other DP Canyon samples. Total uranium in sample 04LA-96-0140 is less than the background value (6.8 mg/kg in 04LA-96-0140 versus a background value of 6.99 mg/kg). Although there is only one measured total uranium value for DP Canyon from sample 04LA-96-0140, total uranium can be calculated from the isotopic abundance of uranium-234, uranium-235, and uranium-238. The total uranium calculation uses the specific activity of these isotopes (specific activity units are picocuries per gram; values can be found in Ryti et al. [1998, 58093]).

Figure 3.2-1 shows maximum results for the inorganic COPCs normalized by background values. Figure 3.2-1 also includes measured total uranium from reach DP-4, calculated total uranium for other reaches, and silver results for comparison with reach LA-2 sample results. Figure 3.2-1a is based on the maximum value (whether it is a detected sample result or a detection limit) for an analyte. Figure 3.2-1b uses only the maximum detected sample results. Two inorganic COPCs (antimony and selenium) were not detected with sufficient frequency to draw conclusions about potential contaminant sources, if any, in the DP Canyon watershed. Antimony was detected in two samples from reach DP-2, and some detection limits for reach DP-2 samples were greater than the background value. However, the predominance of nondetect antimony sample results suggests that antimony is not an important contaminant in DP Canyon sediments. Detected selenium results are above the background value in reaches DP-1, DP-2, and DP-3, but these values are similar to the background value or other nondetect results. Most nondetect sample results for selenium are a factor of two to four times the background value, providing an upper limit for any possible selenium contamination in DP Canyon sediments.

(a)



(b)

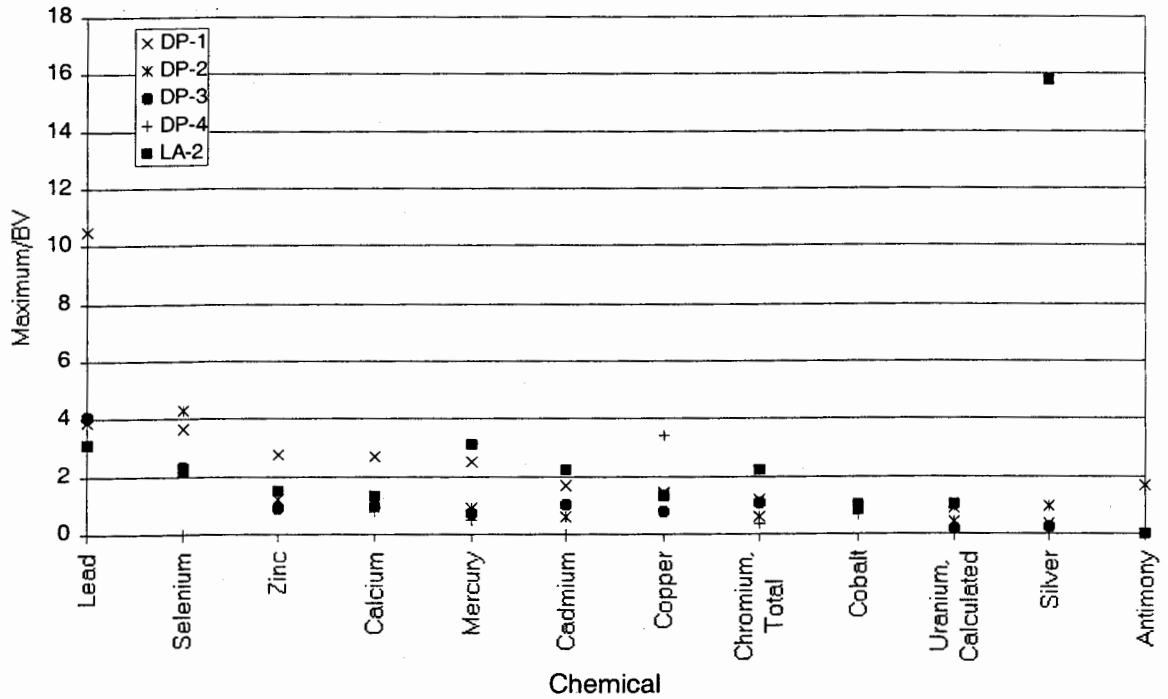


Figure 3.2-1. Maximum inorganic chemical results normalized by background value; (a) maximum value of detects and nondetects; (b) maximum detected sample results

Antimony, cadmium, calcium, total chromium, lead, and zinc have the highest detected value in reach DP-1. The maximum copper result was from a field duplicate sample (36.1 mg/kg for sample 0121-97-1351, which is a field duplicate of 0121-97-1350 [copper = 15.1 mg/kg]) collected in reach DP-4 from a fine-grained sediment layer. The field duplicate sample yielded no notable elevated values for other COPCs. In addition, the other inorganic COPCs were not elevated in sample 0121-97-1351. The remainder of the copper sample results are positively correlated with zinc (see Appendix E). Because zinc shows a decreasing concentration trend from reach DP-1 to DP-4, the correlation between copper and zinc suggests a probable Los Alamos townsite origin for copper. Cobalt concentrations are not correlated with other COPCs (like zinc and cesium-137 discussed in Appendix E). No cobalt values are greater than the background value, which suggests that cobalt is not an important contaminant in DP Canyon sediments.

The common trend in the maximum concentration for cadmium, calcium, total chromium, lead, mercury, and zinc suggests a common source for these contaminants. The scatter plots and statistical analyses that show a positive correlation with zinc and other inorganic COPCs supports the common-source concept (see Appendix E). Because the highest concentrations were measured in reach DP-1, which is nearest the head of DP Canyon, the source or sources appear to be in the Los Alamos townsite. Calcium is an exception; possible calcium sources are the concrete storm water culvert (that feeds reach DP-1) and the abundant concrete debris throughout DP-1. The largest concentrations for three of these inorganic chemicals (cadmium, total chromium, and zinc) are from reach LA-2, suggesting another source or set of sources in Los Alamos Canyon for these analytes. Lastly, the silver and calculated uranium results in Figure 3.2-1 show that there are other sources for these analytes in Los Alamos Canyon, because no results above the background value for silver or uranium were reported for DP Canyon sediments.

The geographic context of the sample data also suggests that there are different sources of contamination. As evidenced by the occurrence of lead and mercury in reach DP-1, the Los Alamos townsite is the source for some metals, as shown on Figure 3.2-2. The highest concentrations and the highest percentage of sample results above the background values occur in reach DP-1, and especially reach DP-1 West. For cobalt, there is no apparent geographical concentration trend; thus it is difficult to ascertain the source of cobalt leading to modestly elevated concentrations in reaches DP-2 and DP-3. There are relatively few detected selenium results; thus there is only weak evidence for a decline in concentration from the head of DP Canyon to its confluence with Los Alamos Canyon. In summary, the nature and spatial trend of inorganic COPCs in DP Canyon largely indicate that the cumulative affects of urban activity within the Los Alamos townsite are responsible for many of the inorganic COPCs.

3.2.2 Radionuclide COPCs in Sediment

Seven radionuclides were identified as COPCs in Section 3.1.2: americium-241; cesium-137; plutonium-238; plutonium-239,240; strontium-90; tritium; and uranium-234. All these radionuclides were reported above background values in prior investigations at one or more PRSs in the watershed, most notably the PRS 21-011(k) outfall, as summarized in Section 1.3.2.

The normalized plot for the radionuclides, Figure 3.2-3, is based on the reported values for each radionuclide (results were not censored by the minimum detectable activity value). The normalized plot shows that six radionuclides were detected at activities far above the background value (more than 10 times the background value). These key radionuclides are americium-241; cesium-137; plutonium-238; plutonium-239,240; strontium-90; and tritium. The background value for americium-241 is based on alpha spectroscopy, which is about 10 times less than the typical gamma spectroscopy detection limit for americium-241. The remaining radionuclide, uranium-234, was measured at a maximum activity less than the background value.

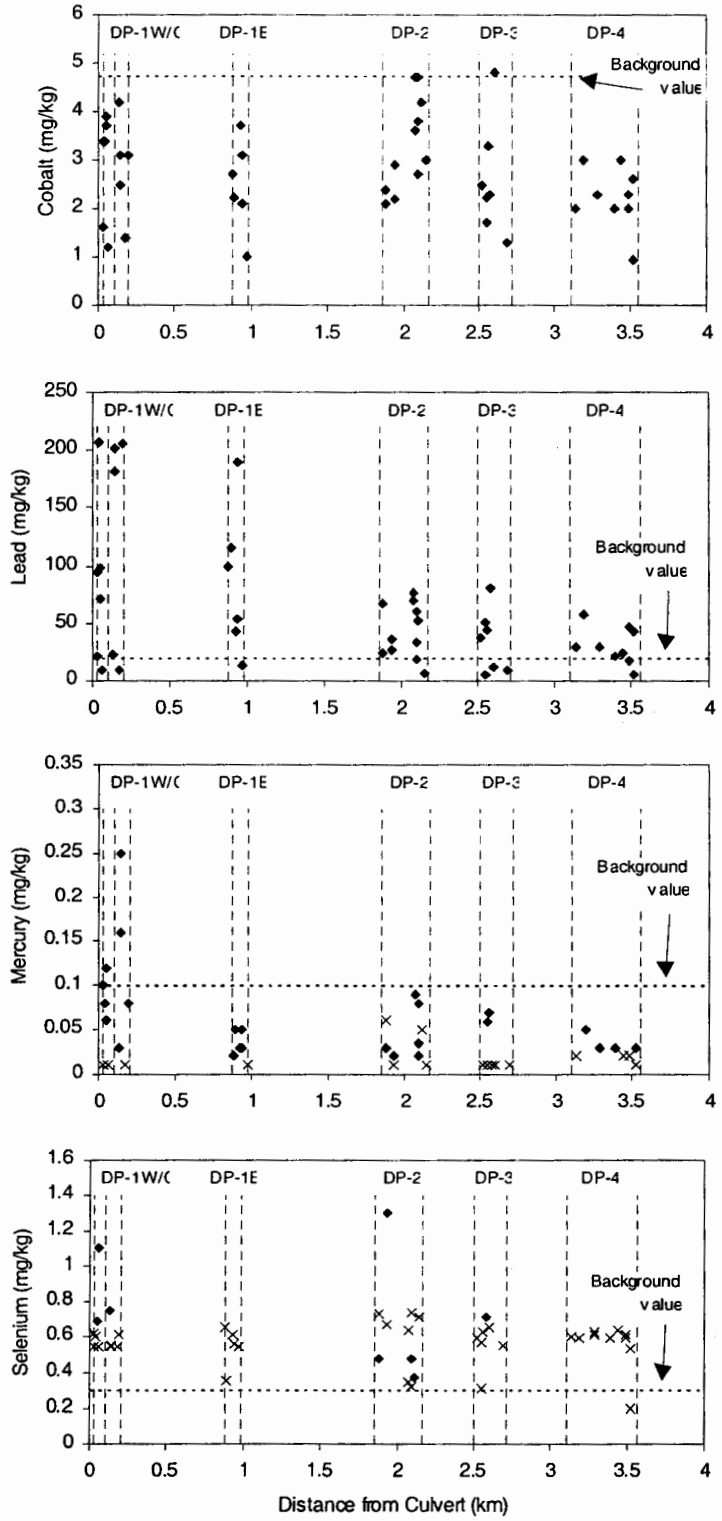


Figure 3.2-2. **Cobalt, lead, mercury, and selenium concentrations versus distance from the culvert at the head of DP Canyon. Note: "x" symbols represent nondetect sample results.**

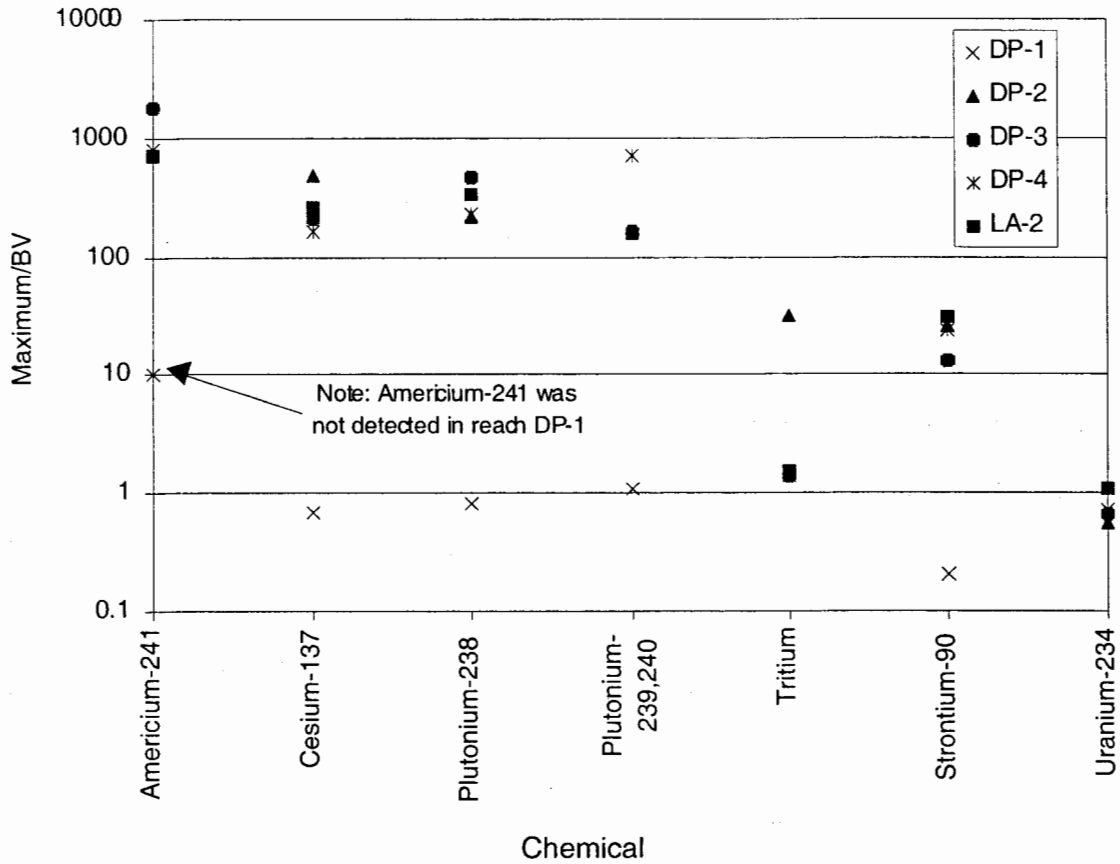


Figure 3.2-3. Maximum radionuclide results normalized by background value

Evidence of the general source areas for radionuclide COPCs and variations between reaches are seen in plots showing radionuclide concentration as a function of distance along the channel (Figure 3.2-4). Concentrations of americium-241; cesium-137; plutonium-239,240; and strontium-90 clearly increase greatly in DP-2 relative to upstream, reflecting their source at the PRS 21-011(k) outfall, and remain elevated in reaches DP-3 and DP-4. The occurrence of the highest americium-241 values in slightly different locations than the highest cesium-137 and strontium-90 values is also seen in this plot. The isotopic plutonium results also show variation in isotopic ratio, which is evident from Figure 3.2-4. The variation in isotopic ratios between these key radionuclides is discussed further in Section 3.3.

With the exception of uranium-234, all other radionuclide COPCs significantly correlate with cesium-137. In addition, the statistical correlation is highly significant for americium-241; plutonium-238; plutonium-239,240; and strontium-90. The lack of correlation with uranium-234 is not surprising because none of the uranium-234 sample results is greater than the background value. Thus, there is only a limited inventory of uranium-234 in DP Canyon sediments. Even so, the uranium-234 sample (0121-97-1432) in reach DP-4 with the isotopic ratio indicative of enriched uranium also had high values for americium-241 (28.6 pCi/g) and cesium-137 (93.2 pCi/g).

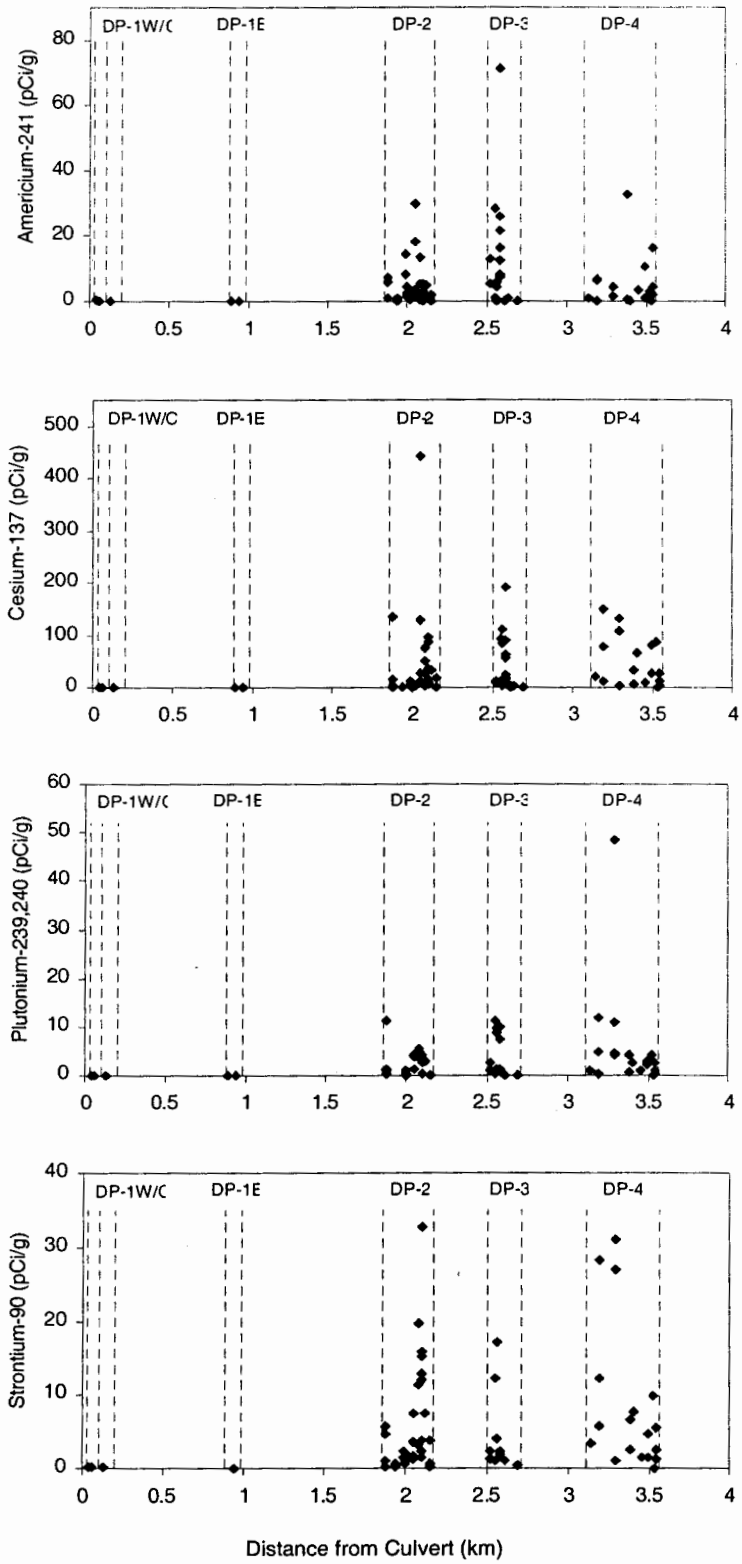


Figure 3.2-4. **Americium-241; cesium-137; plutonium-239,240; and strontium-90 concentrations versus distance from the culvert at the head of DP Canyon**

Although there are strong correlations of cesium-137 with americium-241; plutonium-238; plutonium-239,240; and strontium-90, there is also variation in the concentration ratios between these radionuclides. As discussed in Section 3.3, the variation in isotopic ratios apparently relate to variations in the contaminant release history from the PRS 21-011(k) outfall, and are modified by the downstream addition of sediments from numerous sources.

Tritium was detected at low levels above the background value in reaches DP-1, DP-3, and DP-4. The maximum value for reach DP-2 was resampled, and the resample value (0.23 pCi/g for sample CA21-98-0083) was much less than the original value (3 pCi/g in sample 0121-97-1362). The large difference in the resample data suggests high uncertainty in the tritium sample results. However, even if the maximum value in reach DP-2 is excluded, the largest tritium sample result for DP Canyon sediments is from reach DP-2. Thus, even with some uncertainty in the maximum value, the sediment sample results suggest that tritium is associated with releases from the PRS 21-011(k) outfall.

Lastly, it is worth noting that plutonium-239,240 and tritium were measured slightly above background value in reach DP-1. One possible explanation for these modestly elevated concentrations is stack emissions or other airborne deposition of these contaminants from TA-21 sources. This explanation likely seems based on the elevated concentrations detected in a "baseline" study of mesa-top soils at TA-21, which showed greatly elevated isotopic plutonium, uranium, and tritium levels in soils surrounding the main TA-21 industrial complex (Ryti 1997, 58239).

3.2.3 Organic COPCs in Sediment

Thirty-three organic chemicals were detected in DP Canyon sediment samples and therefore are identified as COPCs, as discussed in Section 3.1.3. There are three major groups of organic COPCs in DP Canyon sediments: PCBs and pesticides, SVOCs, and VOCs. One PCB (Aroclor-1260) and six pesticides were detected in DP Canyon sediments. Two VOCs, acetone and toluene, were detected. Lastly, 25 SVOCs were detected, including polycyclic aromatic hydrocarbons (PAHs) or plasticizers (various phthalates). In addition, organic analyses in DP Canyon included analysis for TPH-DROs. The TPH-DRO data will help determine the contribution of DP Tank Farm (PRS 21-029) and other Los Alamos townsite organic contaminant sources to DP Canyon sediments.

The upper Los Alamos Canyon sediment investigation included one sample collected from reach DP-4. Information for this sample was included in data review and statistical analyses of the upper Los Alamos Canyon sediment data (Reneau et al. 1998, 59160). The sample ID is 04LA-96-0140; results from this sample will supplement the information collected in the current investigation. The results for sample 04LA-96-0140 are consistent with the other results for DP Canyon sediments, except that one additional organic COPC (dibenzofuran) was detected in sample 04LA-96-0140. Dibenzofuran was detected in sample 04LA-96-0140 at about one-tenth the EQL, and was not detected in any other DP Canyon samples. Because the dibenzofuran detection frequency is less than 2% (1 detect in 56 combined samples; see Table D-3.0-3, Summary of Organic Chemical Analyses for Sediment in DP Canyon Reaches), dibenzofuran will not be added to the DP Canyon sediment COPC list.

The normalized plots for organic chemicals in Figure 3.2-5 use the maximum detected sample results. Figure 3.2-5a presents the normalized plot for TPH-DROs and PAHs, Figure 3.2-5b presents the normalized plot for PCBs and pesticides, and Figure 3.2-5c presents the normalized plot for miscellaneous SVOCs and VOCs. These plots show that 12 chemicals were measured at greater than 10 times the EQL in reach DP-1, and 7 chemicals were measured greater than 5 times the EQL in other reaches. However, TPH-DROs were detected in all reaches, and the maximum value in reach DP-4 was 20 times the EQL. The maximum value for detected PAHs is less than 10 times the EQL in reach DP-2 and less than 5 times the EQL in reaches DP-3 and DP-4. The maximum concentration of these detected PAHs is roughly 2 times the EQL or less in reach DP-2. The only detected PCB, Arolcor-1260, shows a decreasing concentration down DP Canyon, but the maximum concentration in reach LA-2 is greater than the concentration in reaches DP-2, DP-3, or DP-4, indicating other sources in upper Los Alamos Canyon. Two pesticides, aldrin and Heptachlor Epoxide, were detected only in reach DP-1. The other pesticides were detected in multiple reaches, and the highest concentrations for all pesticides detected in DP Canyon, except 4,4'-DDE, were from reach DP-1. Pesticide concentrations decrease from DP-1 to DP-2, but the order of concentrations between DP-3 and DP-4 does not always follow the physical order of these reaches. Other than phthalates, only 2,4,6-trichlorophenol was detected at levels greater than the EQL for the chemicals plotted in Figure 3.2-5c. Phthalates are known field and laboratory contaminants and commonly occur in the environment from industrial and residential activities.

Based on a review of the concentration trend plots and the statistical analyses presented in Appendix E, the organic chemical COPCs fall into two groups. The first group consists of TPH-DROs, PAHs, Aroclor-1260, and pesticides, which have the maximum values in reach DP-1. The detected values for these organic COPCs are positively correlated with zinc (Appendix E), which is an indicator of COPCs with a probable Los Alamos townsite source. The second group consists of the miscellaneous SVOC and VOC chemicals shown in Figure 3.2-5c. These chemicals are not collocated with other COPCs. There is also little process knowledge to warrant predicting their presence in DP Canyon sediments, with the exception of benzoic acid (a breakdown product of benzene) and toluene. VOC samples were collected to document the presence or absence of BTEX or benzene, toluene, ethylene, and xylene associated with releases from DP Tank Farm and non-Laboratory sources in the Los Alamos townsite. Although the presence of two of the BTEX components was inferred from the DP Canyon sediment data, the reported values for these chemicals do not suggest significant BTEX contamination in DP Canyon sediments.

Evidence of the general source areas for organic COPCs and variations between reaches are seen in plots showing the concentrations of representative organic COPCs as a function of distance from the head of DP Canyon (Figure 3.2-6). Figure 3.2-6 shows the geographic changes in concentrations of TPH-DROs, a representative PAH [benzo(a)pyrene] and a representative pesticide (4,4'-DDT). TPH-DRO concentrations show a decreasing trend from the head of DP Canyon to the confluence with Los Alamos Canyon. This concentration trend suggests that oils are entering DP Canyon from the Los Alamos townsite. The plot for benzo(a)pyrene shows a similar decreasing trend for detected sample results, but also shows that many samples have elevated detection limits. The presence of elevated detection limits somewhat impairs the visual evidence for a concentration trend. Lastly, 4,4'-DDT shows a decreasing concentration trend of both detected and nondetected sample results for samples collected further from the head of DP Canyon. Thus, the detected sample results indicate that Los Alamos townsite is the source of organic contamination in DP Canyon.

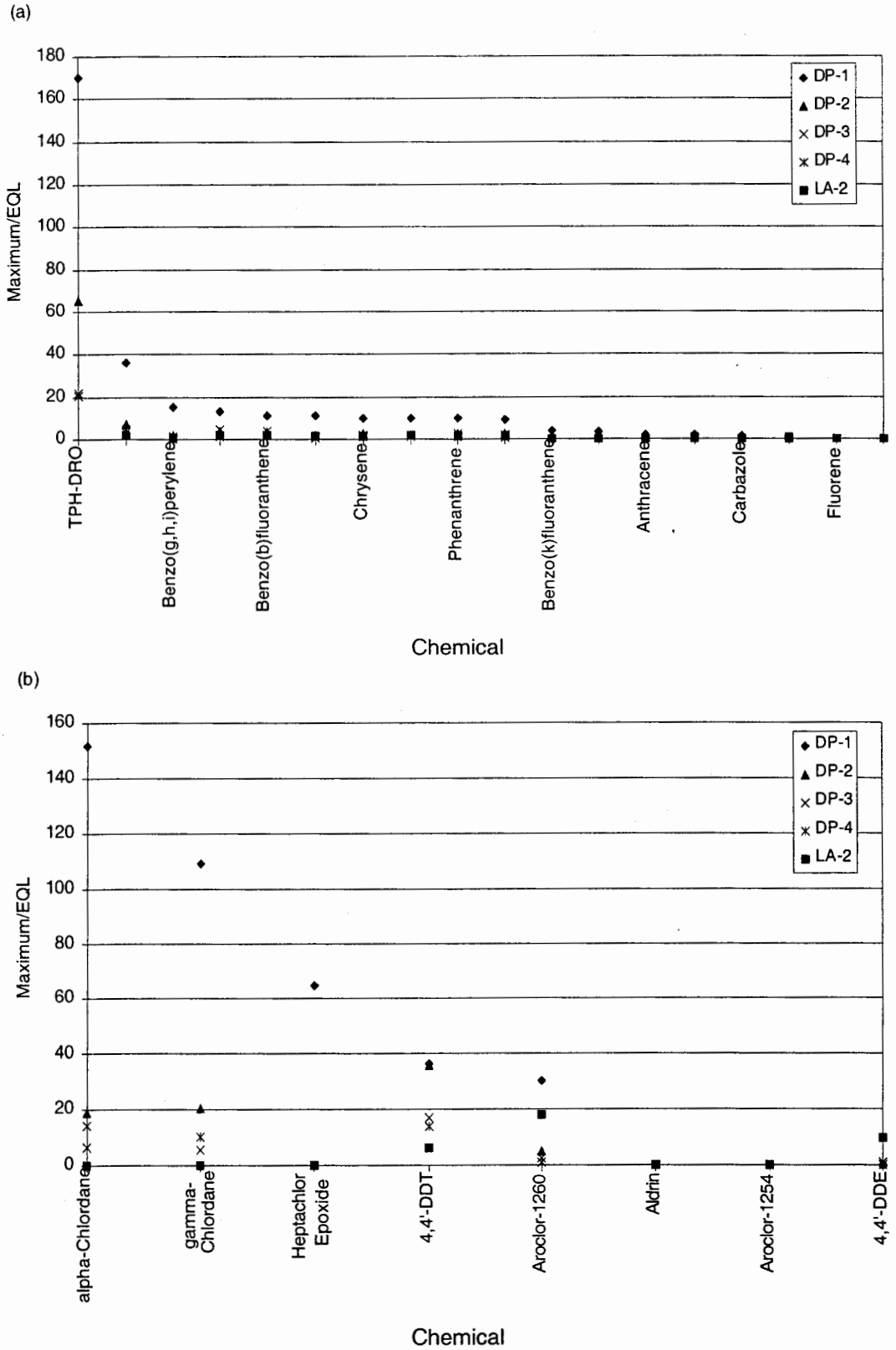


Figure 3.2-5. Maximum organic chemical results normalized by expected detection limits, including detects and nondetects; (a) TPH-DROs and PAHs; (b) PCBs/pesticides

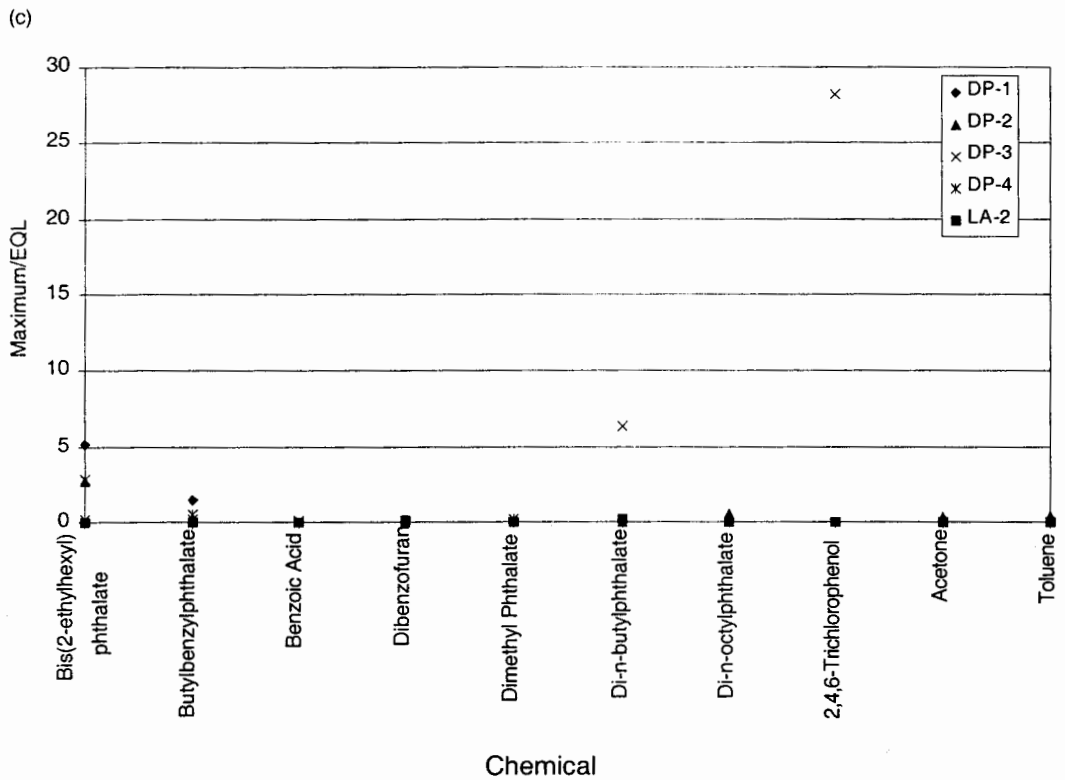


Figure 3.2-5 (continued). **Maximum organic chemical results normalized by expected detection limits, including detects and nondetects; (c) non-PAH SVOCs and VOCs**

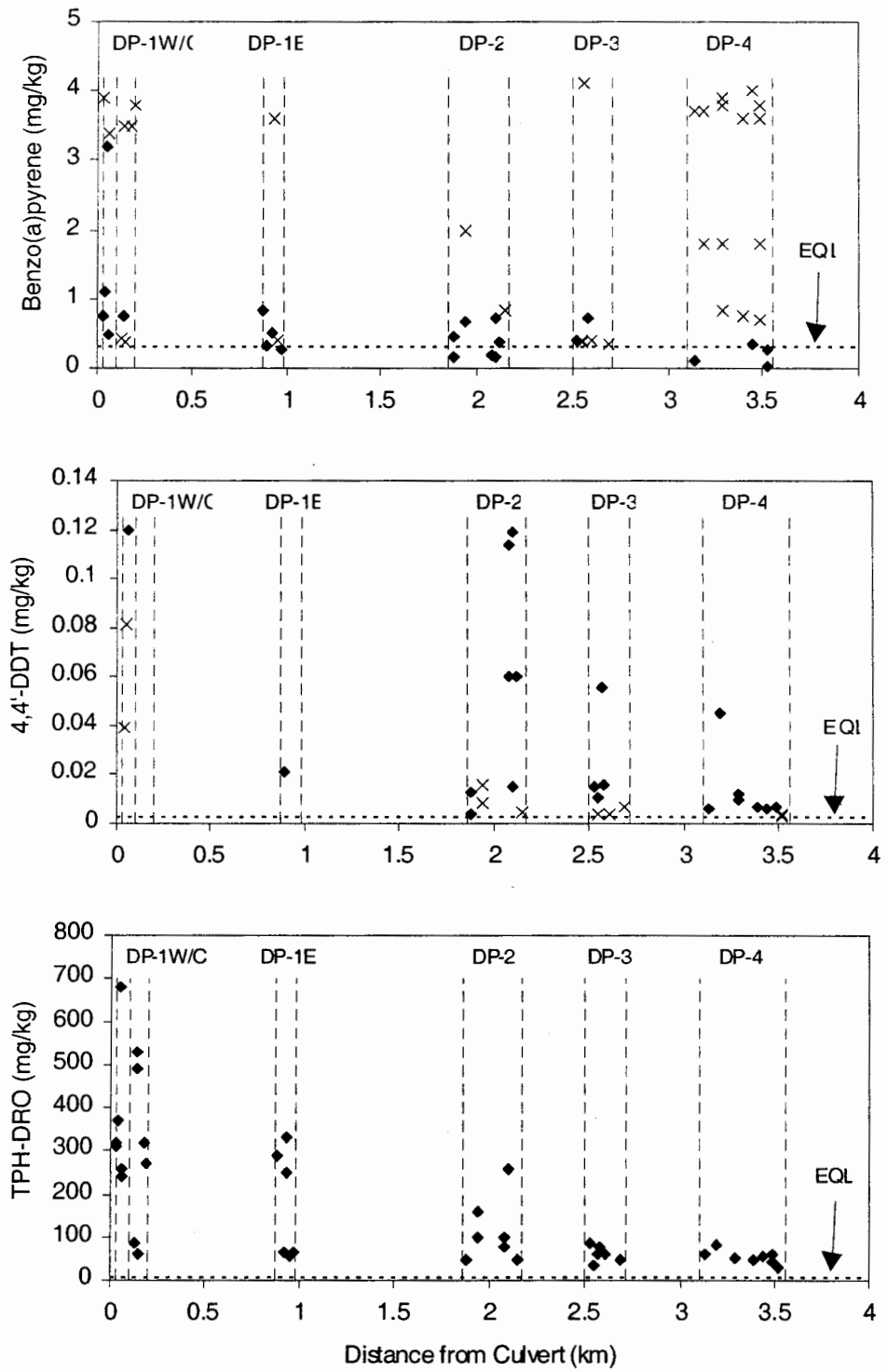


Figure 3.2-6. **Benzo(a)pyrene, 4,4'-DDT, and TPD-DRO concentrations versus distance from the culvert at the head of DP Canyon. Note: "x" symbols represent nondetect sample results.**

3.2.4 Inorganic COPCs in Alluvial Groundwater

Nine inorganic chemicals were identified as alluvial groundwater COPCs based on statistical and graphical data evaluations, as discussed in Section 3.1.5. Only one alluvial groundwater COPC, calcium, also was a sediment COPC. Thus, contaminated sediments may not be the source for most of these inorganic alluvial groundwater COPCs. To evaluate the contribution of storm water runoff to contaminated alluvial groundwater, a scatter plot was prepared that shows the relation between the concentration of the nine inorganic COPCs in alluvial groundwater and the concentration of the same analytes in storm water (Figure 3.2-7). The identity of the COPCs is not important in this plot; rather the overall similarity or difference in concentrations between storm water and alluvial groundwater is most important. Figure 3.2-7a shows the relation between the unfiltered sample results, and Figure 3.2-7b shows the filtered sample data. The plot also shows the line of equality to help determine which sampling locations have the higher concentration. Figure 3.2-7a shows that unfiltered concentrations of inorganic chemical COPCs are distributed both above and below the line of equality. Two values for manganese are noted on Figure 3.2-7a, and these values show that concentrations of manganese in unfiltered water from LAUZ-1 and DP Spring are much lower than concentrations in unfiltered storm water. Unfiltered storm water is not viewed to represent the most appropriate data for evaluating alluvial groundwater baseline conditions, because the suspended particulates may settle out of suspension or be filtered as water passes through the alluvial matrix. Thus, the filtered sample results are a better indicator of the input of COPCs from storm water into DP Canyon alluvial groundwater. Figure 3.2-7b shows that all filtered sample results for LAUZ-1, LAUZ-2, and DP Spring are above the line of equality, except for the manganese maximum result for DP Spring. Thus, concentrations of inorganic COPCs are greater in alluvial groundwater than storm water, which suggests that storm water does not contribute a significant amount to the concentration of alluvial groundwater inorganic COPCs in DP Canyon. The implication is that storm water recharging the alluvial aquifer is altered physically or geochemically in the subsurface, which results in alluvial groundwater that is chemically distinct from its storm water source. This interpretation is discussed further in Chapter 4 as part of the revised conceptual model.

3.2.5 Radionuclide COPCs in Alluvial Groundwater

Five radionuclides were identified as alluvial groundwater COPCs, based on statistical and graphical data evaluations (see Section 3.1.5). Four of these COPCs, plutonium-239,240; strontium-90; tritium; and uranium-234, are also sediment COPCs. The remaining alluvial groundwater COPC, uranium-235, is inferred to represent releases of enriched uranium from the PRS 21-011(k) outfall, which also is suggested by identifying uranium-234 as a COPC in sediment. The identification of specific uranium isotopes is somewhat hampered by the apparent small inventory of enriched uranium and the confounding effects on these data of detection limits and background uranium concentrations. However, contaminated sediments are the apparent source for all these alluvial groundwater radionuclide COPCs. Radionuclides were not measured in storm water, because the storm water sampling stations were located upstream of known radionuclide source areas. Spatial trends in radionuclide concentrations were evaluated by preparing a scatter plot (Figure 3.2-8) that shows the relations between the concentration of radionuclides in the first alluvial groundwater well (LAUZ-1) and the downgradient alluvial groundwater sampling locations (LAUZ-2 or DP Spring). Figure 3.2-8 shows only the relations between the unfiltered sample results, which show that only three radionuclide COPCs were detected at multiple sampling locations. Tritium and uranium-235 were detected in one sample and thus one location each, and these COPCs are absent from Figure 3.2-8. Only strontium-90 and uranium-234 were detected in filtered water samples. The sample results for strontium-90 basically are identical in unfiltered and filtered samples. Sample results for uranium-234 are not greatly affected by sample filtering. Figure 3.2-8 shows that concentrations of radionuclide COPCs are lower in LAUZ-2 and DP Spring than in LAUZ-1. This decreasing spatial concentration trend between LAUZ-1 and DP Spring supports the interpretation that the source of radionuclide contaminants in DP Canyon alluvial groundwater is sediments affected by PRS 21-011(k). Additional discussion of the observed concentrations trends for alluvial groundwater radionuclide COPCs are presented in discussion of the revised conceptual model in Chapter 4.

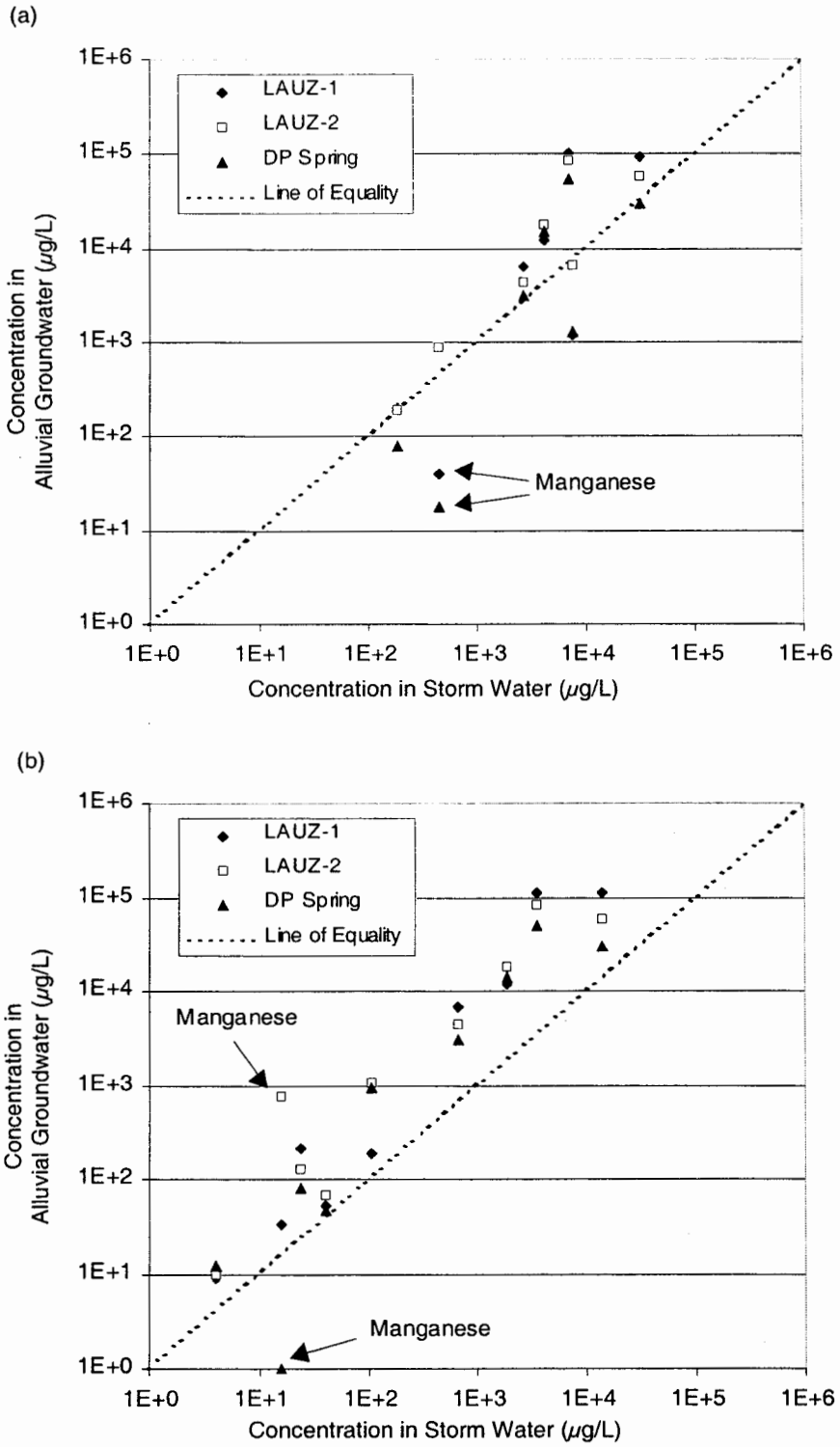


Figure 3.2-7. **Maximum inorganic chemical results by sample collection location for nine water inorganic COPCs; (a) unfiltered sample results; (b) filtered sample results. Note: Symbols reflect sample locations, not different COPCs.**

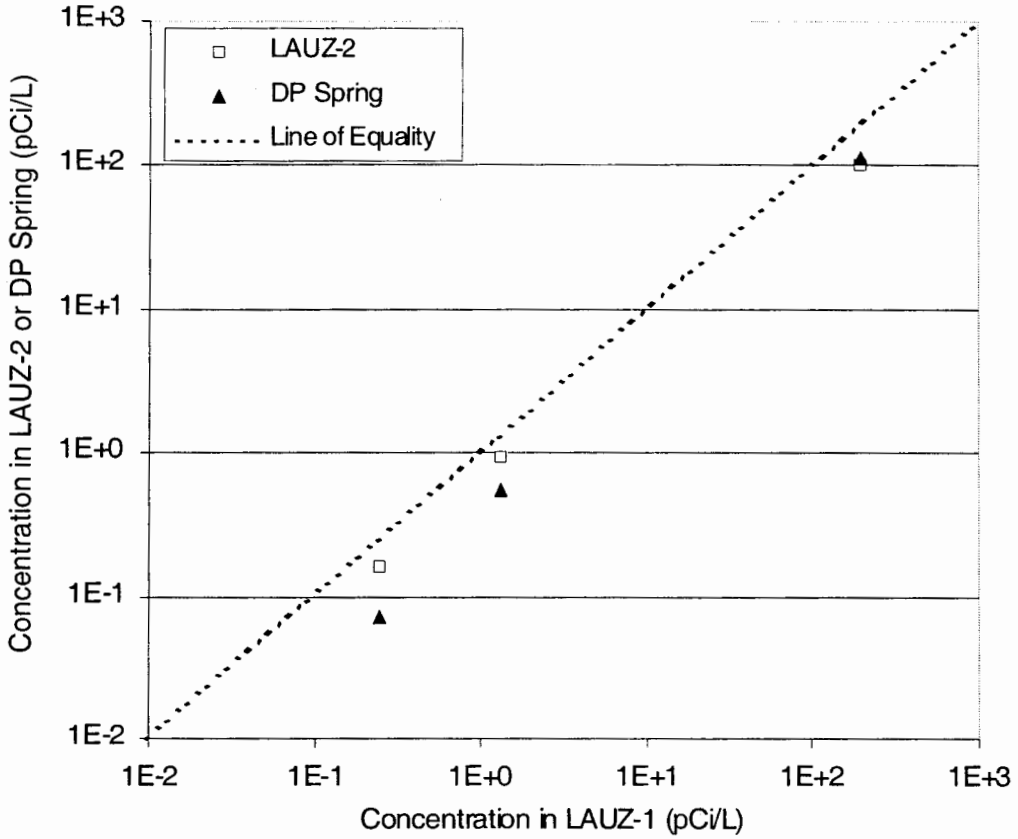
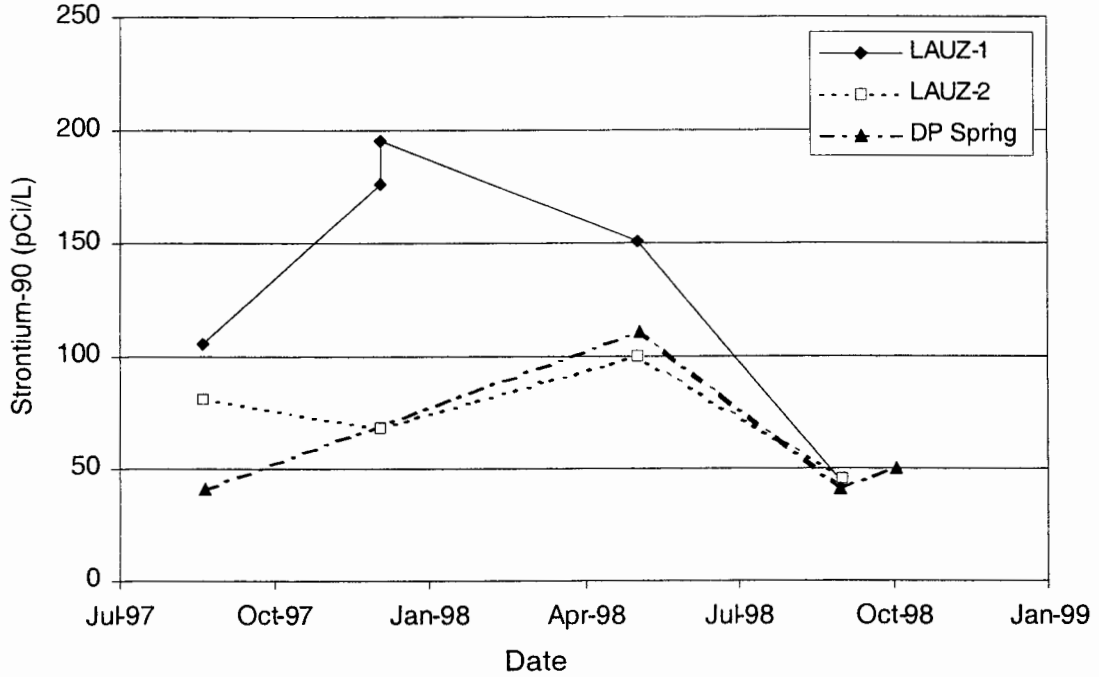


Figure 3.2-8. Maximum unfiltered radionuclide results by sample collection location for three water radionuclide COPCs detected at LAUZ-1, LAUZ-2, and DP Spring (plutonium-239,240; strontium-90; and uranuim-234). Note: Symbols reflect sample locations, not different COPCs.

Because of the frequency of detection of strontium-90 in the current data and the historical detection of strontium-90 in DP Canyon alluvial groundwater, time-series analyses of strontium-90 data from this investigation are presented. The time-series plots show strontium-90 concentrations by sampling location and sample collection date for 1997 and 1998 ER samples (Figure 3.2-9). Figure 3.2-9a shows the time trend for the unfiltered sample results, and Figure 3.2-9b shows the time trend for filtered water data. These limited data show that concentrations in LAUZ-1 were variable, and the maximum concentration was from the fall sampling event. Concentrations in DP Spring also varied, but the highest DP Spring concentration was from a summer sampling event. Concentrations in LAUZ-2 were less variable, and the maximum value was similar to minimum concentration. However, a single year of sampling is not sufficient time to evaluate seasonal trends in strontium-90 concentrations. These plots also show that the concentrations of strontium-90 in unfiltered and filter samples basically are identical.

(a)



(b)

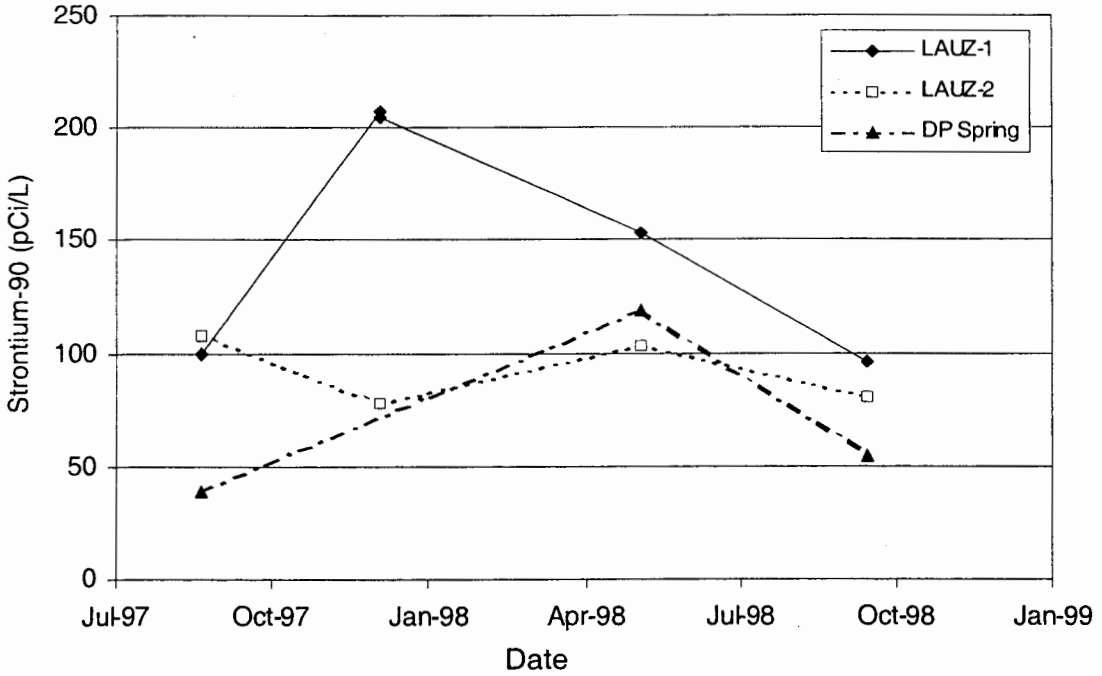


Figure 3.2-9. Time-series plot of quarterly strontium-90 concentrations by sampling location; (a) unfiltered sample results; (b) filtered sample results

To show a longer time series, a plot of the average concentrations (of unfiltered and filtered samples, as well as one pair of field duplicate samples) versus time was constructed that combines data 1997–1998 with 1995 alluvial well data and 1993–1995 samples collected from DP Spring. The 1993–1995 DP Spring strontium-90 results were reported by Goff and Werner (LANL 1996, 63895); NMED and EPA data are presented in Appendix D. Because the EPA strontium-90 sample results appeared to be anomalous, one-half the gross beta result was used as an estimate of strontium-90 sample concentration. Figure 3.2-10 shows the EPA and NMED samples collected in September and October 1998, Laboratory ER Project samples collected in February 1995, and the sample data shown in Figure 3.2-9. Figure 3.2-10 shows that the concentration in LAUZ-1 apparently dropped by more than 50% between 1995 and 1997–1998. In contrast, little variation in DP Spring strontium-90 concentrations is noted between 1993 and 1998. There is also little change from the February 1995 LAUZ-2 concentration and the 1997–1998 concentrations. Thus, the existing data do not provide consistent evidence for an increase or decrease in strontium-90 concentrations over time. Some decrease is expected from radioactive decay, and some decrease in concentration could be associated with removal of approximately 400 yd^3 of the contaminated soil from the PRS 21-011(k) hillslope where storm water runoff historically was in contact with highly contaminated hillslope contaminants. Because of the similarities in concentration at LAUZ-2 or DP Spring over time, the value reported for LAUZ-1 in February 1995 may be anomalous (i.e., a laboratory reporting or analysis error).

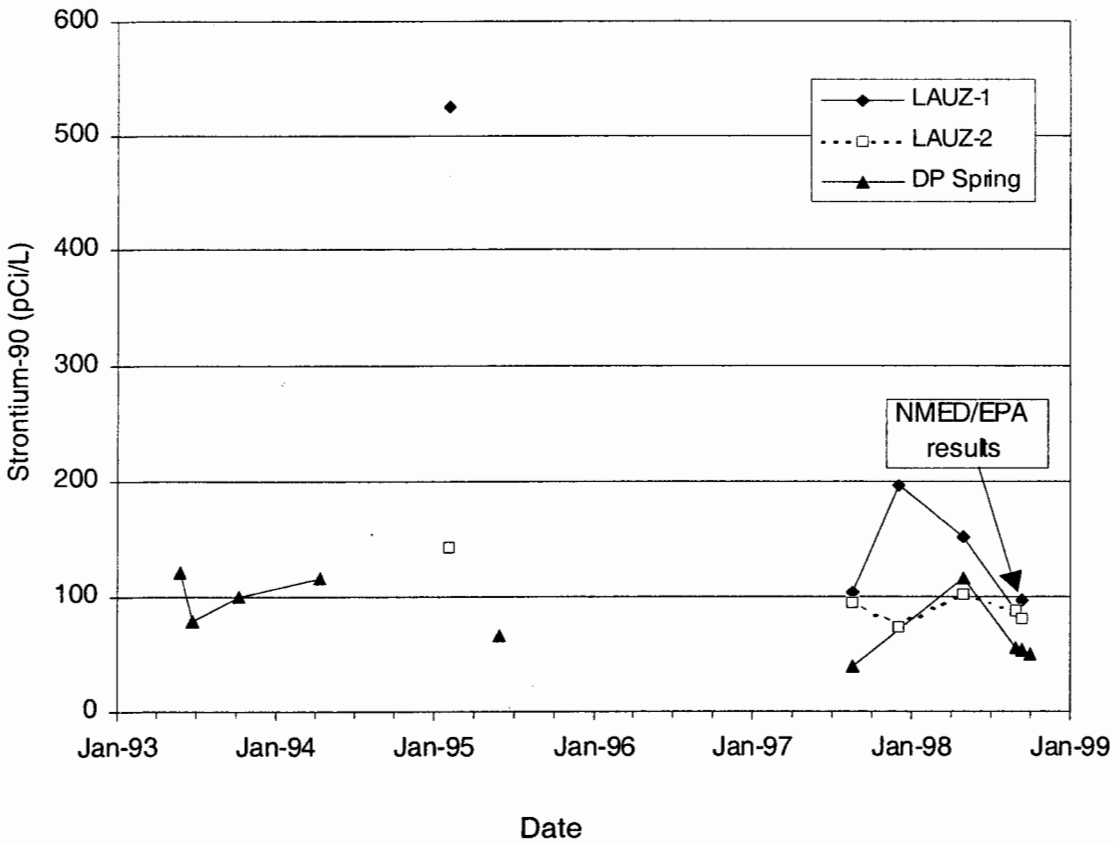


Figure 3.2-10. Time-series plot of average strontium-90 concentrations by sampling location

3.2.6 Organic COPCs in Alluvial Groundwater

Two organic chemicals were detected in DP Canyon alluvial groundwater or DP Spring samples and therefore were identified as COPCs, as discussed in Section 3.1.6. Bis(2-ethylhexyl)phthalate was detected in two filtered alluvial groundwater samples, which seems contrary to the known solubility of this chemical. One VOC (1,2-dichloroethane) was detected in an unfiltered DP Spring sample. After this VOC was detected, DP Spring was resampled, but no VOCs were detected in this resample or any later sampling event. Thus, the presence of 1,2-dichloroethane was not confirmed by any other sample data. The limited detection frequency and somewhat anomalous detection of organic chemicals do not indicate significant contamination of organic COPCs in alluvial groundwater or DP Spring. Thus, discussion of the potential sources for these COPCs is not warranted.

3.2.7 Multimedia Assessment of COPCs

The multimedia assessment of DP Canyon COPCs is based on the similarity or dissimilarity of COPCs by analyte groups (inorganic chemicals, radionuclides, and organic chemicals) and media (sediment or water). Inorganic COPCs are not similar because only calcium is found in both sediment and alluvial groundwater. As discussed in Section 3.2.1, the possible source for calcium in both alluvial groundwater and sediment may be the abundant concrete in reach DP-1. A concrete culvert, approximately 30 m long, is located at the head of DP Canyon. This culvert is another likely calcium source. The radionuclide COPCs are similar in both alluvial groundwater and sediment, and the alluvial groundwater radionuclide COPC list is basically a subset of the sediment COPC list. Radionuclides not detected in alluvial groundwater or not detected in filtered water samples are known to have lower water solubility. Lastly, there is basically no overlap in the organic COPCs because only two organic chemicals were identified as COPCs in alluvial groundwater or DP Spring. This lack of overlap is predicted by the low solubility of the organic chemicals identified as sediment COPCs.

An important part of the data assessment for DP Canyon is understanding the relevance of the storm water sample results. The storm water data were collected to help provide a "baseline" or initial concentration of COPCs in surface water before it recharged the alluvial groundwater. What is apparent from the graphics presented in Section 3.2.5 is that storm water has a different chemical signature than the alluvial groundwater. To help understand the relation of chemical concentrations in storm water to active channel sediments, a scatter plot was prepared to compare constituent concentrations in the active channel sediments to constituent concentrations in storm water. Figure 3.2-11 shows the concentration of detected inorganic and organic chemicals in the active channel sediments versus the concentration of the same chemicals in unfiltered storm water. The points showing the inorganic chemical data basically fall on a straight line, which suggests that the concentration of the inorganic chemicals in storm water is due to a suspended solid load of sediment particles. This point is also evident by examining the difference between filtered and unfiltered storm water samples. In addition, storm water also acts to supply contamination to the sediments, which complete the cycle of contaminant transport and deposition. Sodium shows as an outlier on the plot, and has a higher concentration in unfiltered storm water than in sediment. Thus, sodium appears to be entering DP Canyon in storm water events, and residual amounts of sodium may be associated with use of road salts during the winter. The organic chemicals generally are present at a lower concentration than the inorganic chemicals. An exception is bis(2-ethylhexyl)phthalate, which is presented in unfiltered storm water at a much higher percentage than other organic chemicals. The apparent introduction of this one plasticizer from storm water could explain its presence in alluvial groundwater, with the important exception that bis(2-ethylhexyl)phthalate was detected in filtered alluvial groundwater and not detected in filtered storm water. In summary, the simplest interpretation is that the unfiltered storm water data support the evaluation of sediment contaminant transport and that these storm water data do not provide useful information on the baseline concentrations of chemicals in alluvial groundwater.

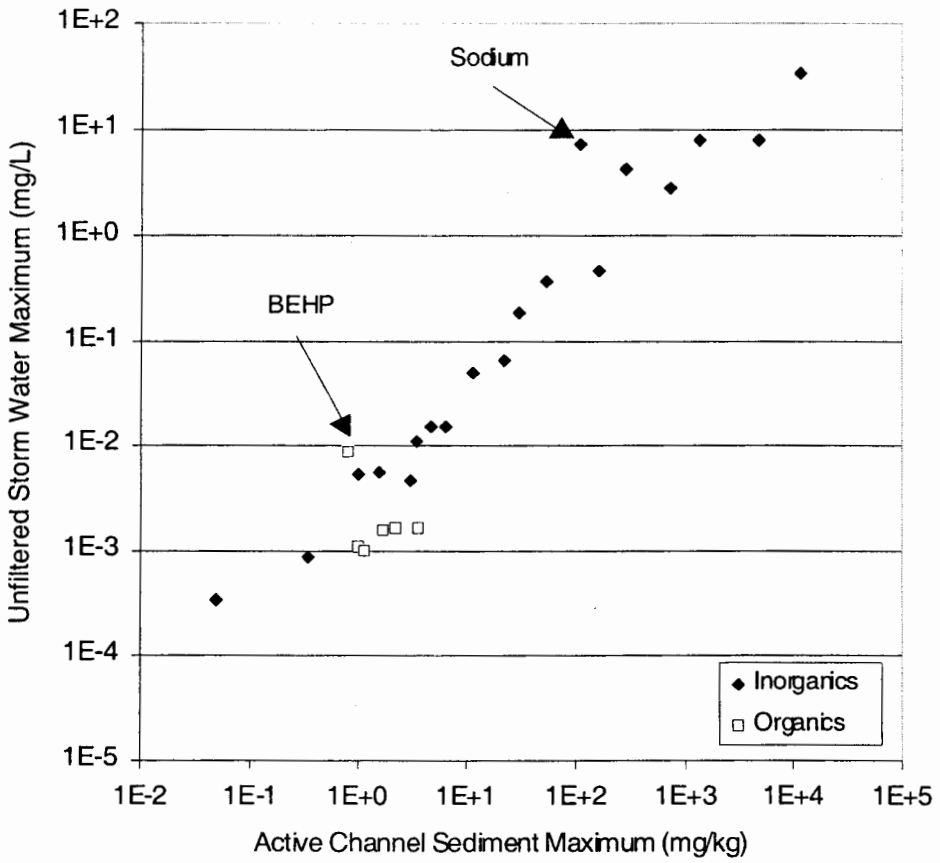


Figure 3.2-11. Maximum unfiltered storm water sample results versus maximum active channel (c1 geomorphic unit) sediment sample results for detected inorganic and organic chemicals in storm water. Note: BEHP is bis(2-ethylhexyl)phthalate; each symbol represents a different chemical.

3.3 Key Contaminant Analyses in Sediment

Key contaminants are those that can be unambiguously associated with Laboratory effluent releases and are at sufficient concentrations to support the analysis of how contaminants and sediments have been transported and deposited over time. The key contaminants are also used to guide field investigations and make preliminary assessments of data sufficiency. The radionuclides americium-241; cesium-137; plutonium-238; plutonium-239,240; and strontium-90 were selected as key contaminants for DP Canyon because they are the best indicators of the potential impacts to canyon sediment from Laboratory operations, specifically operations conducted at TA-21. These five radionuclides were also identified as key COPCs in upper Los Alamos Canyon sediments (Reneau et al. 1998, 59160). The assessment of reach sediment data from upper Los Alamos Canyon indicated that DP Canyon, specifically PRS 21-011(k), is the most important source of the americium-241, cesium-137, plutonium-238, and strontium-90. Uranium and tritium were also reported in PRS 21-011(k) effluent; these radionuclides were not present in high concentrations in sediment and water and are therefore not good measures of sediment transport. Although plutonium-239,240 is present in DP Canyon sediments and at PRS 21-011(k), most plutonium-239,240 contamination in upper Los Alamos Canyon is believed to be derived from one or more PRSs in Los Alamos Canyon above the confluence with DP Canyon. Key contaminants also were selected based on their suspected contribution to human-health risk. The human-health risk evaluation conducted for sediment contamination in upper Los Alamos Canyon indicates that cesium-137 and strontium-90 are the main human-health risk drivers in Los Alamos Canyon and therefore are important in the DP Canyon assessment (Reneau et al. 1998, 59160). Strontium-90 is also a significant contaminant in alluvial groundwater in DP Canyon and upper Los Alamos Canyon (LANL 1995, 50290; Longmire et al. 1996, 54168). However, alluvial groundwater data from upper Los Alamos Canyon above the confluence of DP Canyon indicate that the majority of strontium-90 contamination is from DP Canyon.

Inorganic and organic contaminants identified in DP Canyon are interpreted as being derived from non-Laboratory sources in the Los Alamos townsite (see Section 3.2). These contaminants are not considered indicators of releases from Laboratory PRSs and are not considered key contaminants for the purpose of developing a revised site conceptual model by interpreting their spatial distribution or sediment transport dynamics in DP Canyon. They are evaluated in this report, however, for their contribution to risk.

This section presents and evaluates the sediment data for the key contaminants (americium-241, cesium-137, plutonium-238, plutonium-239,240, and strontium-90). The discussion focuses on examining variations in the concentrations of these radionuclides between geomorphic units and sediment facies in each reach and the effects of particle size variations and sediment transport and deposition on contaminant concentrations. In addition, these data are combined with data on the areas, thicknesses, and density of post-1942 sediments in the geomorphic units to calculate estimates of radionuclide inventories of by geomorphic unit, by facies, and by reach. In Chapter 4 these data are used to refine the conceptual model for contaminant transport and distribution in DP Canyon, and in Chapter 5 these data and data on the other COPCs are used to prepare preliminary assessments of human-health risk and ecological risk.

3.3.1 Geomorphic Evaluation of Radionuclide Data

Concentrations of each radionuclide vary by several orders of magnitude within the sediments of DP Canyon. This variability is affected by the age of the sediment deposits relative to the time of contaminant releases, the physical processes of sediment transport, and the mixing of sediment from a variety of sources. The geomorphic evaluation of these data is a necessary part of this investigation for revising the DP Canyon conceptual model. The updated conceptual model will then describe contaminant inventories, how contaminants are transported through DP Canyon, and the likely consequences for various remediation decisions including "no action." Aspects of the radiological data that are evaluated in a geomorphic context are also presented in this section.

3.3.1.1 Binning of Radionuclide Data

Fixed-point gross gamma radiation data, walkover radiation survey data, and laboratory analytical results for cesium-137 were used to support the designation of geomorphic units (discussed in Section 2.2.1). Analytical results for cesium-137 are, therefore, consistent with the geomorphic unit designations with a few exceptions that result from variability in contaminant concentration within any geomorphic unit. It is assumed that the grouping or "binning" also adequately describes populations of analytical data for other radiological contaminants that are collocated with cesium-137.

The cesium-137 data in each reach were first examined after being "binned" by individual geomorphic units and sediment facies, and where appropriate, these subsets of data were combined into larger bins to increase sample size (Tables 3.3-1, 3.3-2, and 3.3-3). Cesium-137 results from coarse-grained sediments and fine-grained sediments were kept in separate "bins" to evaluate the variation in contaminant concentration as a function of particle size. Samples within the same sediment facies in different units were kept in separate bins if the variations in radionuclide concentration provided information on time-dependent trends in a reach (e.g., where c1 sediment in active channels has less cesium-137 than texturally similar c2 sediment in older, abandoned channel units), but these subsets were combined where no such trends were apparent in the data. These grouped or binned data are used to support the geomorphic assessments and human-health risk assessments in this report; therefore, the specific binning process is an important part of the data evaluation. This discussion of the binning process documents the specific rationale used in this investigation.

3.3.1.2 Evaluation of Effects of Sediment Age and Particle Size

Temporal trends in radionuclide concentration in each reach were evaluated by examining the radionuclide data in terms of different ages of associated geomorphic units. Constraints on relative sediment age were provided by examining radioisotope ratios in sediments, spatial (inset) relations between geomorphic units, and/or vertical stratigraphic relations (deeper sediment layers within a stratigraphic section being older than shallower sediment layers). Because available data indicate that radionuclide COPCs tend to occur in higher concentrations in finer-grained sediments of a given age, it is appropriate to compare samples with similar particle-size characteristics to determine if differences or similarities in radionuclide concentration between samples provide insight into time-dependent trends. For each reach, all samples were compared on scatter plots showing the relation of different radionuclide concentrations to various particle-size parameters (e.g., percent silt and clay and median particle size), helping to identify sediment packages that share similar relations between radionuclide concentration and particle size. Scatter plots comparing radionuclide data and organic matter content were also examined because many contaminants can be preferentially associated with organic colloids (Langmuir 1997, 56037), and positive correlations have been reported between radionuclide concentration and organic matter content in sediments at the Laboratory (Nyhan et al. 1976, 11747). These plots are presented in Appendix B, Figures B2-1 through B2-18.

Additionally, data on radioisotope concentrations in DP Canyon surface water collected at environmental surveillance sampling station DPS-1 in DP-2 (near PRS 21-011[k]) can be used as a general indicator of the contaminant release history and age trends in the key radioisotopes supported by data from the actual effluent (Reneau 1999, 63138). Table 3.3-4 provides a summary of the Environmental Surveillance Group data collected at DPS-1. These data show an overall decreasing trend in concentration over time for all radionuclides. Also, note the spike in the americium-241 concentration in 1979. This corresponds to an overall trend towards higher americium-241 concentrations following 1979, which is also indicated by effluent data (Reneau 1999, 63138) and provides insight into sediment age. Figure 3.3-1 is a plot illustrating the trend of cesium-137 and americium-241 concentrations in surface water at DPS-1

Table 3.3-1
Summary of Binned Analyses and Isotope Ratios in Reach DP-2

Sample ID	Location ID	Geomorphic Unit	Sediment Facies	Median Particle Size Class	Depth (cm)	Americium-241	Cesium-137	Plutonium-238	Plutonium-239,240	Strontium-90	Pu-239/Pu-238 Ratio	Am-241/Pu-239 Ratio	Cs-137/Am-241 Ratio
CA21-98-0096	21-05502	c2	fine	fs[a]	5–20	1.19	6.8	0.053	0.355	2.43	—[b]	—	—
CA21-98-0077	21-10951	c3a	fine	vfs[c]	0–33	1.56	3.43	0.068	0.28	0.56	—	—	—
CA21-98-0078	21-10951	c3a	fine	vfs	33–60	2.5	3.66	0.112	0.475	0.54	—	—	—
CA21-98-0079	21-10951	c3a	fine	vfs	60–73	4.1	4.85	0.229	0.915	0.76	—	—	—
				average		**2.34**	**4.69**	**0.12**	**0.51**	**1.07**	**4.3**	**4.8**	**2.0**
				standard deviation		**1.30**	**1.54**	**0.08**	**0.28**	**0.91**			
				maximum		**4.10**	**6.80**	**0.23**	**0.92**	**2.43**			
				minimum		**1.19**	**3.43**	**0.05**	**0.28**	**0.54**			
				median		**2.03**	**4.26**	**0.09**	**0.42**	**0.66**			
				number of samples		**4**	**4**	**4**	**4**	**4**			
CA21-98-0092	21-05499	c3b	fine	vfs	0–20	5.3	88	0.218	2.97	15.1	—	—	—
0121-97-1363	21-05499	c3b	fine	vfs	20–41	1.65	94.7	0.181	4.13	32.8	—	—	—
CA21-98-0094	21-05499	c3b	fine	fs	40–55	0.75	8.6	0.047	2.46	11.9	—	—	—
CA21-98-0095	21-05499	c3b	fine	fs	55–76	1.3	9.6	0.096	3.46	15.9	—	—	—
CA21-98-0070	21-05501	c3b	fine	fs	0–20	1.03	0.69	0.08	0.2	0.11	—	—	—
0121-97-1361	21-05501	c3b	fine	fs	20–51	5.73	2.5	0.398	0.923	4.76	—	—	—
CA21-98-0072	21-05501	c3b	fine	vfs	55–70	5.9	14.4	0.347	1.411	5.8	—	—	—
CA21-98-0074	21-10950	c3b	fine	fs	0–29	0.65	0.96	—	—	0.13	—	—	—
CA21-98-0075	21-10950	c3b	fine	vfs	29–51	0.94	1.35	—	—	0.33	—	—	—
CA21-98-0086	21-10954	c3b	fine	fs	0–21	18.4	11.4	0.549	1.238	1.26	—	—	—
CA21-98-0087	21-10954	c3b	fine	csi[d]	30–45	29.8	25.8	0.989	3.77	7.4	—	—	—
CA21-98-0088	21-10954	c3b	fine	vfs	54–65	3.4	442	0.158	3.95	3.74	—	—	—
CA21-98-0136	21-10956	c3b	fine	csi	76–82	2.95	6.2	—	—	12.8	—	—	—
				average		**5.98**	**54.32**	**0.31**	**2.45**	**8.62**	**8.0**	**2.4**	**9.1**
				standard deviation		**8.58**	**120.74**	**0.29**	**1.42**	**9.24**			
				maximum		**29.80**	**442.00**	**0.99**	**4.13**	**32.80**			
				minimum		**0.65**	**0.69**	**0.05**	**0.20**	**0.11**			
				median		**2.95**	**9.60**	**0.20**	**2.72**	**5.80**			
				number of samples		**13**	**13**	**10**	**10**	**13**			

Table 3.3-1 (continued)

Sample ID	Location ID	Geomorphic Unit	Sediment Facies	Median Particle Size Class	Depth (cm)	Americium-241	Cesium-137	Plutonium-238	Plutonium-239,240	Strontium-90	Pu-239/Pu-238 Ratio	Am-241/Pu-239 Ratio	Cs-137/Am-241 Ratio
0121-97-1364	21-05498	f1	fine	vfs	0–30	4.59	32.4	0.611	2.77	7.5	—	—	—
CA21-98-0082	21-05500	f1	fine	csi	0–20	13.4	51.1	0.703	3.41	11.3	—	—	—
0121-97-1362	21-05500	f1	fine	vfs	20–41	5.18	76.2	0.506	4.04	19.6	—	—	—
CA21-98-0084	21-05500	f1	fine	vfs	55–75	1.9	25.7	0.151	5.56	—	—	—	—
CA21-98-0085	21-05500	f1	fine	vfs	75–90	0.65	4.13	—	—	3.29	—	—	—
CA21-98-0081	21-10952	f1	fine	csi	0–23	14.4	6.7	—	—	1.58	—	—	—
CA21-98-0148	21-10952	f1	fine	csi	23–43	8.4	11.2	—	—	2.31	—	—	—
CA21-98-0090	21-10955	f1	fine	vfs	0–14	0.63	3.98	—	—	1.77	—	—	—
CA21-98-0091	21-10955	f1	fine	vfs	14–33	0.75	3.64	—	—	1.49	—	—	—
CA21-98-0099	21-10959	f1	fine	vfs	0–28	1.7	16.5	—	—	3.76	—	—	—
				average		**5.16**	**23.16**	**0.49**	**3.95**	**5.84**	**8.1**	**1.3**	**4.5**
				standard deviation		**5.24**	**24.16**	**0.24**	**1.20**	**6.11**			
				maximum		**14.40**	**76.20**	**0.70**	**5.56**	**19.60**			
				minimum		**0.63**	**3.64**	**0.15**	**2.77**	**1.49**			
				median		**3.25**	**13.85**	**0.56**	**3.73**	**3.29**			
				number of samples		**10**	**10**	**4**	**4**	**9**			
CA21-98-0101	21-10960	c1	coarse	cs[e]	0–5	-0.19	0.27	0.0127	0.0272	0.64	—	—	—
				average		**-0.19**	**0.27**	**0.01**	**0.03**	**0.64**			
				number of samples		**1**	**1**	**1**	**1**	**1**			
0121-97-1441	21-05502	c2	coarse	ms[f]	20–32	1.23	36.3	0.263	2.45	3.88	—	—	—
CA21-98-0080	21-10951	c3a	coarse	cs	73–97	1.21	1.37	0.086	0.133	1.13	—	—	—
				average		**1.22**	**18.84**	**0.17**	**1.29**	**2.51**	**7.6**	**1.0**	**15.4**
				number of samples		**2**	**2**	**2**	**2**	**2**			

Table 3.3-1 (continued)

Sample ID	Location ID	Geomorphic Unit	Sediment Facies	Median Particle Size Class	Depth (cm)	Americium-241	Cesium-137	Plutonium-238	Plutonium-239,240	Strontium-90	Pu-239/Pu-238 Ratio	Am-241/Pu-239 Ratio	Cs-137/Am-241 Ratio
CA21-98-0073	21-05501	c3b	coarse	cs	88–98	7.3	134	1.286	11.11	1.12	—	—	—
CA21-98-0076	21-10950	c3b	coarse	ms	68–93	0.23	1.08	—	—	0.7	—	—	—
CA21-98-0089	21-10954	c3b	coarse	cs	65–78	2.6	128	0.192	4.15	1.68	—	—	—
CA21-98-0137	21-10956	c3b	coarse	cs	82–103	0.15	14.5	—	—	1.55	—	—	—
				average		**2.57**	**69.40**	**0.74**	**7.63**	**1.26**	**10.3**	**0.3**	**27.0**
				standard deviation		**3.35**	**71.39**	**0.77**	**4.92**	**0.44**			
				maximum		**7.30**	**134.00**	**1.29**	**11.11**	**1.68**			
				minimum		**0.15**	**1.08**	**0.19**	**4.15**	**0.70**			
				median		**1.42**	**71.25**	**0.74**	**7.63**	**1.34**			
				number of samples		**4**	**4**	**2**	**2**	**4**			
Background?													
CA21-98-0100	21-10959	f1	coarse	cs	39–53	0.21	0.219	—	—	0.19	—	—	—
				average		**0.21**	**0.22**	**—**	**—**	**0.19**			
				number of samples		**1**	**1**	**—**	**—**	**1**			

[a] fs = fine sand.

[b] A dash in the table means "not analyzed" or not calculated in the case of isotope ratios.

[c] vfs = very fine sand.

[d] csi = coarse silt.

[e] cs = coarse sand.

[f] ms = medium sand.

Table 3.3-2
Summary of Binned Analyses and Isotope Ratios in Reach DP-3

Sample ID	Location ID	Geomorphic Unit	Sediment Facies	Median Particle Size Class	Depth (cm)	Americium-241	Cesium-137	Plutonium-238	Plutonium-239,240	Strontium-90	Pu-239/Pu-238 Ratio	Am-241/Pu-239 Ratio	Cs-137/Am-241 Ratio
CA21-98-0102	21-10961	c3a	fine	fs[a]	8–23	13	10.3	0.81	2.47	2.38	—[b]	—	—
				average		**13.00**	**10.30**	**0.81**	**2.47**	**2.38**			
				number of samples		**1**	**1**	**1**	**1**	**1**			
0121-97-1432	21-5497	c3b	fine	fs	53–65	28.6	93.2	2.21	11.2	12.1	—	—	—
CA21-98-0104	21-10962	c3b	fine	vfs[c]	0–31	6	111	0.445	9.73	17.1	—	—	—
CA21-98-0105	21-10962	c3b	fine	csi[d]	31–65	4.2	85	0.649	8.8	—	—	—	—
CA21-98-0106	21-10962	c3b	fine	csi	114–136	0.2	2.48	0.0258	0.606	—	—	—	—
CA21-98-0108	21-10963	c3b	fine	vfs	0–17	7.6	10.4	0.402	1.255	1.99	—	—	—
CA21-98-0109	21-10963	c3b	fine	vfs	17–41	71	90	2.79	7.44	—	—	—	—
CA21-98-0110	21-10963	c3b	fine	fs	41–61	7	192	0.941	10.08	2.35	—	—	—
				average		**17.80**	**83.44**	**1.07**	**7.02**	**8.39**	**6.6**	**2.5**	**4.7**
				standard deviation		**25.17**	**64.00**	**1.03**	**4.32**	**7.46**			
				maximum		**71.00**	**192.00**	**2.79**	**11.20**	**17.10**			
				minimum		**0.20**	**2.48**	**0.03**	**0.61**	**1.99**			
				median		**7.00**	**90.00**	**0.65**	**8.80**	**7.23**			
				number of samples		**7**	**7**	**7**	**7**	**4**			
CA21-98-0111	21-10964	f1	fine	ms[e]	0–20	16.6	15.4	—	—	—	—	—	—
CA21-98-0112	21-10964	f1	fine	vfs	20–40	21.7	18.7	—	—	—	—	—	—
CA21-98-0113	21-10964	f1	fine	vfs	48–77	25.9	22.5	—	—	—	—	—	—
CA21-98-0115	21-10964	f1	fine	vfs	77–95	8.3	64	—	—	—	—	—	—
CA21-98-0114	21-10964	f1	fine	vfs	95–120	12.6	57.8	—	—	—	—	—	—
				average		**17.02**	**35.68**						**2.1**
				standard deviation		**7.01**	**23.26**						
				maximum		**25.90**	**64.00**						
				minimum		**8.30**	**15.40**						
				median		**16.60**	**22.50**						
				number of samples		**5**	**5**						

Table 3.3-2 (continued)

Sample ID	Location ID	Geomorphic Unit	Sediment Facies	Median Particle Size Class	Depth (cm)	Americium-241	Cesium-137	Plutonium-238	Plutonium-239,240	Strontium-90	Pu-239/Pu-238 Ratio	Am-241/Pu-239 Ratio	Cs-137/Am-241 Ratio
CA21-98-0119	21-10966	f2	fine	csi	0–18	1.05	2.2	—	—	—	—	—	—
				average		**1.05**	**2.20**						
				number of samples		**1**	**1**						
CA21-98-0120	21-10967	c1	coarse	cs[f]	0–5	-0.22	1.03	0.0207	0.084	0.39	—	—	—
				average		**-0.22**	**1.03**	**0.02**	**0.08**	**0.39**			
				number of samples		**1**	**1**	**1**	**1**	**1**			
CA21-98-0103	21-10961	c3a	coarse	vcs[g]	51–58	5.3	10.8	0.371	0.922	1.35	—	—	—
CA21-98-0154	21-05497	c3b	coarse	cs	105–135	0.77	12.9	0.066	0.393	1.11	—	—	—
CA21-98-0107	21-10962	c3b	coarse	ms	136–152	0.37	6.5	0.085	1.407	4.08	—	—	—
CA21-98-0118	21-10965	f1	coarse	vcs	70–113	0.12	2.28	—	—	—	—	—	—
				average		**1.64**	**8.12**	**0.17**	**0.91**	**2.18**	**5.4**	**1.8**	**5.0**
				standard deviation		**2.45**	**4.72**	**0.17**	**0.51**	**1.65**			
				maximum		**5.30**	**12.90**	**0.37**	**1.41**	**4.08**			
				minimum		**0.12**	**2.28**	**0.07**	**0.39**	**1.11**			
				median		**0.57**	**8.65**	**0.09**	**0.92**	**1.35**			
				number of samples		**4**	**4**	**3**	**3**	**3**			
Background?													
CA21-98-0116	21-10965	f1	fine	csi	0–23	-0.35	0.17	0.0071	0.102	1.06	—	—	—
CA21-98-0117	21-10965	f1	fine	vfs	23–56	0.11	0.021	—	—	—	—	—	—

[a] fs = fine sand.

[b] A dash in the table means "not analyzed."

[c] vfs = very fine sand.

[d] csi = coarse silt.

[e] ms = medium sand.

[f] cs = coarse sand.

[g] vcs = very coarse sand.

Table 3.3-3
Summary of Binned Analyses and Isotope Ratios in Reach DP-4

Sample ID	Location ID	Geomorphic Unit	Sediment Facies	Median Particle Size Class	Depth (cm)	Americium-241	Cesium-137	Plutonium-238	Plutonium-239,240	Strontium-90	Pu-239/Pu-238 Ratio	Am-241/Pu-239 Ratio	Cs-137/Am-241 Ratio
0121-97-1347	21-05486	c2b	fine	vfs[a]	14–27	10.5	26.9	0.602	2.1	4.8	—[b]	—	—
CA21-98-0131	21-05490	c2b	fine	vfs	0–28	6.3	78	0.944	4.9	12.2	—	—	—
0121-97-1353	21-05490	c2b	fine	vfs	28–53	6.78	149	1.192	11.88	28.3	—	—	—
0121-97-1355	21-05491	c2b	fine	fs[c]	0–30	4.28	133	1.046	48.3	26.9	—	—	—
CA21-98-0152	21-05491	c2b	fine	cs[d]	53–83	1.45	3.61	0.058	4.5	0.54	—	—	—
0121-97-1354	21-05491	c2b	fine	fs	30–46	1.45	109	0.09	4.45	31.1	—	—	—
CA21-98-0122	21-10973	c2b	fine	ms[e]	5–20	32.7	31.8	1.34	4.18	6.7	—	—	—
				average		**9.07**	**75.90**	**0.75**	**11.47**	**15.79**	**15.3**	**0.8**	**8.4**
				standard deviation		**10.90**	**56.68**	**0.52**	**16.53**	**12.67**			
				maximum		**32.70**	**149.00**	**1.34**	**48.30**	**31.10**			
				minimum		**1.45**	**3.61**	**0.06**	**2.10**	**0.54**			
				median		**6.30**	**78.00**	**0.94**	**4.50**	**12.20**			
				number of samples		**7**	**7**	**7**	**7**	**7**			
0121-97-1350	21-05487	c2a	fine	fs	0–40	3.41	9.18	0.233	0.879	1.41	—	—	—
CA21-98-0149	21-10968	f1	fine	fs	0–20	1.8	4.12	0.07	0.357	1.33	—	—	—
CA21-98-0121	21-10968	f1	fine	fs	20–40	4.5	12.9	0.356	0.991	2.64	—	—	—
CA21-98-0150	21-10968	f1	fine	vfs	40–70	16.2	25.6	1.312	2.54	5.5	—	—	—
04LA-96-0140	LA-0016	f1	fine	fs	0–8	2.74	87.82	0.688	4.15	9.87	—	—	—
				average		**5.73**	**27.92**	**0.53**	**1.78**	**4.15**	**3.4**	**3.2**	**4.9**
				standard deviation		**5.94**	**34.41**	**0.49**	**1.55**	**3.62**			
				maximum		**16.20**	**87.82**	**1.31**	**4.15**	**9.87**			
				minimum		**1.80**	**4.12**	**0.07**	**0.36**	**1.33**			
				median		**3.41**	**12.90**	**0.36**	**0.99**	**2.64**			
				number of samples		**5**	**5**	**5**	**5**	**5**			

Table 3.3-3 (continued)

Sample ID	Location ID	Geomorphic Unit	Sediment Facies	Median Particle Size Class*	Depth (cm)	Americium-241	Cesium-137	Plutonium-238	Plutonium-239,240	Strontium-90	Pu-239/Pu-238 Ratio	Am-241/Pu-239 Ratio	Cs-137/Am-241 Ratio
CA21-98-0130	21-10969	c1	coarse	vcs[f]	0–5	0.18	1.11	0.0139	0.054	0.09	—	—	—
				average		**0.18**	**1.11**	**0.01**	**0.05**	**0.09**			
				number of samples		**1**	**1**	**1**	**1**	**1**			
0121-97-1349	21-05486	c2b	coarse ("fine")	cs	35–54	0.838	80.7	0.076	2.98	1.52	—	—	—
0121-97-1348	21-05488	c2b	coarse	ms	0–24	0.079	65.2	0.094	2.5	7.6	—	—	—
0121-97-1352	21-05489	c2b	coarse	ms	40–70	0.937	21.2	0.279	1.05	3.38	—	—	—
CA21-98-0133	21-05490	c2b	coarse	cs	54–105	0.06	11.5	0.053	0.475	5.7	—	—	—
CA21-98-0126	21-05491	c2b	coarse	cs	53–83	1.55	3.32	0.041	4.3	0.99	—	—	—
CA21-98-0151	21-10973	c2b	coarse	cs	38–50	0.38	6.7	0.0231	0.488	2.51	—	—	—
				average		**0.64**	**31.44**	**0.09**	**1.97**	**3.62**	**21.9**	**0.3**	**49.1**
				standard deviation		**0.58**	**33.08**	**0.09**	**1.55**	**2.56**			
				maximum		**1.55**	**80.70**	**0.28**	**4.30**	**7.60**			
				minimum		**0.06**	**3.32**	**0.02**	**0.48**	**0.99**			
				median		**0.61**	**16.35**	**0.06**	**1.78**	**2.95**			
				number of samples		**6**	**6**	**6**	**6**	**6**			

[a] vfs = very fine sand.

[b] A dash in the table means "not analyzed."

[c] fs = fine sand.

[d] cs = coarse sand.

[e] ms = medium sand.

[f] vcs = very coarse sand.

Table 3.3-4
Summary of Environmental Surveillance Data from Surface Water Sampling Station DPS-1

Year	Tritium	Sr-90	Cs-137	Pu-238	Pu-239,240	Am-241	Pu-239,240/ Pu-238 Ratio
1967	540000	28600	34000	3.87	76.1	1.29	20
1968	20000	11360	13400	4.25	28.8	4.52	6.8
1969	430000	800	3490	5.55	9.1	3.58	1.6
1970	402222	568	692	0.81	2.2	1.19	2.7
1971	356000	716	1200	1.16	2.07	0.6	1.8
1972	396100	—[a]	350	0.32	5.68	0.33	18
1973	310000	—	260	2.91	10.1	—	3.5
1974	11000	—	48	0.17	0.27	—	1.6
1975	19000	—	12	0.27	0.57	—	2.1
1976	445000	384	71	0.3	0.58	—	1.9
1977	130000	—	—	0.69	1.67	—	2.4
1978	81200	197	35	6.81	3.26	—	0.5
1979	3200	—	24	0.08	0.39	7.6	4.9
1980	4100	9.5	19	0.4	0.97	4.7	2.4
1981	5100	—	23	0.28	0.72	—	2.6
1981	1300	298	30	1.44	2.38	—	1.7
1982	46000	362	6	0.31	0.48	—	1.5
1982	64000	—	31	0.61	1.11	—	1.8
1983	29000	—	—	1.91	2.87	—	1.5
1984	300	—	121	4.4	8.2	—	1.9
1984	4500	—	34	0.229	0.438	—	1.9
1985	1500	—	72	0.494	0.162	—	0.3
1985	800	—	—	0.008	0.012	—	1.5
1986	1200	—	59	0.067	0.18	—	2.7
1986	600	—	12	0.013	0.06	—	4.6
1986	900	—	36.5	0.035	—	—	NC[b]
1987	-1500	—	27	0.021	0.114	—	5.4
1987	500	—	16	-0.01	0.014	—	NC
1988	700	—	43	0	—	—	NC
1989	1200	—	—	0	—	—	NC
1990	—	—	—	—	—	—	NC
1991	dry	dry	dry	dry	dry	—	NC
1992	800	19.6	44.8	0	0.182	0.3	NC
1993	—	—	—	—	—	—	NC
1994	200000	6.5	1.4	0.028	0.054	0.525	1.9
1995	200000	84.5	1.56	0.032	0.026	0.065	0.8
1996	—	0.2	0.38	0.005	0.044	0.053	8.8

[a] A dash in the table means "not reported."

[b] NC = not calculated.

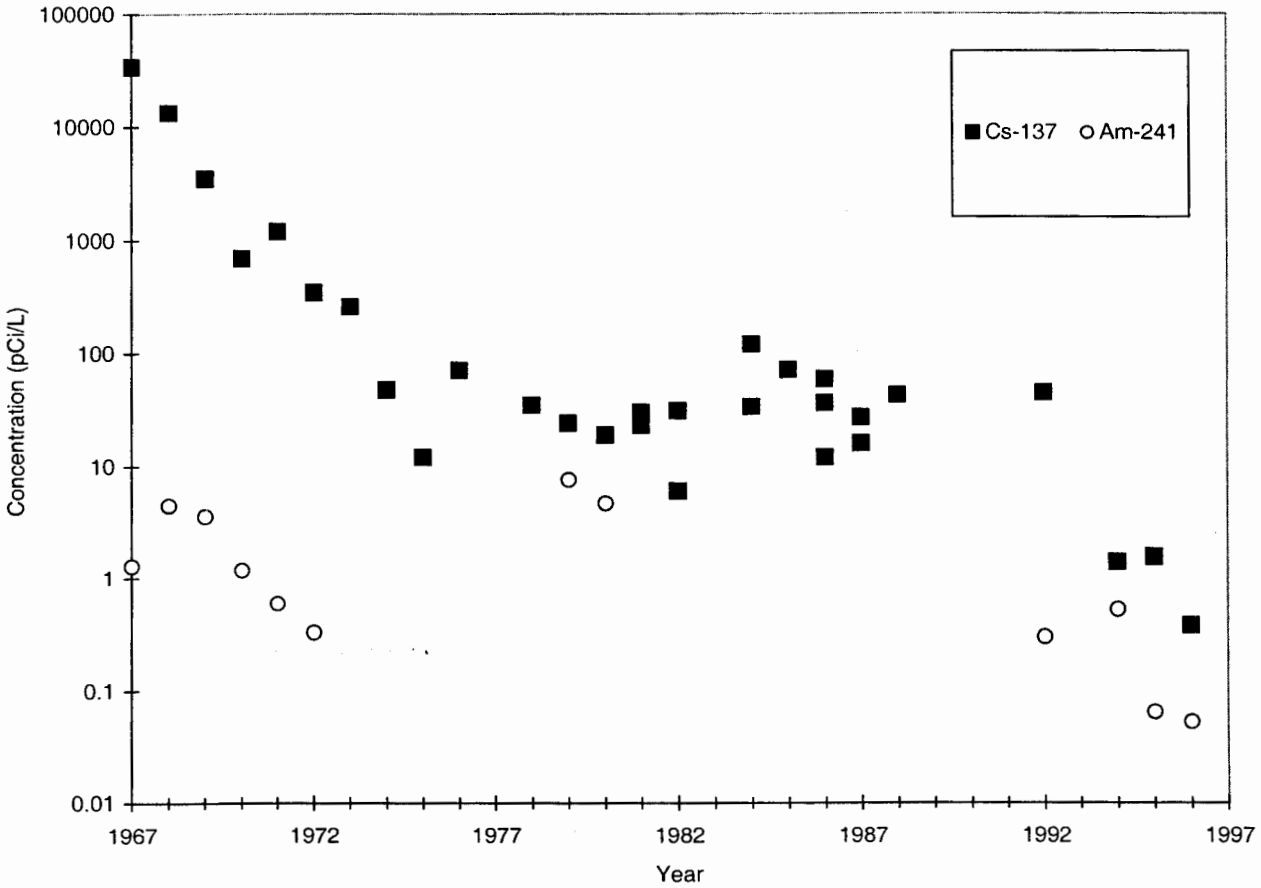


Figure 3.3-1. Plot of cesium-137 and americium-241 in surface water at DPS-1

3.3.1.3 Radionuclide Inventory

The discussion of radionuclide inventory in DP Canyon provides information for understanding sediment transport and deposition and the potential future contributions of DP Canyon contaminants to contamination in Los Alamos Canyon. Radionuclide inventories and concentration trends were useful in the Los Alamos Canyon investigation for developing the revised conceptual model for sediment transport. The key radionuclides americium-241, cesium-137, and strontium-90 were identified in the upper Los Alamos Canyon Reach Report as largely derived from sources in DP Canyon although the percent of the total inventory present in DP Canyon was unknown (Reneau et al. 1998, 59160). To build on the revised conceptual model presented in that report, it is important to calculate the inventories of these key isotopes within DP Canyon and assess those inventories in the context of the Los Alamos Canyon watershed.

The estimated inventories of the key radionuclides are calculated using the data on average radionuclide concentrations (picocuries per gram), the estimated area (square meters) and average thickness (meters) of each sediment package, sediment density (grams per cubic meter), and average gravel content (proportion). Area and thickness data are summarized in Section 2.3, and gravel data are presented in Section B-3.0. Sediment density measurements are presented in Section B-4.0 of Reneau et al. (1998, 59159). These calculations assume that the volume of each unit occupied by gravel contains no or very minimal radionuclide contamination because of the relations between particle size and radionuclide concentration in DP Canyon sediment samples. The total radionuclide inventory in each reach is

normalized by reach length, as measured along the stream channel on FIMAD topographic maps, which were prepared to facilitate comparison of the amount of each radionuclide in reaches of varying lengths and extrapolation between reaches (units of millicuries per kilometer).

This report does not discuss the inventory of organic and inorganic contaminants in DP Canyon because of their inferred non-point source origin from the Los Alamos townsite and long duration of input to the canyon. Therefore, calculating the inventory for these contaminants will not provide results relevant to an evaluation of contaminant transport and residence time associated with Laboratory operations.

3.3.1.4 Potential Remobilization of Contaminants

Estimates of the percentage of the total radionuclide inventory most susceptible to remobilization in each reach were based on proximity to the active channel and the geomorphic history of channel changes (see Section 2.3). These estimates assume a time scale of approximately 50 yr and geomorphic processes similar to those documented during the past 45 yr (post-1942) and involve judgments as to the average sediment residence time in the different units. Where the average sediment residence time in a particular geomorphic setting is judged to be greater than 50 yr, most of the sediment is assumed to be not susceptible to remobilization; instead, additional sediment deposition may be the most important geomorphic process (e.g., most of the f1 units). All active channel sediment is assumed to be susceptible to remobilization during the next 50 yr. Abandoned channel units that occur adjacent to the active channel and that record deposition during high-intensity floods within narrow reaches, such as the channel units in reach DP-3, are also assumed to be susceptible to remobilization. However, local areas of abandoned post-1942 channel deposits that occur away from the active channel, such as a c3b unit in reach DP-4 (location ID 21-05488), are not considered as susceptible to remobilization during the next 50 yr. Most floodplain areas are assumed to be stable for the next 50 yr, based partly on the common presence of trees greater than 100 yr old, although overland flow could result in relatively small amounts of sediment remobilization from the floodplains.

3.3.1.5 Contaminant Concentration and Isotope Ratios

The volume of effluent and the amount of plutonium in the effluent released from PRS 21-011(k) both show decreasing trends over the duration of the release history. A memo on the PRS 21-011(k) release history contains two figures that illustrate the effluent volume and plutonium trends over time (Reneau 1999, 63138). These trends may be recorded in the concentrations of contaminants in sediments collected in a geomorphic and stratigraphic context, and therefore may be useful for determining relative age of geomorphic units.

The ratios of the different radionuclides in PRS 21-011(k) effluent have also varied over time and can provide insight into the age of sediment. For example, variations in the ratio of plutonium-239,240 to plutonium-238 (plutonium 239/238 ratios) indicate variations in the use of plutonium in Laboratory operations. Early Laboratory operations primarily used weapons-grade plutonium, which is dominated by plutonium-239,240, and high plutonium-239/238 ratios are found in sediments whose plutonium is derived largely from early Laboratory operations (such as Pueblo Canyon downstream from TA-45 where plutonium 239/238 ratios typically are 100 to 300 [Reneau et al. 1998, 59159]). In contrast, research using plutonium-238 became more important at the Laboratory beginning in about 1961, resulting in lower plutonium 239/238 ratios (Reneau 1999, 63138). Monitoring data from the PRS 21-011(k) outfall indicate average plutonium 239/238 ratios of approximately 1 to 7 from 1968 until the releases stopped in 1986. An additional change in radionuclide releases documented by the PRS 21-011(k) outfall data is the increased discharge of americium-241 beginning in 1978. Average ratios of cesium-137 to americium-241

at PRS 21-011(k) from 1973 to 1977 are approximately 8 to 9, whereas average ratios from 1978 to 1985 are 0 to 6. The ratio of americium-241 to plutonium-239,240 is highest after 1978, averaging approximately 4 to 9 from 1978 to 1985 and only 0 to 8 from 1973 to 1977.

Note that the cesium-137/americium-241 ratios in sediment deposits change over time because of radioactive decay of cesium-137 (half-life of 30.2 yr), although the major differences between geomorphic units are still apparent. Sediment deposited in 1975 with an original cesium-137/americium-241 ratio of 8 to 9 now have a cesium-137/americium-241 ratio of 5 to 3, and sediment deposited in 1982 with an original ratio of 0 to 6 now have a ratio of 0 to 4.

In this report the ratios of various radionuclides were calculated from the analytical data for each sample and for averages in each bin. Averages for each bin are presented in tables for each reach, and the actual ratios of individual samples are sometimes used to constrain the age of specific sediment layers. Note that all these ratios are approximate, in part because of the relatively poor precision of many of the analyses associated with reported results close to the detection limit in many samples or the use of relatively low-precision analytical methods (i.e., the use of gamma spectroscopy measurements for americium-241 instead of the more precise alpha spectrometry method). However, the calculation of isotopic ratios using average concentrations within many samples should be more reliable than ratios calculated from individual samples because uncertainties can be reduced by averaging a large data set. In addition, sediment with the highest radionuclide concentrations probably provides the most accurate estimate of isotopic ratios in the initial releases because sediment with low concentrations may include relatively high percentages of fallout-derived radionuclides.

3.3.2 Contaminant Concentrations

Data from this investigation were collected to represent concentrations and variability within geomorphic units with sample allocation made to statistically represent units with greater volume and those units with greater expected variability in concentrations. The purpose of the sample allocation process was to provide a more accurate estimate of contaminant inventory. The comparisons made in Section 3.3.2.1 and 3.3.2.2 do not use the data in that manner, but rather combine data from all geomorphic units to provide an overview of spatial trends in contaminant concentration within DP Canyon.

3.3.2.1 Comparisons Among Reaches

The comparisons of contaminant concentrations are illustrated with box plots shown in Figure 3.3-2. These plots combine sample results from different geomorphic units, facies, and depths into one group to compare overall concentration trends. Each plot shows specific radionuclide concentrations, including background data, ranked among all reaches. The boxes show the median (horizontal bar within each box) and the 25th and 75th percentiles (upper and lower bounding ends of each box or interquartile range) of the ranked values. Comparing the boxes representative of each reach shows that the interquartile ranges for the reaches are similar, and the median values are within a factor of two. Thus, the concentrations of radiological contaminants are comparable among reaches DP-2, DP-3, and DP-4.

Reach DP-3 contains the highest median of the ranked values for americium-241 and plutonium-238, and the highest median concentration for americium-241, cesium-137, and plutonium-238. Reach DP-4 contains the highest median of the ranked values for cesium-137; plutonium-239,240; and strontium-90 and the highest median concentration for plutonium-239,240 and strontium-90.

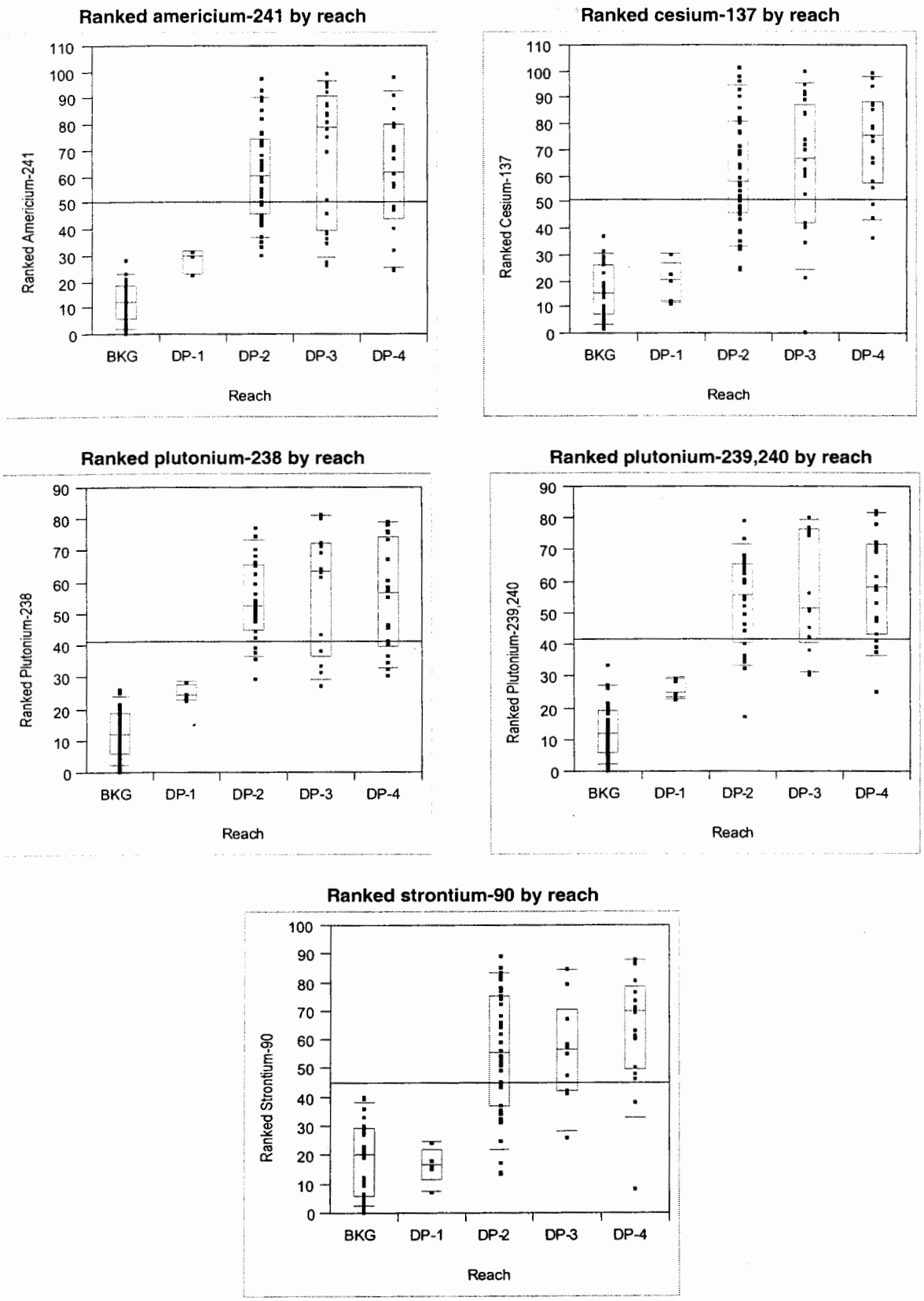


Figure 3.3-2. Summary of ranked radionuclide concentration by reach

3.3.2.2 Comparisons Between Facies and Reaches

A series of box plots (Figures 3.3-3 through 3.3-7) illustrate comparisons between fine- and coarse-grained facies among reaches for the key radionuclides. The plots compare the median radionuclide concentration for each facies and the median of the ranked radionuclide concentrations, which are organized by reach. Both the median of the ranked radionuclide concentrations and median radionuclide concentrations in each reach are highest in the fine-grained facies, with the difference between facies being the least for reach DP-2. Exceptions are plutonium-238 and plutonium-239,240, where the coarse-grained facies yields a slightly higher median of the ranked values and higher median concentration in DP-2, and cesium-137 which yields a slightly higher median of the ranked values in coarse-grained deposits in DP-2.

Reach DP-2

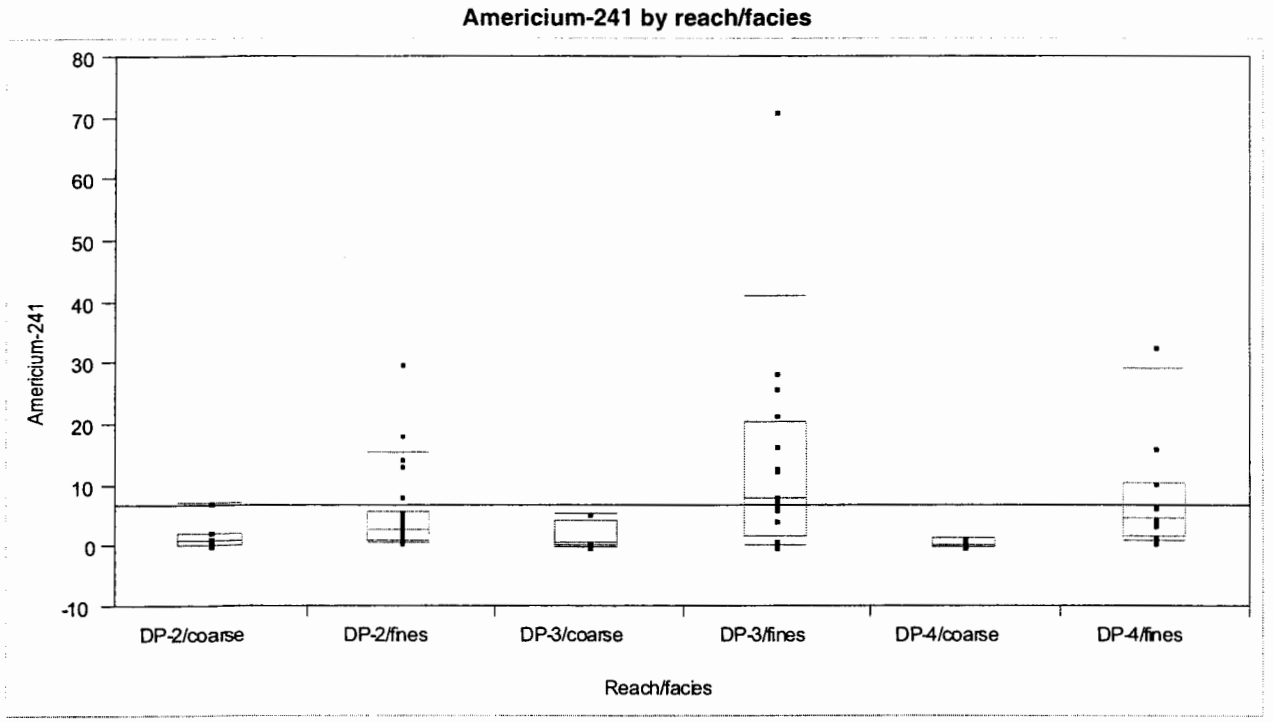
In reach DP-2, average americium-241 and strontium-90 concentrations are highest in the fine-grained deposits within c3b units, averaging 5.98 pCi/g, and 8.62 pCi/g, respectively. Average cesium-137 and plutonium-239,240 concentrations are highest in the coarse-grained facies of the c3b units. Similarly, high average cesium-137 concentrations occur in the c3b fine-grained facies. For americium-241; plutonium-239,240; and strontium-90, the f1 units contain average concentrations intermediate to concentrations found in the c3b fine-grained and coarse-grained sediments, whereas cesium-137 average concentrations are lower in the f1 units (Table 3.3-1). Concentrations of all key radioisotopes are low in the c1 coarse-grained deposits.

Reach DP-3

In reach DP-3, average concentrations of all key radionuclides are highest in the fine-grained sediments in the c3b units, with comparable average concentrations of americium-241 occurring in the f1 fine-grained sediments. The maximum concentrations of all radionuclides are highest in c2b fine-grained sediments (Table 3.3-2). Concentrations of all the key radioisotopes are low in the c1 sediment.

Reach DP-4

In reach DP-4, average concentrations of all key radionuclides are highest in the fine-grained sediments in the c2b units, with comparable average concentrations of americium-241 in the f1 fine-grained sediments. The average cesium-137 concentration of coarse-grained sediments in the c2b units in DP-4 is higher than in coarse-grained sediments in DP-2 and DP-3. The maximum concentrations of all radionuclides in DP-4 are highest in c2b fine-grained sediments (Table 3.3-3). Concentrations of all key radioisotopes are low in the coarse-grained deposits in the c1 sediment.



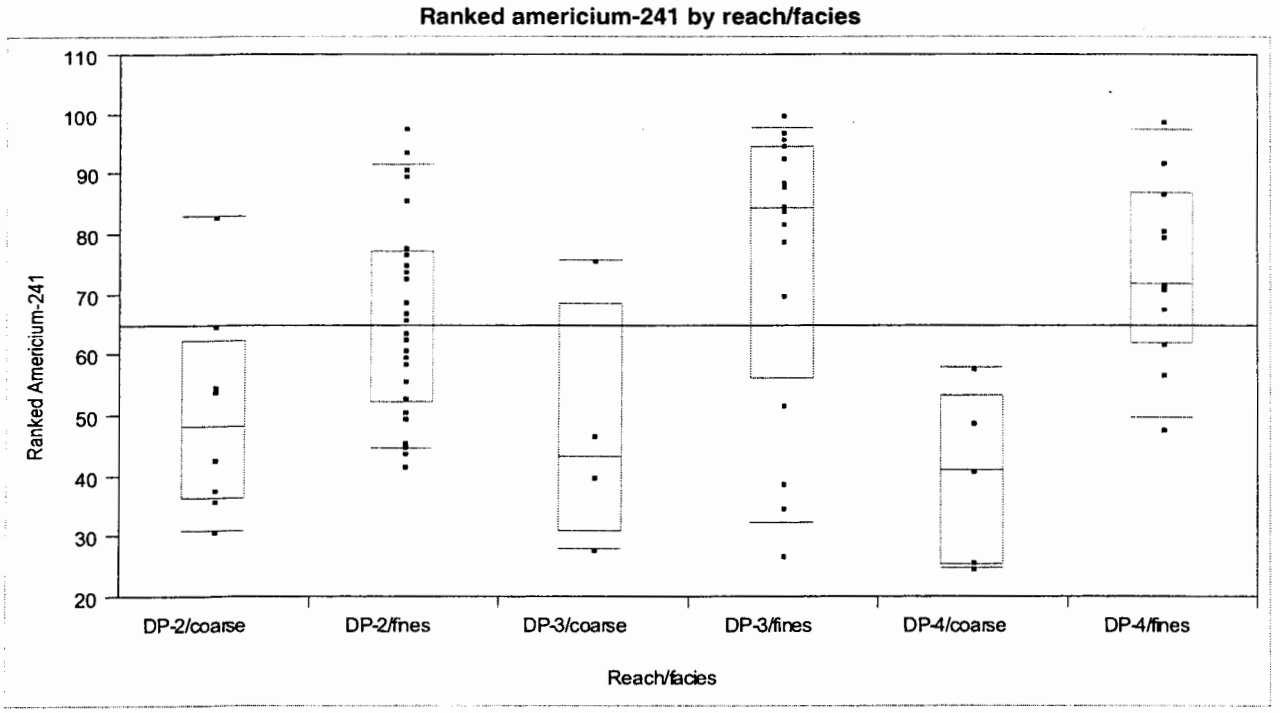
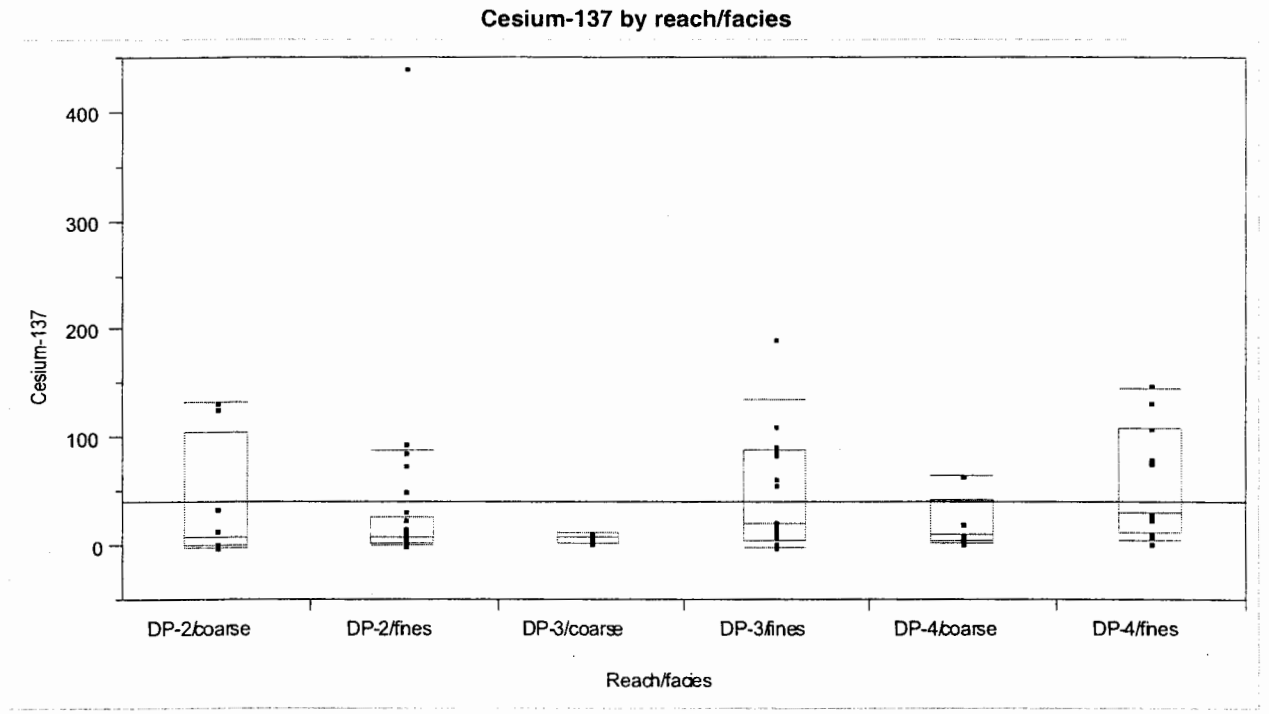


Figure 3.3-3. Concentration and ranked values for americium-241 by reach



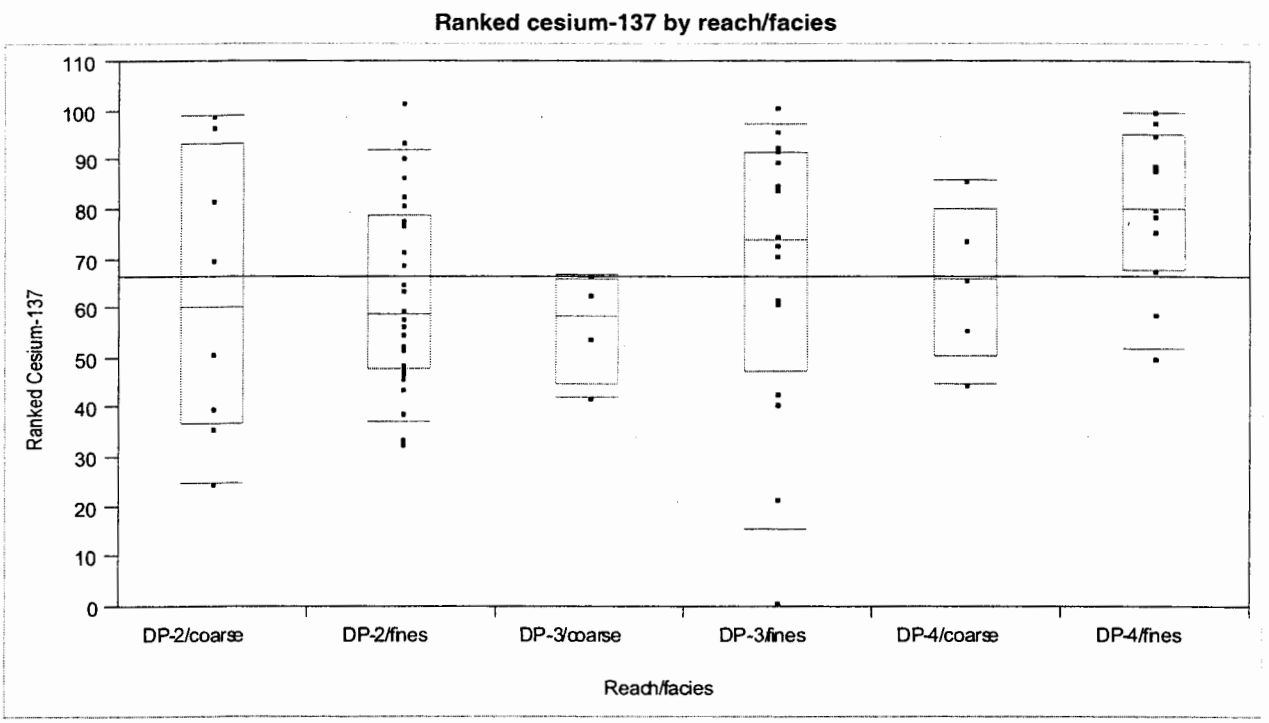
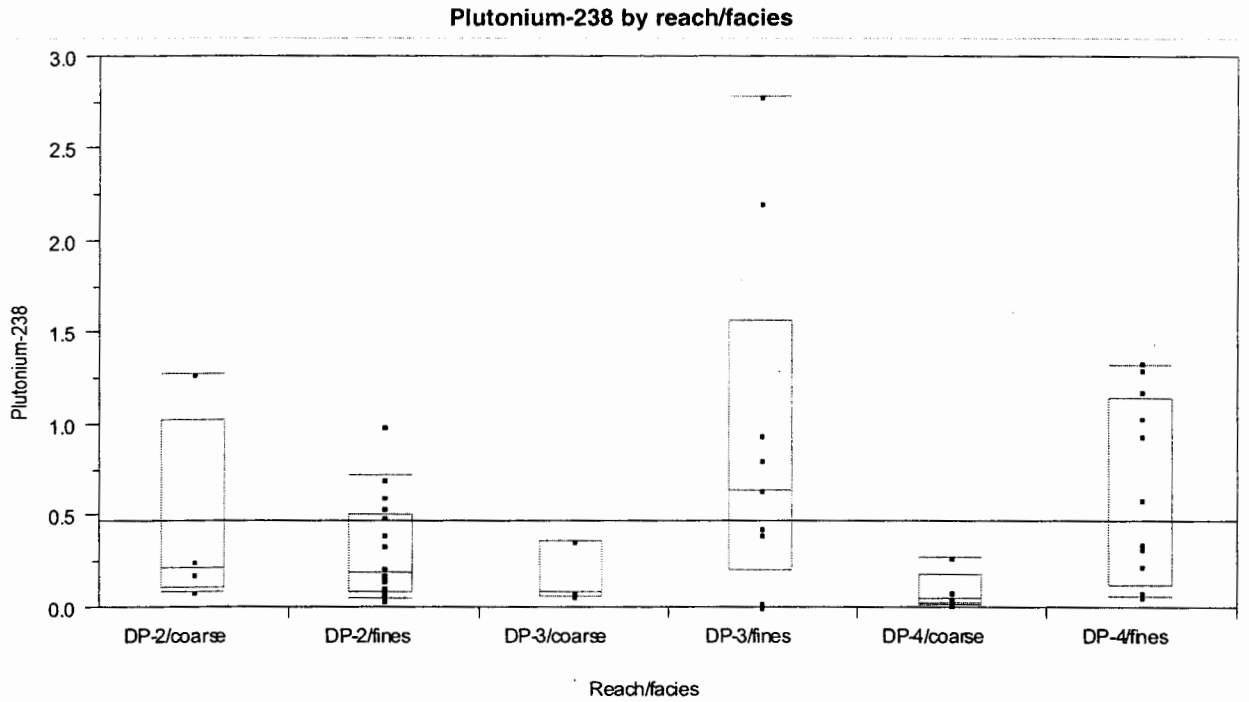


Figure 3.3-4. Concentration and ranked values for cesium-137 by reach



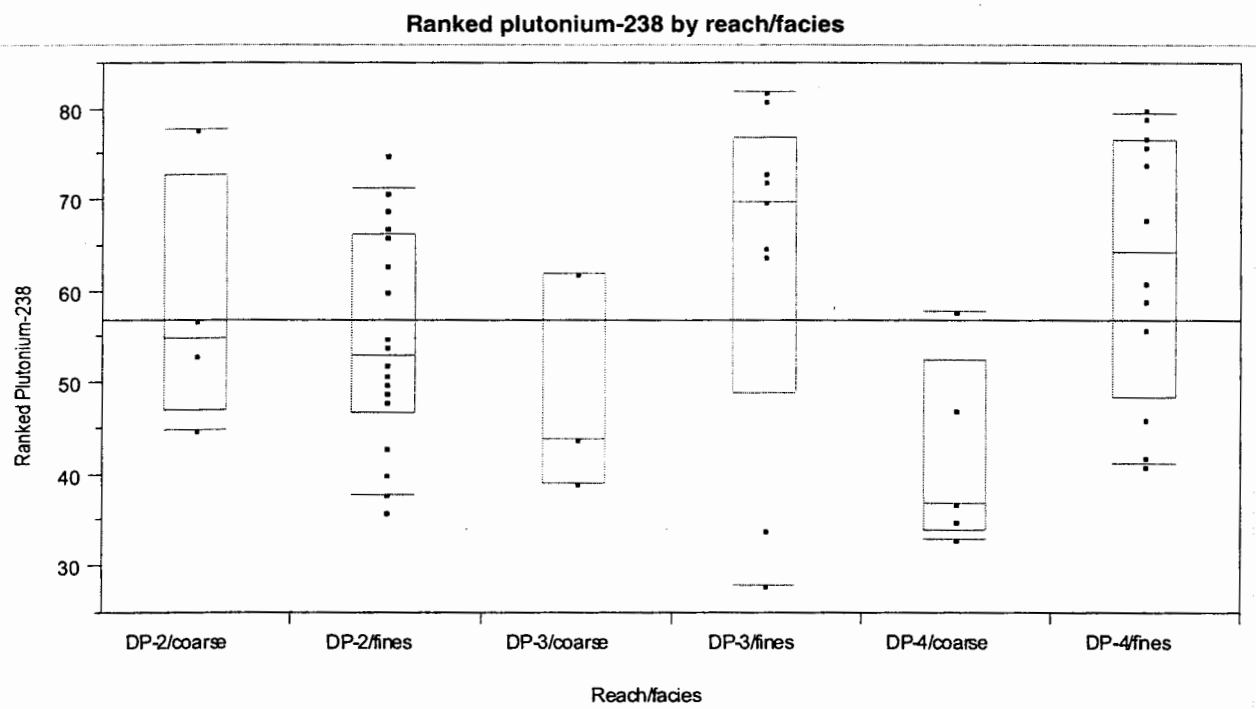
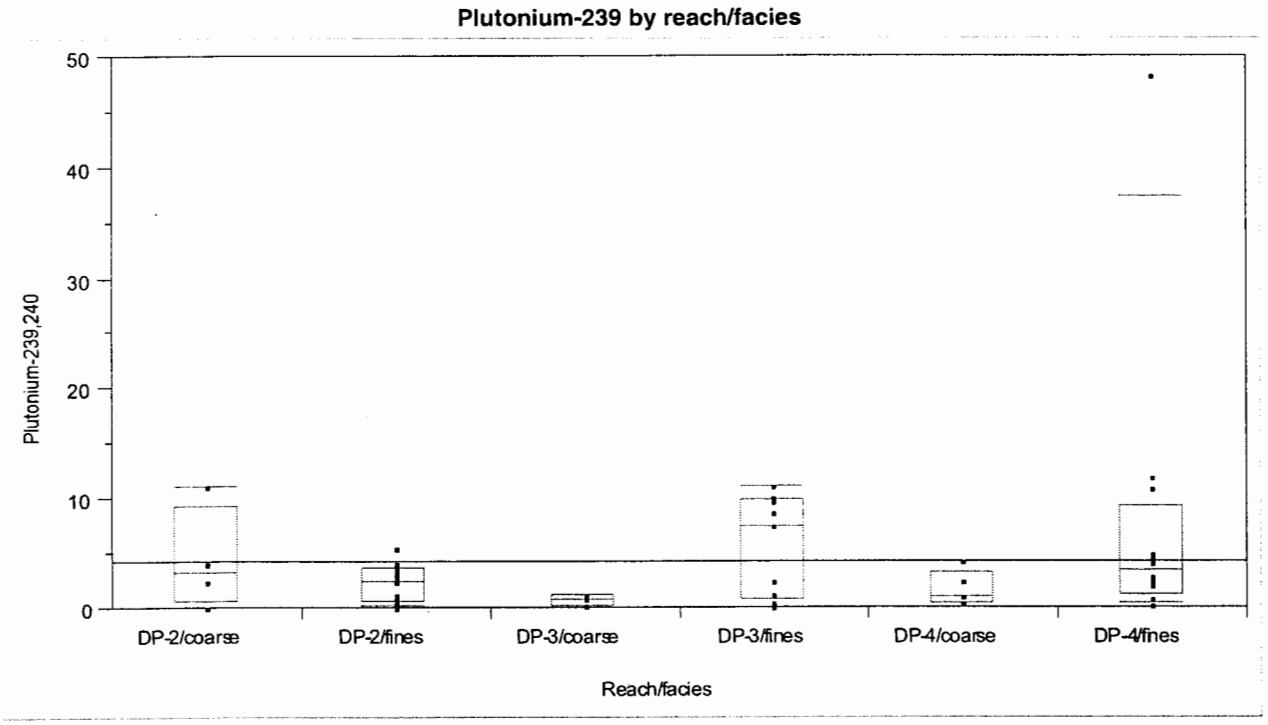


Figure 3.3-5. Concentration and ranked values for plutonium-238 by reach



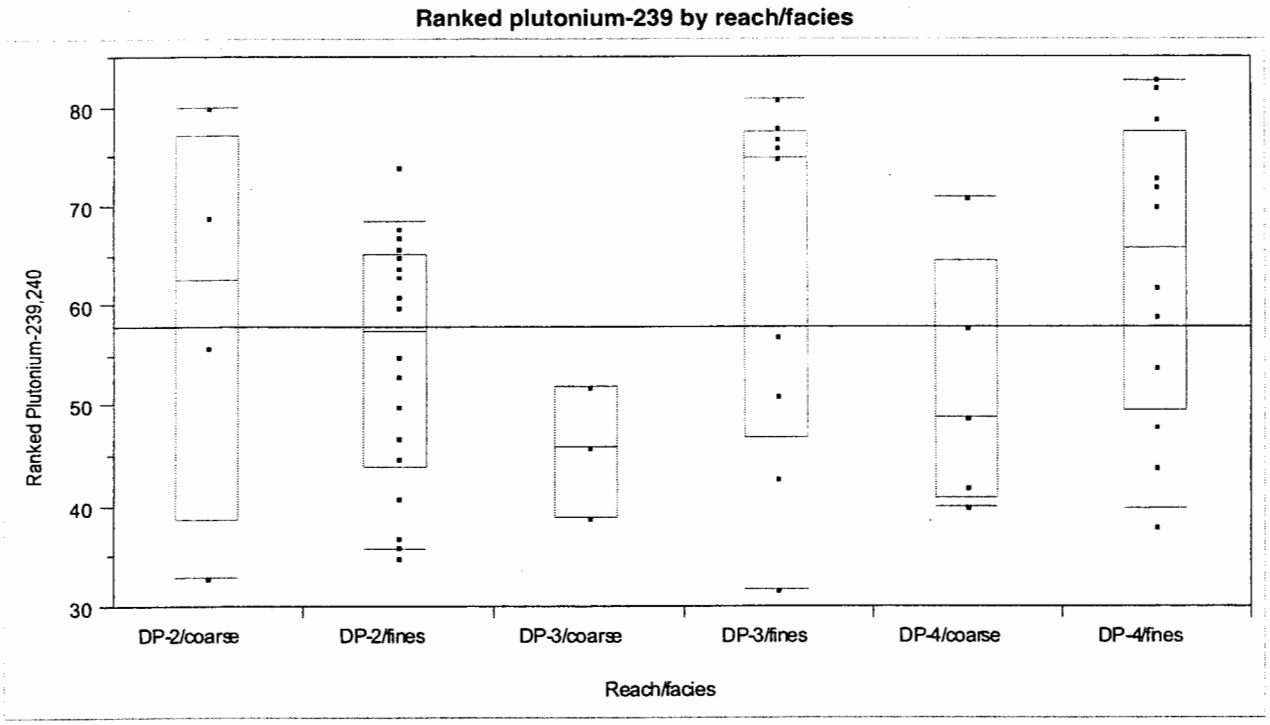


Figure 3.3-6. Concentration and ranked values for plutonium-239,240 by reach

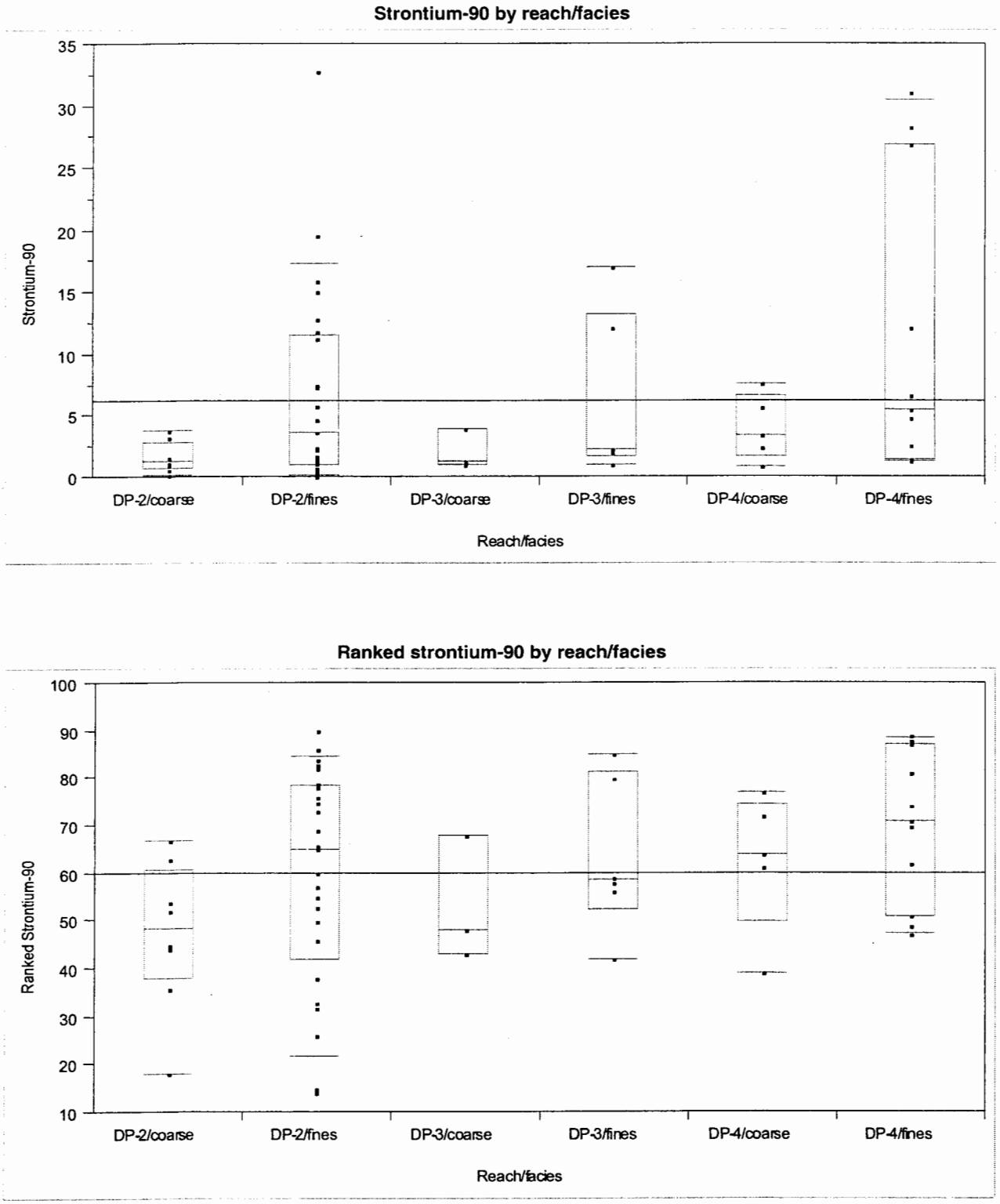


Figure 3.3-7. Concentration and ranked values for strontium-90 by reach

3.3.3 Age and Particle Size Relations

3.3.3.1 Reach DP-2

Age relations for DP-2 sediments are provided by comparing ratios of different radionuclides to temporal variations in ratios in the original effluent (Reneau 1999, 63138). Table 3.3-1 shows that the coarse-grained sediments in the c3b units have the highest average Cs/Am concentration ratio. The fine-grained c3b and f1 sediments have similar and significantly lower ratios than the coarse-grained c3b sediments. These ratios can be used to infer that the coarse-grained sediments at depth within the c3b units are the oldest post-1942 sediments in the reach and predate 1978. Fine-grained sediments stratigraphically higher within the c3b units and on the f1 floodplains likely are younger than 1978. This age relation is also supported by examining the plutonium-239/238 ratios. Except for c3b location 21-05499, where stratigraphically high fine-grained sediments appear to be relatively old, a fine-grained layer at 54 to 65 cm at c3b location 21-10954, and a deep (55 to 75-cm) layer in an f1 unit (location 21-05500), plutonium-239/238 ratios are lower in the higher stratigraphic layers suggesting that the shallower sediments are significantly younger and not genetically related to the underlying sediments.

Scatter plots of the concentrations of americium-241; cesium-137; plutonium-239,240; and strontium-90 versus particle size for reach DP-2 (Appendix B, Figures B-2.0-5 through B-2.0-8) show relatively poor correlations between high concentrations and fine particle sizes. Strontium-90 shows the best correlation of all the radionuclides. This correlation may be caused by the relatively high solubility of strontium-90 and the potential for migration to optimal sorption sites. The data in the plots also indicate that overall higher contaminant concentrations occur within the c3b units than the other units. This is based on data supporting decreasing contaminant concentrations in PRS-21-011(k) effluent over time. The overall poor correlations are interpreted to be caused by minimal transport of sediments following initial sorption of contaminants in the PRS 21-011(k) effluent.

3.3.3.2 Reach DP-3

As in reach DP-2, age estimates for sediments in DP-3 are based on the relation of the key radionuclides within sampled layers to records of the release history for PRS 21-011(k). Table 3.3-2 shows that all fine- and coarse-grained sediments have relatively low Cs/Am concentration ratios. Most notably, the coarse-grained sediments in the c3b units in reach DP-3 do not have the high Cs/Am concentration ratios that the coarse-grained sediments in the c3b units in reach DP-2 have, implying a younger age for the c3b coarse-grained sediments in reach DP-3. The plutonium 239/238 ratios of all fine- and coarse-grained deposits in reach DP-3 are comparable with younger c3b fine-grained sediments in reach DP-2. The radionuclide concentration ratios do not appear to provide evidence of distinct age relations, except for the possible young age implied by the low Cs/Am concentration ratio in the f1 unit. Additionally, no clear trend between isotopic ratios is apparent for either Cs/Am or plutonium-239/238 concentration profiles within stratigraphic sections in reach DP-3. This analysis suggests that most sediment in reach DP-3 is relatively young and may largely post-date 1978.

Scatter plots of the concentrations of americium-241; cesium-137; plutonium-239,240; and strontium-90 versus particle size for reach DP-3 show moderate correlations between high concentrations and fine particle sizes (Appendix B, Figures B-2.0-10 through B-2.0-13). Cesium-137; plutonium-239,240; and strontium-90 show the best correlations.

3.3.3.3 Reach DP-4

Isotopic ratios for reach DP-4 sediments indicate that the coarse-grained c2b sediments are the oldest post-1942 sediments in this reach, and have relatively high Cs/Am ratios and relatively high plutonium-239/238 ratios. The Cs/Am ratios of overlying fine-grained layers in the c2b units are relatively low. One exception is sample location 21-05491, which has a coarse-grained layer with a low Cs/Am ratio at 53–83 cm depth and a relatively high Cs/Am ratio in an overlying fine-grained layer. The f1 units characterized in reach DP-4 have low Cs/Am ratios that are indicative of relatively young, post-1978, sediment. Plutonium-239/238 ratios consistently show older coarse-grained sediments in c2b units underlying younger fine-grained sediments, implying that deposition of fine-grained sediments onto abandoned channel sediments (floodplains) occurred after a significant depositional hiatus. Average plutonium-239/238 ratios for f1 units also indicate a young age for those sediments.

Age inferences for sediments in reach DP-4 imply that much of the sediment in reach DP-4 is older than in reaches DP-2 and DP-3. The Cs/Am isotope ratios indicate that abandoned channel sediment (coarse-grained facies) in reach DP-4 may be older than abandoned channel sediment found in reach DP-2. The average Cs/Am ratio for abandoned channel sediments in reach DP-4 is 49 compared with 27 in reach DP-2, and the maximum in reach DP-4 is 825 compared with 97 in reach DP-2. These isotope ratios suggest a pre-1978 age. Plutonium-239/238 ratios do not provide evidence of earlier (pre-1961) deposits in DP-4. In contrast, average and maximum Cs/Am ratios for fine-grained sediments in the "c" units and "f1" units are comparable across all reaches, suggesting that much of the deposition of fine-grained sediments onto abandoned channel deposits and on floodplains may have occurred after 1973. This relative age estimate is also supported by relatively low plutonium-239/238 ratios for the fine-grained sediments.

Scatter plots of the concentrations of americium-241; cesium-137; plutonium-239,240; and strontium-90 versus particle size for reach DP-4 (Appendix B, Figures B-2.0-15 through B-2.0-18) show relatively strong correlations between concentrations and particle sizes for all radionuclides. The data in the plots also indicate that overall higher contaminant concentrations occur within the c2b units than within the other units.

3.3.3.4 Reach Overview

An assessment of the overall age trends for geomorphic units is illustrated with scatter plots of sediment data plotted according to geomorphic unit categories. Figures 3.3-8 and 3.3-9 show scatter plots of cesium-137 versus americium-241, and of plutonium-238 versus plutonium-239,240 concentration data, respectively, from all reaches organized into three groups: data from ca units (combined lower-concentration channel units from each reach), data from cb units (combined higher-concentration channel units from each reach); and data from f1 units. These plots show that the data from each of these groups fall within fairly distinct populations. The cb units overall contain more older deposits than the other units, based on isotope ratio data. The fields composed of cb data also show overall higher concentrations for the four plotted radionuclides, suggesting that higher concentrations also indicate older sediments. In general, the "ca" units have lower isotope ratios and fall within an overall lower-concentration population than the "cb" units. The f unit field shows isotope ratios and contaminant concentrations that indicate a range of ages including both typical "ca" and "cb" sediments, which is consistent with the concept that f-unit sediments record deposition of sediments throughout the post-1942 period.

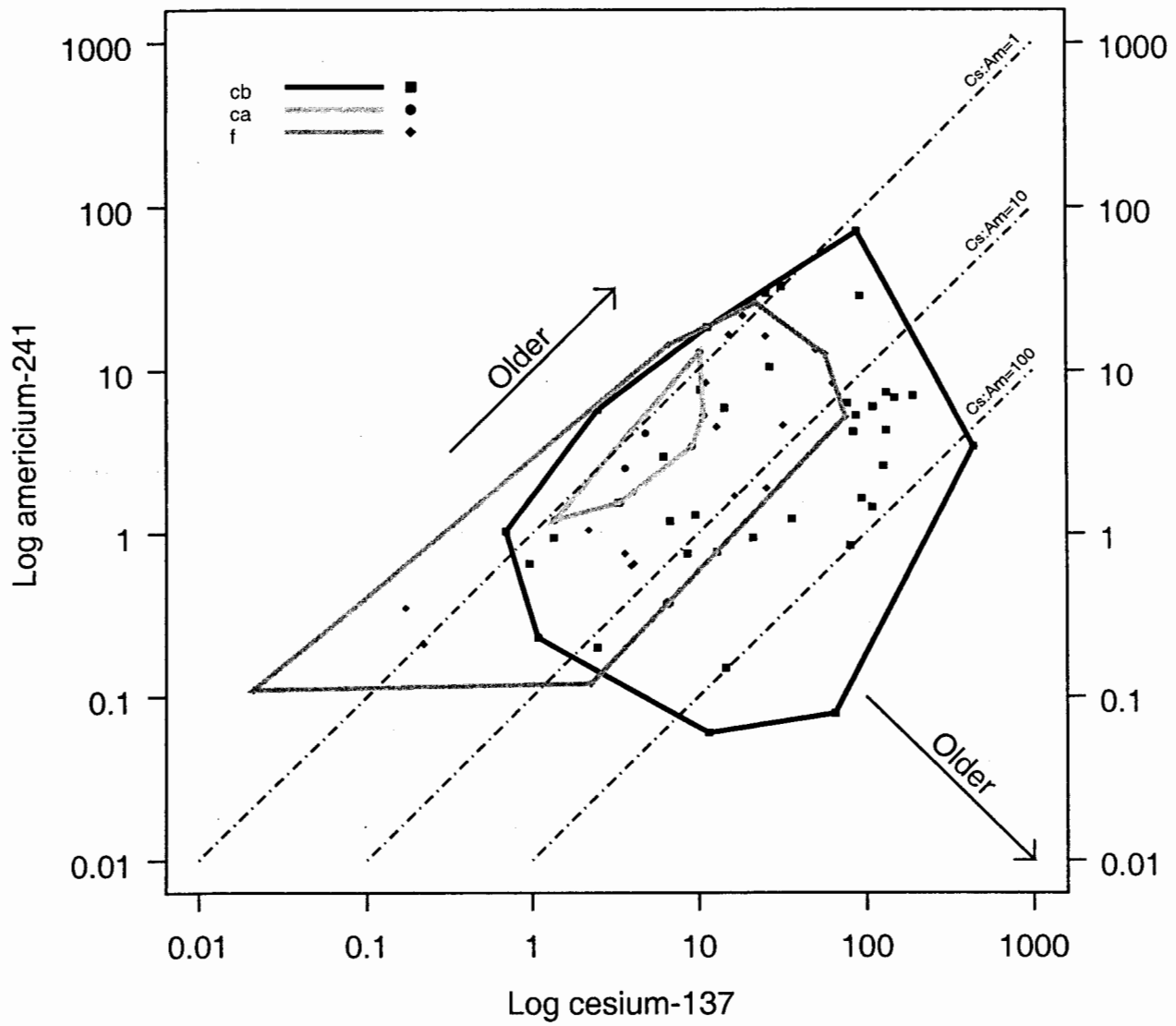


Figure 3.3-8. **Scatter plot of concentration data for cesium-137 presented as log cesium-137 versus americium-241 presented as log americium-241**

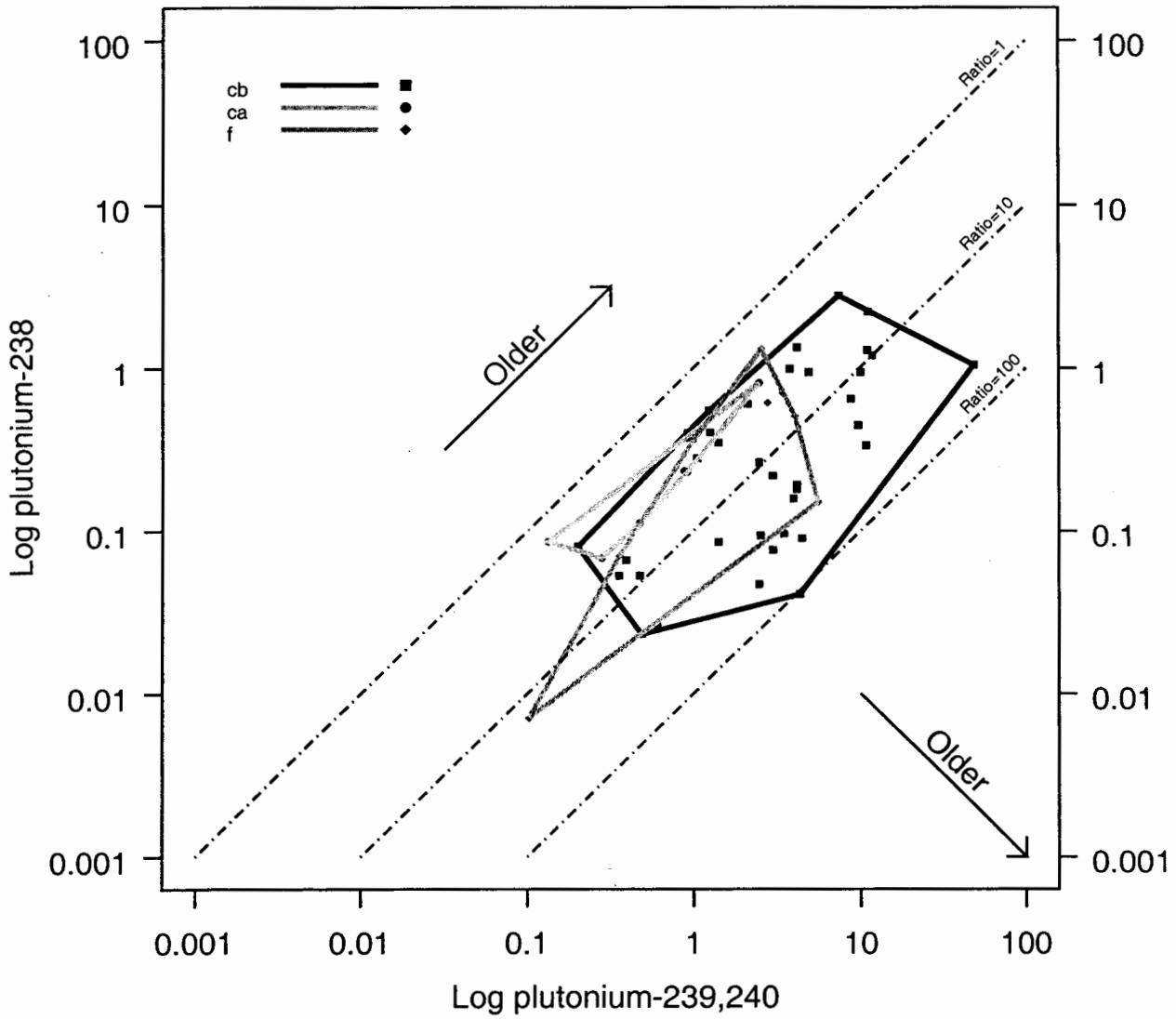


Figure 3.3-9. **Scatter plot of concentration data for plutonium-239,240 presented as log plutonium-239,240 versus plutonium-238 presented as log plutonium-238**

3.3.4 Contaminant Inventory

This section presents the inventory of key radionuclides by reach and compares inventories between reaches and within the various geomorphic units. Table 3.3-5 shows the estimated inventory for americium-241; cesium-137; plutonium-239,240; and strontium-90 in DP-2. Most of the inventory of each radionuclide in DP-2 occurs within fine-grained sediments in the c3b and f1 units. For each of these radionuclides, the estimated inventory is highest within the f1 units. It is notable, however, that 22% of the estimated cesium-137 and 22% of the estimated plutonium-239,240 inventory is in coarse-grained sediments within the c3b units. A comparison of the inventories of the combined c3b (coarse- and fine-grained sediments) and f1 units shows that the f1 units contain higher inventory than the c3b units for all radionuclides except cesium-137. Because concentrations of each contaminant are comparable between bins, the variations in inventory reflect variation in the volume of each geomorphic unit. Total estimated inventory of each radionuclide in geomorphic units that are susceptible to erosion from flood scouring (all "c" units) in reach DP-2 is 43% for americium-241; 62% for cesium-137; 42% for plutonium-239,240; and 42% for strontium-90.

In reach DP-3, the largest radionuclide inventory occurs within fine-grained sediments in the c3b and f1 units, with 82% of the americium-241 inventory; 91% of the cesium-137 inventory; 68% of the plutonium-239,240 inventory; and 81% of the strontium-90 inventory (Table 3.3-6). The estimated inventory of each radionuclide is highest within the f1 units with the exception of cesium-137, which is higher in the c3b fine-grained sediments. The high inventories reflect a combination of large unit areas and higher concentrations in the c3b and f1 bins. One main difference in the spatial distribution of inventory between reach DP-3 and reach DP-2 is the shift to significantly less cesium-137 and plutonium-239,240 inventory in coarse-grained sediments. The estimated inventory of cesium-137 in coarse-grained c3b sediments decreases from 22% of the reach total in reach DP-2 to 1% of the reach total in reach DP-3. The estimated plutonium-239,240 inventory in coarse-grained c3b sediments decreases from 22% of the reach total in reach DP-2 to 6% of the reach total in reach DP-3. The narrow, steep nature of reach DP-3 makes all geomorphic units outside the active channel equally susceptible to erosion during floods. This susceptibility is supported by the apparent overall young age of sediments within reach DP-3.

In reach DP-4, the largest radionuclide inventory occurs within fine-grained sediments in the c2b and f1 units, with 80% of the americium-241 inventory; 64% of the cesium-137 inventory; 88% of the plutonium-239,240 inventory; and 73% of the strontium-90 inventory (Table 3.3-7). The estimated inventory for each radionuclide is highest within the c2b unit with the exception of americium-241, which is higher in the f1 unit. Twenty percent of the estimated cesium-137 inventory occurs with coarse-grained sediments in the c2b unit. The relatively high cesium-137 inventory in the coarse-grained c-unit sediments in DP-2 and DP-4 is consistent with the inferred comparable age of sediments in those two reaches.

Table 3.3-8 provides a summary of the estimated cesium-137 inventory for all of DP Canyon and compares the DP Canyon cesium-137 inventory with that in Los Alamos Canyon (Reneau et al. 1998, 59160; Reneau et al. 1998, 59159). The results summary is organized to illustrate the relative contributions of each facies with each sampled and unsampled reach. Note that approximately 61% of the length of DP Canyon below PRS 21-011(k) was characterized in this investigation, thus minimizing uncertainty in inventory estimates in the unsampled reaches.

Table 3.3-5
Reach DP-2 Estimated Inventory

Geomorphic Unit	Sediment Facies	Area (m^2)	Estimated Average Thickness (m)	Estimated Volume (m^3)	Estimated Proportion Non-gravel	Density (g/m^3)	Estimated Average Cs-137 (pCi/g)	Estimated Cs-137 Inventory (μCi)	Percent of Total Cs-137 in Reach	Estimated Average Am-241 (pCi/g)	Estimated Am-241 Inventory (μCi)	Percent of Total Am-241 in Reach	Estimated Average Pu-239 (pCi/g)	Estimated Pu-239,240 Inventory (μCi)	Percent of Total Pu-239,240 in Reach	Estimated Average Sr-90 (pCi/g)	Estimated Sr-90 Inventory (μCi)	Percent of Total Sr-90 in Reach
c1	coarse	606	0.5	303	0.5	1.23	0.27	50	0%	0	0	0%	0.027	5	0%	0.64	119	1%
c2	fine	102	0.37	38	0.91	1.04	4.69	168	0%	2.34	84	1%	0.51	18	0%	1.07	38	0%
c2	coarse	102	0.5	51	0.5	1.23	18.84	591	1%	1.22	38	1%	1.29	40	1%	2.51	79	1%
c3a	fine	627	0.53	332	0.96	1.04	4.69	1556	3%	2.34	776	10%	0.51	169	3%	1.07	355	4%
c3a	coarse	627	0.5	314	0.5	1.23	18.84	3632	7%	1.22	235	3%	1.29	249	4%	2.51	484	6%
c3b	fine	529	0.52	275	0.95	1.04	54.32	14763	29%	5.98	1625	22%	2.45	666	12%	8.62	2343	28%
c3b	coarse	529	0.5	265	0.5	1.23	69.4	11289	22%	2.57	418	6%	7.63	1241	22%	1.26	205	2%
f1	fine	1917	0.43	824	0.96	1.04	23.16	19060	37%	5.16	4247	57%	3.95	3251	58%	5.84	4806	57%
							Total	**51110**	**100%**	**Total**	**7423**	**100%**	**Total**	**5639**	**100%**	**Total**	**8429**	**100%**
c1	coarse	606	0.5	303	0.5	1.23	0.27	50	0%	0	0	0%	0.027	5	0%	0.64	119	1%
c2	coarse	102	0.5	51	0.5	1.23	18.84	591	1%	1.22	38	1%	1.29	40	1%	2.51	79	1%
c3a	coarse	627	0.5	314	0.5	1.23	18.84	3632	7%	1.22	235	3%	1.29	249	4%	2.51	484	6%
c3b	coarse	529	0.5	265	0.5	1.23	69.4	11289	22%	2.57	418	6%	7.63	1241	22%	1.26	205	2%
	Subtotal	**1864**		**932**				**15563**			**692**			**1535**			**887**	
c2	fine	102	0.37	38	0.91	1.04	4.69	168	0%	2.34	84	1%	0.51	18	0%	1.07	38	0%
c3a	fine	627	0.53	332	0.96	1.04	4.69	1556	3%	2.34	776	10%	0.51	169	3%	1.07	355	4%
c3b	fine	529	0.52	275	0.95	1.04	54.32	14763	29%	5.98	1625	22%	2.45	666	12%	8.62	2343	28%
f1	fine	1917	0.43	824	0.96	1.04	23.16	19060	37%	5.16	4247	57%	3.95	3251	58%	5.84	4806	57%
	Subtotal			**1469**				**35547**			**6732**			**4104**			**7542**	
							Total	**51110**	**100%**	**Total**	**7423**	**100%**	**Total**	**5639**	**100%**	**Total**	**8429**	**100%**

Note: equations: inventory (μCi) = concentration (pCi/g) × density (g/cm^3) × portion nongravel × volume (m^3).

Table 3.3-6
Reach DP-3 Estimated Inventory

Geomorphic Unit	Sediment Facies	Area (m^2)	Estimated Average Thickness (m)	Estimated Volume (m^3)	Estimated Proportion Non-gravel	Density (g/m^3)	Estimated Average Cs-137 (pCi/g)	Estimated Cs-137 Inventory (μCi)	Percent of Total Cs-137 in Reach	Estimated Average Am-241 (pCi/g)	Estimated Am-241 Inventory (μCi)	Percent of Total Am-241 in Reach	Estimated Average Pu-239 (pCi/g)	Estimated Pu-239,240 Inventory (μCi)	Percent of Total Pu-239,240 in Reach	Estimated Average Sr-90 (pCi/g)	Estimated Sr-90 Inventory (μCi)	Percent of Total Sr-90 in Reach
c1	coarse	506	0.25	127	0.5	1.23	1.03	80	1%	0	0	0%	1.03	80	5%	0.39	30	2%
c2	fine	75	0.37	28	0.91	1.04*	10.3	271	3%*	13	341	10%*	2.47	65	4%*	2.38	63	4%
c2	coarse	75	0.25	19	0.5	1.23	8.12	94	1%	1.64	19	1%	8.12	94	5%	2.18	25	1%
c3a	fine	28	0.45	13	0.91	1.04	10.3	123	1%	13	155	4%	2.47	29	2%	2.38	28	2%
c3a	coarse	28	0.25	7	0.5	1.23	8.12	35	0%	1.64	7	0%	8.12	35	2%	2.18	9	1%
c3b	fine	81	0.65	53	0.94	1.04	93.2	4797	49%	17.8	916	26%	7.02	361	21%	8.39	432	25%
c3b	coarse	81	0.25	20	0.5	1.23	8.12	101	1%	1.64	20	1%	8.12	101	6%	2.18	27	2%
f1	fine	168	0.7	118	0.94	1.04	35.68	4102	42%	17.02	1957	56%*	7.02	807	47%*	8.39	965	56%
f2	fine	87	0.72	63	0.99	1.04	2.2	142	1%	1.05	68	2%*	2.47	159	9%*	2.38	153	9%
							Total	**9744**	**100%**	**Total**	**3483**	**100%**	**Total**	**1732**	**100%**	**Total**	**1733**	**100%**
c1	coarse	506	0.25	127	0.5	1.23	1.03	80	1%	0	0	0%	1.03	80	5%	0.39	30	2%
c2	coarse	75	0.25	19	0.5	1.23	8.12	94	1%	1.64	19	1%	8.12	94	5%	2.18	25	1%
c3a	coarse	28	0.25	7	0.5	1.23	8.12	35	0%	1.64	7	0%	8.12	35	2%	2.18	9	1%
c3b	coarse	81	0.25	20	0.5	1.23	8.12	101	1%	1.64	20	1%	8.12	101	6%	2.18	27	2%
	Subtotal	**690**		**173**				**310**			**46**			**310**			**92**	
c2	fine	75	0.37	28	0.91	1.04*	10.3	271	3%*	13	341	10%*	2.47	65	4%*	2.38	63	4%
c3a	fine	28	0.45	13	0.91	1.04	10.3	123	1%	13	155	4%	2.47	29	2%	2.38	28	2%
c3b	fine	81	0.65	53	0.94	1.04	93.2	4797	49%	17.8	916	26%	7.02	361	21%	8.39	432	25%
f1	fine	168	0.7	118	0.94	1.04	35.68	4102	42%	17.02	1957	56%*	7.02	807	47%*	8.39	965	56%
f2	fine	87	0.72	63	0.99	1.04	2.2	142	1%	1.05	68	2%*	2.47	159	9%*	2.38	153	9%
	Subtotal			**273**				**9434**			**3437**			**1422**			**1641**	
							Total	**9744**	**100%**	**Total**	**3483**	**100%**	**Total**	**1732**	**100%**	**Total**	**1733**	**100%**

Note: equations: inventory (μCi) = concentration (pCi/g) × density (g/cm^3) × portion nongravel × volume (m^3).

* No data available for these analytes in these units; c2 value assumed same as c3a, f1 and f2 values assumed same as c3a. Lack of data from f1 and f2 may add significant uncertainty for Pu-239,240 and Sr-90.

Table 3.3-7
Reach DP-4 Estimated Inventory

Geomorphic Unit	Sediment Facies	Area (m^2)	Estimated Average Thickness (m)	Estimated Volume (m^3)	Estimated Proportion Non-gravel	Density (g/m^3)	Estimated Average Cs-137 (pCi/g)	Estimated Cs-137 Inventory (μCi)	Percent of Total Cs-137 in Reach	Estimated Average Am-241 (pCi/g)	Estimated Am-241 Inventory (μCi)	Percent of Total Am-241 in Reach	Estimated Average Pu-239 (pCi/g)	Estimated Pu-239,240 Inventory (μCi)	Percent of Total Pu-239,240 in Reach	Estimated Average Sr-90 (pCi/g)	Estimated Sr-90 Inventory (μCi)	Percent of Total Sr-90 in Reach
c1	coarse	1697	0.5	849	0.5	1.23	1.11	579	5%	0.18	94	6%	0.054	28	3%	0.09	47	2%
c2a	fine	78	0.33	26	0.99	1.04	27.92	740	6%	5.73	152	10%	1.78	47	5%	4.15	110	6%
c2a	coarse	78	0.5	39	0.5	1.23*	31.44	754	6%*	0.64	15	1%*	0.488	12	1%*	3.62	87	4%
c2b	fine	252	0.22	55	0.95	1.04	75.9	4157	34%	9.07	497	32%	11.47	628	64%	15.79	865	45%
c2b	coarse	252	0.5	126	0.5	1.23	31.44	2436	20%	0.64	50	3%	0.488	38	4%	3.62	281	15%
f1	fine	586	0.22	129	0.98	1.04	27.92	3669	30%	5.73	753	48%	1.78	234	24%	4.15	545	28%
							Total	**12335**	**100%**	**Total**	**1560**	**100%**	**Total**	**987**	**100%**	**Total**	**1934**	**100%**
c1	coarse	1697	0.5	849	0.5	1.23	1.11	579	5%	0.18	94	6%	0.054	28	3%	0.09	47	2%
c2a	coarse	78	0.5	39	0.5	1.23*	31.44	754	6%*	0.64	15	1%*	0.488	12	1%*	3.62	87	4%
c2b	coarse	252	0.5	126	0.5	1.23	31.44	2436	20%	0.64	50	3%	0.488	38	4%	3.62	281	15%
	Subtotal	**2027**		**1014**				**3770**			**159**			**78**			**414**	
c2a	fine	78	0.33	26	0.99	1.04	27.92	740	6%	5.73	152	10%	1.78	47	5%	4.15	110	6%
c2b	fine	252	0.22	55	0.95	1.04	75.9	4157	34%	9.07	497	32%	11.47	628	64%	15.79	865	45%
f1	fine	586	0.22	129	0.98	1.04	27.92	3669	30%	5.73	753	48%	1.78	234	24%	4.15	545	28%
	Subtotal			**210**				**8566**			**1402**			**909**			**1520**	
							Total	**12335**	**100%**	**Total**	**1560**	**100%**	**Total**	**987**	**100%**	**Total**	**1934**	**100%**

Note: equations: inventory (μCi) = concentration (pCi/g) × density (g/cm^3) × portion nongravel × volume (m^3).

* No data available for these analytes in these units.

Table 3.3-8
Summary of Area, Volume, and Cs-137 Inventory Estimates For DP Canyon

Reach	Approx. Distance Below Culvert, Upstream End (km)	Approx. Distance Below Culvert, Downstream End (km)	Approx. Length Sampled Reach (km)	Approx. Length Unsampled Reach (km)	Area of Post-1942 Channel Units (m^2)	Area of Post-1942 Floodplain Units (m^2)	Average Width of Post-1942 Channel Units (m)	Average Width of Post-1942 Floodplain Units (m)	Average Width of Post-1942 Geomorphic Units (m)	Est. Volume of Post-1942 Coarse-grained Sediment (m^3)	Est. Volume of Post-1942 Coarse-grained Sediment (m^3/km)	Est. Volume of Post-1942 Fine-grained Sediment (m^3)	Est. Volume of Post-1942 Fine-grained Sediment (m^3/km)	Est. Cs-137 Inventory in Post-1942 Coarse-grained Deposits (μCi)	Est. Cs-137 Inventory in Post-1942 Fine-grained Deposits (μCi)	Est. Total Cs-137 Inventory (Sampled Reaches) (mCi)	Est. Total Cs-137 Inventory (Unsampled Reaches) (mCi)	Est. Total Cs-137 Inventory, Coarse-grained (Sampled Reaches) (mCi/km)	Est. Total Cs-137 Inventory, Fine-grained (Sampled Reaches) (mCi/km)	Est. Total Cs-137 Inventory (Sampled Reaches) (mCi/km)	Est. Average Cs-137 Concentration in Post-1942 Coarse-grained Deposits (pCi/g)	Est. Average Cs-137 Concentration in Post-1942 Fine-grained Deposits (pCi/g)
DP-2	1.856	2.172	0.316		1864	1917	5.9	6.1	12.0	932	2949	1469	4649	15563	35547	51.1		49.3	112.5	161.7	13.4	23.3
DP-2 to DP-3	2.172	2.502		0.33													14.7					
DP-3	2.502	2.714	0.212		690	255	3.3	1.2	4.5	173	816	273	1288	310	8344	9.7		1.5	44.5	46.0	1.4	29.4
DP-3 to DP-4	2.714	3.106		0.392													17.4					
DP-4	3.106	3.56	0.454		2027	586	4.5	1.3	5.8	1014	2233	210	463	3770	8566	12.3		8.3	18.9	27.2	3.0	39.2
		Total	**0.982**	**0.722**	**Estimated Inventory, DP Canyon Subtotal (mCi)**											**73.2**	**32.1**					
Total Estimated Inventory, DP Canyon (mCi)															**105.3**							
Total Estimated Inventory, Upper Los Alamos Canyon (mCi)															**186.2**							
Total Estimated Inventory, Lower Los Alamos Canyon (mCi)															**57.4**							
Total Estimated Inventory, Los Alamos Canyon System (mCi)															**348.9**							

Notes: 1. Average concentration Cs-137 (pCi/g) = estimated inventory (μCi)/estimated volume (m^3)/density (gm/cm^3). Assumes constant density of 1.25 gm/cm^3 ;for coarse-grained facies and 1.04 g/cm^3 for fine-grained facies, and provides average concentration in entire deposit, including gravel fraction (assumes no Cs in >2 mm fraction).

2. Inventory in unsampled reaches assumes same inventory as DP-3.

The radionuclide inventory characteristics for each investigation reach is also presented in Figures 3.3-10 through 3.3-14. Each figure shows the contaminant inventory normalized by the mapped reach length, the sediment volumes of the mapped reaches and facies, and the average contaminant concentrations by reach and facies. The reaches are separated into coarse and fine facies to contrast contaminant storage in these materials within a reach and to support comparisons of the inventories in these materials across reaches.

The left plot of each figure shows normalized inventory and normalized volume. This is the total inventory (in millicuries) and the total sediment volume (in cubic meters) for the reach divided by the length (in kilometers) of the investigation reach. Using Figure 3.3-11 as an example, the cesium-137 inventory in fine-grained facies in DP-2 is normalized to 110 mCi/km. In contrast, the cesium-137 inventory in DP-3 is normalized to 45 mCi/km. The normalized sediment volumes illustrate that the mapped reaches, and the facies within those reaches, are highly variable and that inventory is a function of sediment volume and contaminant concentration. The right plot for each figure shows the average concentration (in picocuries per gram). These values were calculated using the inventory and sediment volumes for each reach, and the density estimates for coarse and fine sediments. Figure 3.3-11 shows increasing average concentrations of 23, 31, and 39 pCi/g for cesium-137 in fine-grained facies in DP-2, DP-3, and DP-4. This is in contrast to the declining normalized inventories of 110, 45 and 19 mCi/km.

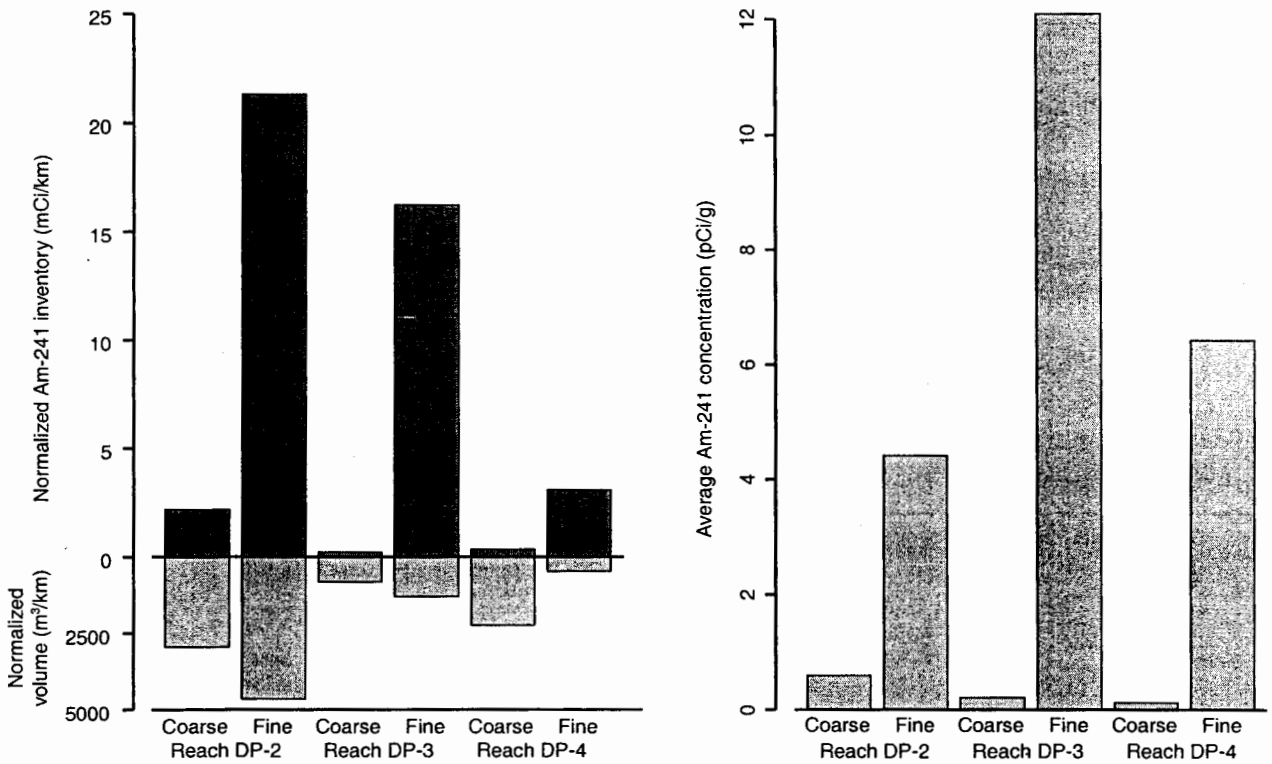


Figure 3.3-10. Americium-241 normalized inventory, normalized sediment volumes, and average concentrations

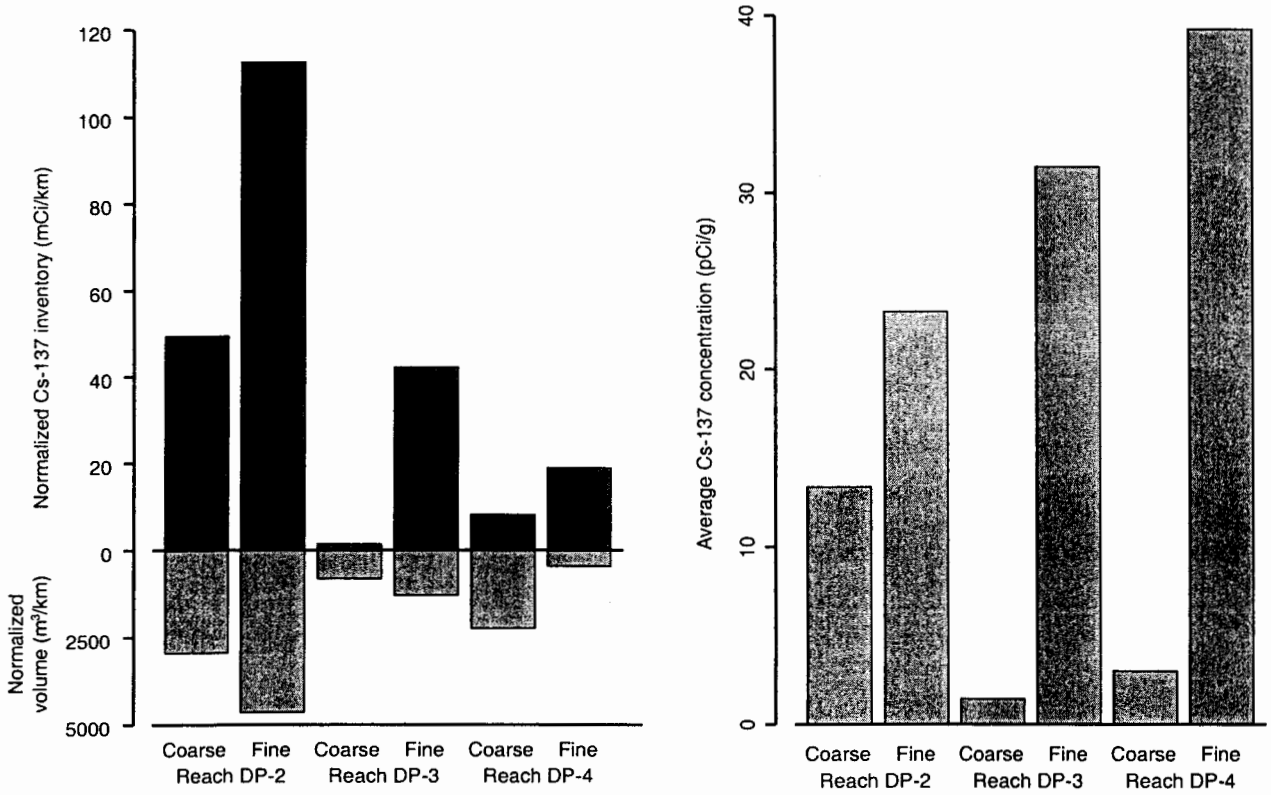


Figure 3.3-11. Cesium-137 normalized inventory, normalized sediment volumes, and average concentrations

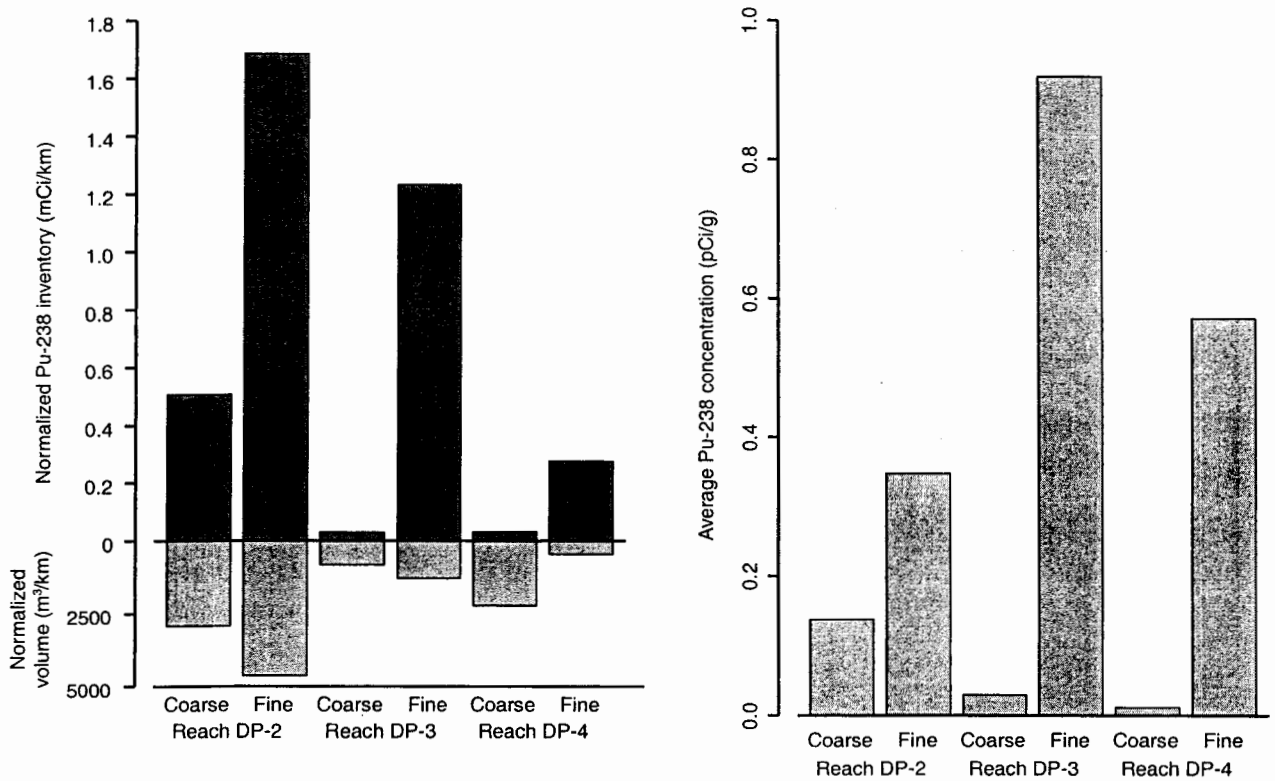


Figure 3.3-12. Plutonium-238 normalized inventory, normalized sediment volumes, and average concentrations

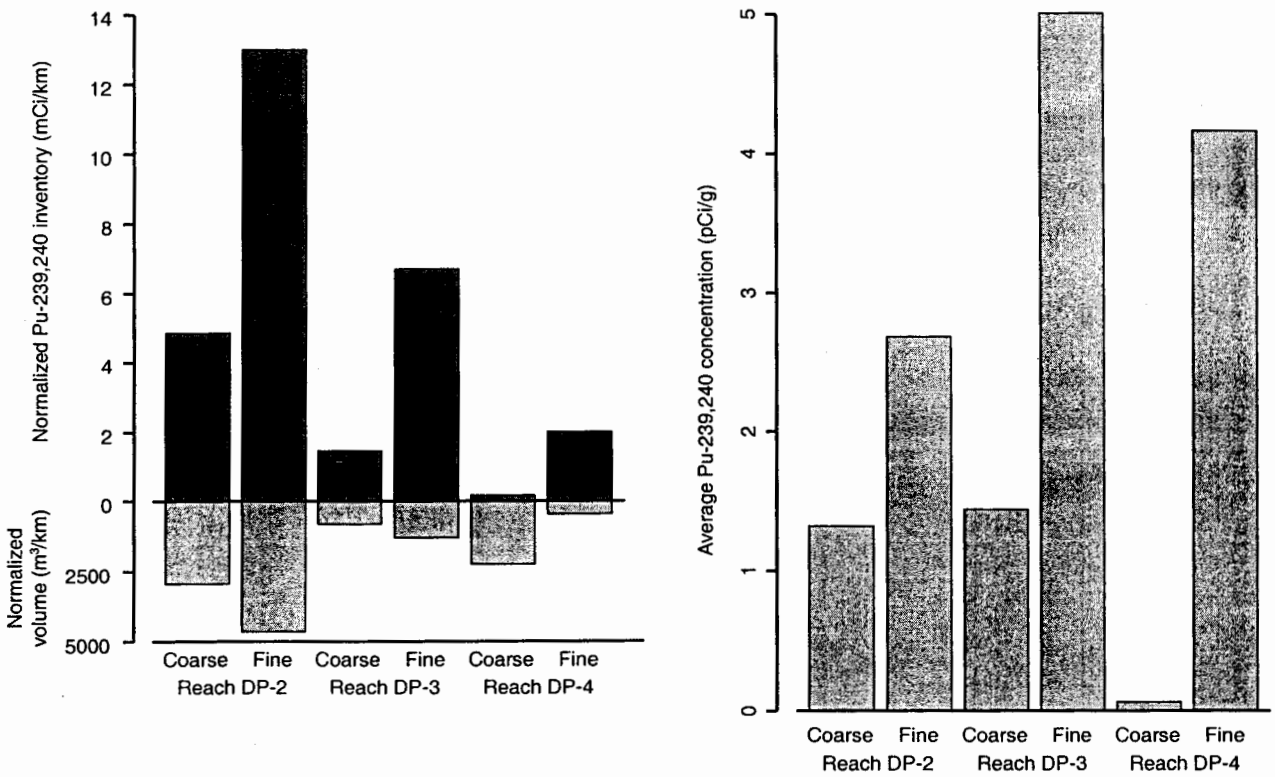


Figure 3.3-13. Plutonium-239,240 normalized inventory, normalized sediment volumes, and average concentrations

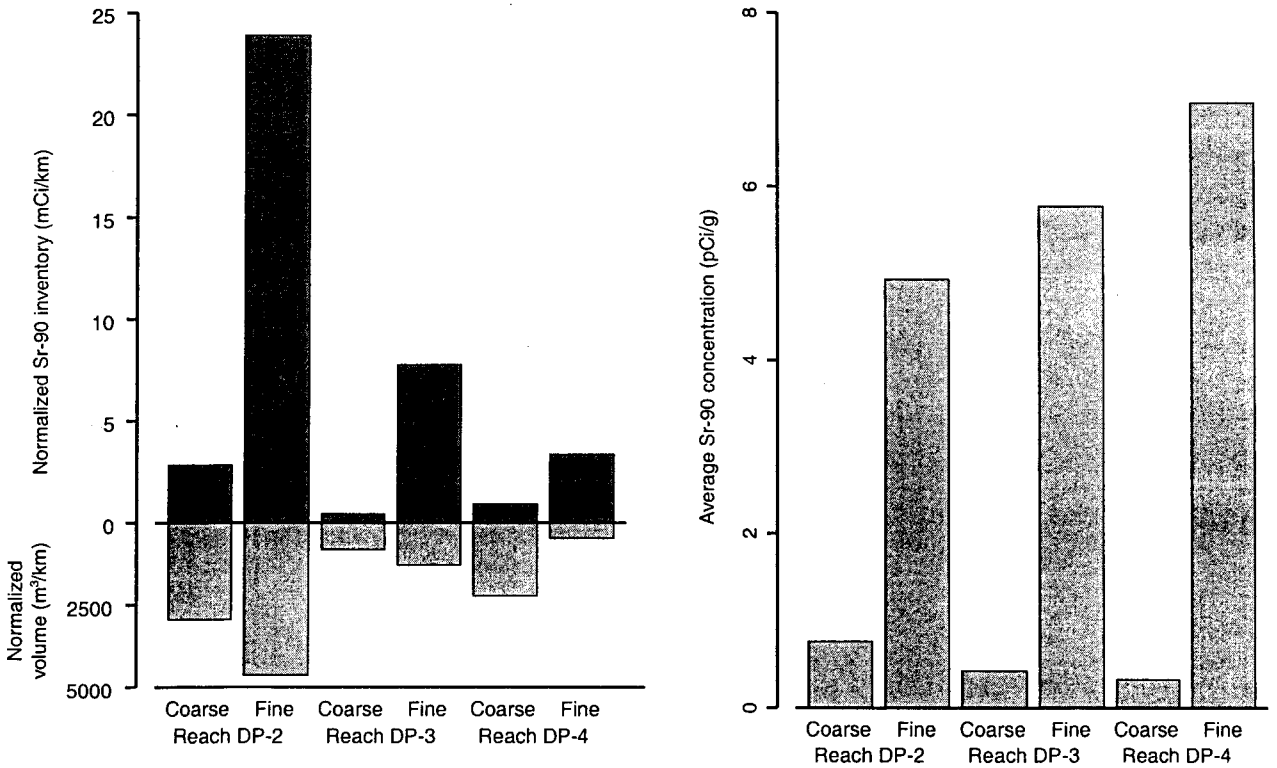


Figure 3.3-14. Strontium-90 normalized inventory, normalized sediment volumes, and average concentrations

4.0 REVISED CONCEPTUAL MODEL

The validation and refinement of the conceptual model is necessary in order to perform a defensible quantitative evaluation of risk in the sampled reaches, qualitatively evaluate risk in intervening unsampled areas, and evaluate the future redistribution of contaminants and their associated impacts. Data were collected during this investigation to test hypotheses concerning the nature, distribution, and transport of contaminants associated with sediment. These hypotheses were addressed as part of the preliminary conceptual model and were developed based on results of previous investigations.

This section presents the current conceptual model of contamination in DP Canyon sediments and alluvial groundwater, which has been revised and refined from the preliminary conceptual model presented in Section 1.6 of this report. This conceptual model includes discussions of the general nature and extent of contamination within sediments and alluvial groundwater, controlling factors for present-day contaminant distribution and variations in contaminant levels, geomorphic processes that redistribute these contaminants, and inferences about the fate and future transport of these contaminants.

4.1 Nature and Extent of Contamination in Sediment

4.1.1 Analytes above Background Values

Fifty analytes are present within sediments; sixteen of these analytes are present within alluvial groundwater in DP Canyon at levels above background values and are considered chemicals of potential concern (COPCs) (see Section 3.2 and Tables 3.2-1 and 3.2-2). The contaminants most relevant to the revised conceptual model are radionuclides that are associated with effluent releases from potential release site (PRS) 21-011(k), and inorganic and organic compounds associated with runoff from the Los Alamos townsite. Significant radionuclide contamination is present throughout reaches DP-2, -3, and -4, but is absent in DP-1. As noted in the preliminary conceptual model, PRS-21-029 (the DP Tank Farm) could potentially contribute diesel range organic (DRO)- and other fuel-related organic contaminants (BTEX compounds) to the sediment and/or alluvial groundwater; however, a discernable contribution from the DP Tank Farm is not substantiated by data from this investigation. Organic compound concentrations typically are highest in reach DP-1 West and DP-1 Central, and contaminants known to be associated with the DP Tank Farm are highest west of the location where the releases from the tank farm could enter DP Canyon.

Polychlorinated biphenyls (PCBs) and pesticides detected in this investigation include Aroclor-1260; alpha-chlordane; gamma-chlordane; 4,4'-DDE; 4,4'-DDT; and Heptachlor Epoxide. The highest concentrations of each of these contaminants are in reach DP-1 or in reach LA-2 in Los Alamos Canyon (see Figure 3.2-5b). These data suggest a townsite source for these contaminants in DP Canyon, and a source other than DP Canyon for the PCB and pesticide contamination in Los Alamos Canyon.

Inorganic chemicals identified as COPCs in this investigation include antimony, cadmium, calcium, chromium, cobalt, copper, lead, mercury, selenium, and zinc (Table 3.2-1). The concentrations of these inorganic compounds do not correlate well with concentrations of the key radionuclides (see Appendix E of this report), suggesting different sources for the contaminants. The degree of positive correlation that does exist is mainly a function of the relation of contaminant concentration to weight percent of fine-grained particles. Reneau et al. (1998, 59160) inferred that PRS 21-011(k) might be a source of chromium, uranium, and zinc contamination identified as COPCs in sediments in Los Alamos Canyon below the confluence with DP Canyon (Reneau et al., 59160, Table 4.1-1). However, data from this investigation indicate that chromium and zinc contamination in DP Canyon sediments is derived from storm water runoff from the Los Alamos townsite. Total uranium is not a COPC in DP Canyon, suggesting a source for the total uranium in upper Los Alamos Canyon that is not within the DP Canyon watershed.

4.1.2 Horizontal and Vertical Extent of Contamination

The horizontal and vertical extent of contaminated sediment in DP Canyon has been defined using a combination of geomorphic mapping, stratigraphic and sedimentological data, field radiological measurements, and analytical results. The distribution of young (post-1942) geomorphic units shown on the geomorphic maps in Chapter 2 illustrates the horizontal extent of contamination that has been distributed by floods along the full length of DP Canyon and across the canyon floor. Stratigraphic and sedimentological data supplemented with fixed-point field radiological measurements and laboratory analytical results indicate that the vertical extent of contamination in sediment ranges from depths of less than approximately 10 cm on floodplains (f1 and f2 units) to less than 1 m below the present elevation of the stream channel in abandoned channel units (e.g., c2, c3). However, the vertical extent of contaminants in the coarse-grained sediment is not well constrained by analytical results because it often is not practical to sample deposits that are below the water table. Contaminants could be present through the full thickness of the alluvium below the active and abandoned channel sediments as a result of possible translocation of contaminants adsorbed to sediment particles or organic colloids and transport of contaminants in solution. Evidence for translocation of contaminants adsorbed to sediment particles or organic colloids has been obtained in Pueblo Canyon (Reneau et al. 1998, 59159). Transport of contaminants in solution, especially strontium-90, is shown by their occurrence in alluvial groundwater in DP Canyon (this investigation) and in upper Los Alamos Canyon (Longmire et al. 1996, 54168). Strontium-90 has also been reported in solution in storm water samples in DP Canyon (e.g., Dale 1996, 58930). However, contaminant concentrations in the coarse channel sediments probably decrease with depth, as observed in Pueblo Canyon, and it is probable that only a small percentage of the total contaminant inventory is contained within these deep sediments.

4.2 Variations in Contaminant Concentrations in Sediment

The present distribution of COPCs and variations in contaminant concentration in DP Canyon sediments are largely controlled by variations in the contaminant releases and sediment-transport processes that have operated during the past 45 yr. Sediment transport processes also affect spatial variations in any present or future risk that may be associated with these contaminants.

One component of the preliminary conceptual model that was confirmed by this investigation is the relation of occurrence of the highest organic and inorganic contaminant concentrations in the reach (DP-1) closest to the initial contaminant source. Higher concentrations of these contaminants are also associated with fine-grained sediments than with coarse-grained sediments. Since the organic and inorganic COPCs are believed to be largely derived from Los Alamos townsite runoff, input of these contaminants to DP Canyon is recorded in sediments deposited during the entire period since the townsite was developed. No known peak period of input is discernable, since age control in reach DP-1 is poor. In fact, results of unfiltered storm water samples collected for this investigation document that input of these contaminants is an ongoing process.

The observed temporal variation in contaminant concentrations of the key radionuclides in sediment is consistent with the preliminary conceptual model. High concentrations of these radionuclides are found in sediments relating to the release history at PRS-21-011(k) and record temporal variations in peak releases of different radionuclides (e.g., the americium-241 peak occurring in approximately 1978 and 1979). In general, sediments that record the earliest releases tend to occur as layers at the bottom of the stratigraphic sections, and higher stratigraphic layers record later period releases. Reach DP-3 is an exception, where only relatively young sediments are present, suggesting that reach DP-3 has less capacity to store sediment for long periods than DP-2 and DP-4. One key revision to the preliminary conceptual model is the observation that the highest average concentrations of cesium-137,

plutonium-238, and plutonium-239,240 occur in relatively coarse-grained sediments rather than in fine-grained sediments in reach DP-2 near the initial release site. Variations in contaminant concentration as they pertain to evaluating risk and understanding important transport processes are discussed in the following sections.

4.2.1 Relations to Particle Size Variations

Variations in particle size characteristics between sediment deposits of similar age have a major influence on vertical and horizontal variations in contaminant concentrations in DP Canyon and also have important implications for evaluating risk. Both maximum and average concentrations for the key radionuclides are higher in the relatively fine-grained sediments in all reaches, with a few exceptions. The exceptions are the highest average cesium-137 concentration, and the maximum and highest average concentration of plutonium-239,240 occurring in coarse-grained sediments in specific units in reach DP-2. The occurrence of maximum and high average concentrations of cesium-137 and plutonium-239,240 in reach DP-2 is interpreted to be the result of minimal remobilization of the coarse-grained channel sediments that initially came in contact with effluent from PRS-21-011(k). For all COPCs in this investigation, trends of higher COPC concentrations with increasing percentages of clay-sized particles and/or silt and clay particles are also evident (Section 3.3 and Section B-3.0 of this report), which explains some of the variation in contaminant concentration within a reach. The correlation of higher contaminant concentrations to fine-grained particle sizes also improves down-canyon from PRS 21-011(k). Remobilization of the coarse-grained sediments during floods hydrodynamically separates fine-grained particles and organic matter to which the contaminants likely adsorb. The fine-grained particles and organic matter then are deposited as discrete layers on floodplains or possibly as channel eddy deposits. Thus, the relation of maximum and high average contaminant concentrations to fine-grained particle sizes improves as a function of sediment remobilization and distance from the initial contaminant source.

In reach DP-1, the maximum and average concentrations for the organic and inorganic COPCs is also generally higher in fine-grained sediments. This relation is interpreted to be due to the influence of storm water entering DP Canyon from the Los Alamos townsite. The suspended sediment fraction in storm water runoff typically is relatively fine-grained. Thus the DP Canyon deposits that contain organic and inorganic contaminants are recording the effect of partitioning due to sediment remobilization during floods. Figure E-1.2-7a in Appendix E also shows the abundance of clay-sized sediment in the DP-1 subreaches, further supporting a townsite origin for part of the fine-grained sediment.

The results of this investigation are consistent with previous investigations that showed the influence of particle size variations on contaminant concentrations (e.g., Nyhan et al. 1976, 11747; Reneau 1998, 59160; Reneau 1998, 59159) and support data collection for particle size distribution in sediment samples to understand the basis for variations in contamination. Importantly, contaminant concentrations in the respirable fraction (less than 10 micron-size fraction, including fine silt and clay-sized particles) will be higher than those measured in a bulk sediment sample where less than 20% of the material is within this size range. The smaller size fractions also are more likely to adhere to skin and potentially to be ingested.

4.2.2 Age Trends

As discussed in Section 3.3.1.5, variations in radioisotope ratios provide the best means for determining age trends for sediments comprising geomorphic units within the DP Canyon reaches, and for determining age relations for geomorphic units between reaches. Since no tree-ring age estimates were conducted in DP Canyon, radioisotope ratios in sediment were evaluated in the context of the effluent release history from PRS 21-011(k), as also was done for reach LA-2 East immediately below the confluence of DP Canyon (Reneau et al. 1998, 59160). In general, radionuclide concentration data alone

do not provide a strong means of determining sediment age, because lower concentrations of key radionuclides in sediment that are found in higher stratigraphic positions primarily are associated with deposition following cessation of releases from PRS-21-011(k) in 1986. Also, low concentrations found in lower stratigraphic positions may be related to dilution of effluent concentrations during historic flood deposition. However, an overall trend of higher concentration populations is discernable from the scatter plots shown in Figures 3.3-8 and 3.3-9. Data from abandoned channel sediments with the "b" designator (e.g., c2b, c3b) plot in a field with overall higher concentrations than the abandoned channel sediments with the "a" designator and the f-unit sediments. These data suggest that cb units overall may contain the oldest post-1942 sediments, ca units contain younger sediment, and the f units contain sediments intermediate in age to the channel-unit sediments. This relation is also consistent with the model that the f-unit sediments (and most fine-grained sediments in the c units) are largely derived from reworking of the oldest post-1942 abandoned channel sediments.

In reach DP-2, isotope ratios indicate that the c3b units contain the oldest post-1942 sediments and may be similar in age to the c3 unit in reach LA-2 East. The inferred age of those sediments is between 1952 and 1961, based on the ratios of Cs/Am and plutonium-239/238. The oldest sediment layers in coarse-grained deposits at depth are overlain by fine-grained sediments with lower radionuclide concentrations and isotope ratios indicative of later periods in the release history. The Cs/Am isotope ratios in f1 sediments in reach DP-2 are indicative of relatively recent deposition, largely after 1978. Isotope ratios in sediments in the c2 and c3a units do show some evidence of intermediate or young age, but not enough detailed stratigraphic sampling was conducted to conclude that older sediments do not exist within the units at depth.

In reach DP-3, the oldest sediments are in the c3b unit. Both the coarse- and fine-grained sediments within the c3b unit are inferred to be similar in age to the c2 and c2b units in reach LA-2 East (post-1961) and thus are younger than the oldest sediments in reach DP-2. The Cs/Am ratios in deeper stratigraphic layers within the f1 unit in DP-3 show some evidence of similarity in age to the c3b unit, although the sample population is not sufficient to determine the typical age of f1 sediments. The Cs/Am ratios in the c3a unit indicate a post-1978 age. Of note is the observation that stratigraphic relations of isotope ratios within geomorphic units in reach DP-3 do not show evidence of significantly older sediment preserved at depth. These data support the model that sediments within reach DP-3 may record deposition of sediment that is predominantly younger in age, and also suggest less potential for significant storage or residence for sediment in reach DP-3 than in reach DP-2. Additionally, increased storm water discharge resulting from development in the Los Alamos townsite may have resulted in erosion of most or all of the pre-1961 sediment previously stored in DP-3.

In reach DP-4, the oldest sediments contain relatively high plutonium-239/238 and Cs/Am ratios, indicating a pre-1961 age for most layers within the c2b unit. As with the oldest sediments in DP-2, these ratios potentially relate the c2b unit in DP-4 to the age of the c3 unit in reach LA-2 East. Isotope ratios in sediments comprising the f1 unit indicate a relatively young, possibly post-1978, age. Stratigraphic relations of isotope ratios indicate that some c2b sample locations show evidence of old (pre-1961) coarse-grained sediments overlain by significantly younger (sometimes post-1978) fine-grained sediments. Other c2b sample locations contain evidence of old sediments throughout the stratigraphic profile. The inferred age of sediments in c2b unit in reach DP-4 is comparable to the inferred age of c3b sediments at depth in reach DP-2. The implications are that much of the sediment in reach DP-4 was transported and stored there early in the release history of PRS-21-011(k) and that minimal reworking has occurred. Geomorphic processes have been dominated primarily by localized deposition of fine-grained sediments on floodplains and over abandoned channel sediments.

4.2.3 Spatial Trends

Two key spatial trends in contamination in DP Canyon sediments are an integral part of the conceptual model: spatial trends in key contaminant concentrations and spatial trends in contaminant inventory.

4.2.3.1 Spatial Trends in Radionuclide Concentration

The preliminary conceptual model predicted that contaminant concentrations would decrease downstream from the source. Overall the organic and inorganic contaminants derived from the Los Alamos townsite do show decreasing concentration trends or show very low and constant concentrations with distance down-canyon from the head of the canyon (reach DP-1 West). The overall decreasing trends are likely due to dilution of higher-concentration sediments near the source with uncontaminated (with respect to organic and inorganic contaminants) sediments during down-canyon transport. The trends in radionuclide concentration observed in this investigation warrant a revision to the preliminary conceptual model for DP Canyon. For all key radionuclides, average concentrations in the fine-grained sediments increase down-canyon and are found within DP-3 or DP-4. Average concentrations in coarse-grained sediments decrease down-canyon from DP-2 except plutonium-239, which shows a higher average concentration in DP-3. Average concentrations are derived by dividing the total radionuclide inventory by the volume of sediment. The down-canyon shift to lower average radionuclide concentrations in coarse-grained sediments and higher average radionuclide concentrations in fine-grained sediments is indicative of progressive partitioning of contaminants to more ideal sorption sites (i.e., finer-grained sediments and organic matter) during flood reworking. Higher average concentrations in coarse-grained sediments therefore are found near the source, where sediments that initially were in direct contact with effluent have been subject to little or no flood reworking.

4.2.3.2 Spatial Trends in Radionuclide Inventory

The inventory calculations for DP Canyon (Figures 3.3-10 through 3.3-14) indicate that the highest inventory for each key radionuclide is in reach DP-2 near the initial source of contamination. Fine-grained sediments also contain higher inventories than coarse-grained sediments within each reach. The data represented in Figures 3.3-10 through 3.3-14 also show that the variations in inventory reflect variations in the volume of sediment and the volume of each facies within each reach since the average concentrations for each facies are often comparable or even higher in DP-3 and DP-4 than in DP-2. Reach DP-2 contains a significantly higher volume of sediment than DP-3 or DP-4 because it is wide and has a low gradient. Floodplain units in DP-2 are especially important contributors to the overall volume of sediment and high inventory, although coarse-grained sediments are also important near the source. Table 3.3-8 shows that approximately one-third of the estimated cesium-137 inventory in the entire Los Alamos Canyon system exists within sediments in DP Canyon, and approximately one-half the total cesium-137 inventory in DP Canyon resides within DP-2. Fine-grained sediments contain most of the inventory in DP-2, primarily because of their relatively large volume.

An uncertainty in the conceptual model for the radionuclide inventory in DP Canyon is the percent of the total inventories of the key radionuclides contained on the hillslope below PRS 21-011(k). Some part of the inventory on the hillslope below the 21-011(k) outfall was excavated during an interim action in 1996 (LANL 1996, 55648), but no estimates of the remaining inventory are available for comparison to the estimated inventory of radionuclides in DP Canyon sediments. Except for the freshly excavated area in the upper outfall area and the gully that represents incision that likely is due to effluent releases, the hillslope below PRS-21-011(k) is vegetated and not incised, and does not appear to be contributing contamination at present.

4.3 Fate and Transport of Contaminants

The fate and transport of contaminants in DP Canyon sediments depend on sediment transport processes that will continue to redistribute these contaminants, geochemical characteristics of the contaminants and alluvial groundwater, and radioactive decay. The following sections discuss important transport processes occurring in DP Canyon and the likely effects of these processes on future levels of sediment contamination. Under natural conditions, future changes in contaminant levels from those documented in this investigation will be in large part the result of processes that transport or mix sediment, involving both sediment containing variable levels of contamination and sediment that is presently uncontaminated, in combination with radioactive decay. In addition to transport associated with sediment particles, strontium-90 will also be transported as part of the dissolved load of surface water and alluvial groundwater; therefore, concentrations of strontium-90 in sediment also will be affected by interactions with surface water and alluvial groundwater.

4.3.1 Original Effluent Releases and Resultant Contaminant Distribution

Radionuclide contaminants in the DP Canyon watershed originated in effluent releases from the PRS 21-011(k) outfall, which flowed first down a colluvial slope and then into the main stream channel in DP Canyon; the effluent probably infiltrated into both the slope and the channel bed. Because of the nature of Laboratory operations, radionuclides in the original effluent would have been largely in solution, but because of their geochemical characteristics most of these radionuclides would have tended to adsorb onto sediment particles or organic colloids (e.g., Langmuir 1997, 56037).

Radionuclides in effluent that infiltrated into the colluvial slope below the 21-011(k) outfall would have preferentially adsorbed to organic matter in the soil and finer-grained particles because of their greater surface area and, in the case of clay minerals and solid organic matter, their high cation exchange capacity. Radionuclides in effluent that infiltrated into the stream bed would have encountered mainly coarse-grained sediment, and adsorption of significant amounts of the radionuclides may have been onto small amounts of other components within the coarse-grained sediment (e.g., organic matter, iron oxide coatings on larger grains, or clay particles adhered to larger grains). During the period of effluent releases, radionuclide inventories would have built up incrementally, both on the slope and in the channel. The part of the inventory in the main channel might have remobilized readily during floods, but the inventory on the slope might have been more stable initially. However, later development of a gully on the slope below PRS 21-011(k) allowed both excavation of some of the contaminated soil and easier transport of effluent from the top of the slope into the DP Canyon channel.

4.3.2 Effects of Floods

Floods constitute the primary transport process for sediment and associated contaminants in DP Canyon, and the combined effects of numerous floods during the past 55 yr have largely controlled the horizontal and vertical extent of contaminated sediments and variations in contaminant concentration. Floods therefore indirectly affect any human and ecological exposure to contaminated sediments. Importantly, the present variations in radionuclide concentration in DP Canyon sediments, combined with evidence for the age of different sediment deposits, provide a geomorphic record of the past effects of floods and a means to forecast likely future changes in contamination.

The spatial distribution of contaminants in DP Canyon demonstrates that significant transport of contaminated sediments has occurred throughout the canyon. Overall, concentrations of all the key radionuclides are comparable throughout DP Canyon, suggesting little dilution occurred initially with increasing distance from the source. Later floods have modified the distribution of the nature of

contaminants in DP Canyon. In DP-2 and DP-4, higher stratigraphic layers within sediment packages have contaminant signatures that are indicative of flood deposition of sediment with generally lower concentrations as well as sediment with isotope ratios indicative of later releases from PRS 21-011(k). These floods probably were associated with increased runoff following development in the Los Alamos townsite.

Average sediment residence times, or the average time between floods that remobilize specific sediment particles, will vary among sediments deposited in different geomorphic locations. Residence times for sediment in active channels is relatively short, and sediment in these areas is mobilized easily in floods. In contrast, residence times for sediment deposited on floodplains can be quite long and can exceed 100 yr, based on the ages of trees growing on floodplain surfaces in Los Alamos Canyon (Reneau et al. 1998, 59160). Sediments in most abandoned channel units show highly variable residence times. In DP-2 and DP-4, lower stratigraphic intervals within the c3b (reach DP-2) and c2b (reach DP-4) units show isotopic ratio evidence of ages greater than approximately 30 yr, whereas upper stratigraphic intervals show younger ages. One possible explanation for this difference is that older sediments that initially capped the abandoned channel sediments were remobilized and transported down-canyon as coarse-grained channel sediments and/or in suspension and were deposited on down-canyon floodplains. In DP-4, the high radionuclide concentrations in sediment and high isotope ratios are indicative of older releases from PRS 21-011(k) and suggest possible early remobilization of sediments from DP-2.

An additional effect of erosion and sediment transport during floods is to allow contaminants that previously had been stored in unsaturated sediment to interact with surface water. Strontium-90 adsorbed onto sediment particles or solid organic matter would partially desorb and be transported in the dissolved load of the floods; the transport of strontium-90 within both the dissolved load and the suspended load of DP Canyon floods has been demonstrated by analyses of storm water samples (Dale 1996, 58930).

4.3.3 Effects of Bioturbation

Burrowing mammals and other fauna can be very effective at mixing soils and thus locally changing concentrations of contaminants. Such biological mixing processes are collectively known as bioturbation, a term that also includes mixing by plants, including disruption caused by toppling trees. Bioturbation affects contaminant levels over a range of time frames and spatial scales. Bioturbation can locally increase contaminant levels in soils by transporting contaminated sediment into subsurface layers or onto uncontaminated or less-contaminated surfaces. However, bioturbation also locally decreases contaminant levels by mixing uncontaminated soils, such as those present in pre-1943 deposits, into post-1942 sediment deposits that contain radionuclides above background values. In general, the net effect over time is to reduce the vertical stratification in contamination that resulted from the original deposition of sediment layers with varying radionuclide levels, producing more homogeneous contaminant concentrations in sediments. Where bioturbation is restricted to the depth of post-1942 sediment packages, resulting average contaminant levels for such sediment packages should be similar to those estimated in Section 3.3. Alternatively, where bioturbation extends to greater depths, the effect of such mixing is to reduce average radionuclide concentrations while increasing the volume of contaminated soils.

An additional effect of bioturbation is to bring fresh, loose material to the surface. Such loose material is more susceptible to redistribution by rainsplash, wind, or aboveground animals than material in adjacent areas that are well vegetated or otherwise resistant to erosion. Thus, bioturbation contributes to other transport and exposure pathways. Rainsplash of this loose material causes only very local redistribution, but it is important in the context of transferring contaminated material onto plant surfaces where it can be absorbed by the plants or ingested by animals or humans. Wind and animals can

potentially transport contaminated material onto uncontaminated geomorphic units. Of these processes, wind is likely more significant.

4.3.4 Transport by Wind

Wind may be an important process for at least local redistribution of contaminants within DP Canyon, in addition to being an important part of the exposure pathways (see Section 5.1 discussion of risk assessments). Recently deposited, unvegetated, fine-grained overbank sediment may provide a source for wind-transported sediment with contaminant levels above background, as has been documented in other regions (e.g., Lechler et al. 1997, 58475). Areas disturbed by burrowing mammals may provide an additional source, as discussed in Section 4.3.3. However, wind transport may be of relatively limited importance in DP Canyon because overbank settings generally are well vegetated or covered with litter. In addition, it is important to note that eolian sediment derived from post-1942 deposits will is also be mixed with material eroded from uncontaminated areas, resulting in dilution. Sources of eolian sediment during or between windstorms may be extremely variable, and no attempt has been made to evaluate the relative contributions of contaminated and uncontaminated areas in providing eolian sediment in DP Canyon.

4.3.5 Future Remobilization and Contaminant Transport

A general evaluation of the effects of future remobilization and transport of contaminated sediment by natural processes can be made based on the results of this investigation, particularly using data on important transport processes and resultant changes in radionuclide concentration and distribution since 1942, as discussed in previous sections. A time frame of approximately 50 yr was used in this evaluation, due to the releases of radionuclides that can be used as tracers.

Future floods will continue to redistribute radionuclides within DP Canyon and to transport some of these radionuclides into Los Alamos Canyon. This redistribution will reduce the radionuclide inventory in some reaches and perhaps increase the inventory in some downstream areas. The radionuclides most susceptible to remobilization are in that part of the total inventory contained within the presently active channel (c1), within geomorphic units adjacent to the active channel (such as the typical c2 and c3 units), and along most of reach DP-3 where sediments are susceptible to erosion due to the narrow aspect of the reach. In these areas average sediment residence times are assumed to be less than 30 yr, and remobilization of most of this sediment is considered very likely during the next 50 yr. Deeper layers within those units (often deeper that the elevation of the present channel floor) are however somewhat protected from erosion, as evidenced by old sediments still in place immediately adjacent to PRS 21-011(k). Estimates of the susceptibility to remobilization of post-1942 sediment deposits in DP Canyon suggests that approximately 45% of the americium-241; 63% of the cesium-137; 54% of the plutonium-239,240; and 50% of the strontium-90 is susceptible to remobilization during the next 50 yr. Therefore, it should be assumed that most of the radionuclides present within DP Canyon could be transported downstream into Los Alamos Canyon during the next 50 yr. Because of the short half-lives of cesium-137 and strontium-90 (30.2 and 28.6 yr, respectively), the inventory of these radionuclides will be significantly reduced by radioactive decay in the coming decades.

4.3.6 Transport by Alluvial Groundwater

Strontium-90 is the only key radionuclide in DP Canyon that has significant alluvial groundwater transport potential. Although other contaminants were detected in alluvial groundwater, they are not considered highly mobile due to their low solubility. Analytical data for strontium-90 indicates that it is very mobile with the groundwater (Longmire et al. 1996, 54168). Additionally, tritium released into DP Canyon from

PRS 21-011(k) is barely discernable in sediment and alluvial groundwater in DP Canyon. Although some transport of nonsoluble or low-solubility contaminants probably occurs within alluvial groundwater, as inferred for plutonium in Pueblo Canyon (Reneau et al. 1998, 59159), this transport is expected to be minor.

4.4 Revised Conceptual Model for Alluvial Groundwater

Details of the geochemical evaluation for alluvial groundwater in DP Canyon are presented in Sections 3.2.4 through 3.2.7 of this report. This section focuses on the source of contamination to the alluvial groundwater and refinement of the conceptual model for the geohydrologic system in DP Canyon. It was proposed in the preliminary conceptual model that storm water entering DP Canyon from the Los Alamos townsite is the source of alluvial groundwater in DP Canyon. It follows that many of the contaminants found in the unfiltered storm water would be found in the alluvial groundwater. Observations of rapidly changing groundwater levels in response to storm water entering DP-2 from the townsite support the preliminary conceptual model of recharge in reach DP-2. However, data presented in Section 3.2 (Figures 3.2-7a and 3.2-7b) indicate that the results from unfiltered storm water samples do not correlate well with alluvial groundwater results. The implication is that storm water chemistry is changed due to physical or geochemical processes before and/or during recharge. One possible explanation for this change is that the suspended sediment fraction that contains most of the contaminants is deposited from suspension before it recharges the alluvium. This is supported by the strong correlation between unfiltered storm water results and the results of active channel sediments (c1 units). Remaining particulates are either filtered or sorbed as the water moves through the alluvium. Some inorganic contaminant concentrations are higher in unfiltered alluvial groundwater than in storm water. Radioactive contaminants are also present in unfiltered alluvial groundwater, suggesting that water/sediment interaction can also result in dissolution and mobilization of other contaminants. Thus, a significant revision to the conceptual model is that analytical results from storm water are not useful for establishing baseline conditions for alluvial groundwater in DP Canyon.

Another key aspect of the preliminary conceptual model for DP Canyon is the possible hydrologic connection between alluvial groundwater in reach DP-2 and DP Spring. Strontium-90 is the only contaminant in the alluvial water that occurs in concentrations that are high enough to be useful for understanding the DP Canyon hydrologic system. Strontium-90 results from this investigation strongly support the model for a hydrologic connection because strontium-90 is an efficient tracer due to its relatively high solubility. Figure E-6.2-2 shows that strontium-90 is consistently detected at elevated concentrations at all DP Canyon sampling locations. Strontium-90 concentrations are consistently higher in monitoring well LAUZ-1 than in LAUZ-2 or DP Spring, where concentrations are often comparable. Analytical results do not vary significantly between filtered and unfiltered samples, suggesting the strontium-90 exists primarily in solution. Some variability was observed among sampling events, but there are not enough data to infer seasonal trends that might be caused by variations in general water quality parameters such as pH, conductivity, or temperature. The decreasing strontium-90 concentrations between LAUZ-1 and LAUZ-2 are interpreted to be a result of storm water recharge to the alluvial groundwater along the length of the channel between the two wells. The decreasing trend in concentration is observed even though the alluvial groundwater interacts with a large volume of strontium-90 contaminated sediments as it travels eastward through reach DP-2. Thus, storm water recharge must effectively dilute the strontium-90 concentrations in groundwater. Preparation for a tracer study is currently underway to support refinement of the conceptual hydrologic model and provide specific data on travel and residence times within the geohydrologic system.

5.0 SITE ASSESSMENTS

5.1 Preliminary Human-Health Assessment

5.1.1 Scope and Objectives

The purpose of this section is to evaluate the data for contaminants in DP Canyon sediments and water relative to potential human-health effects. The emphasis of this analysis is to determine whether a site management decision to mitigate potential human-health risks is warranted at present. This analysis uses present-day contaminant concentrations and reasonable present-day exposure scenarios but does not assess the possible effects of future contaminant redistribution or potential future land uses. Those issues will be addressed in a future Los Alamos Canyon watershed report. The assessment in this interim report focuses on risks resulting from direct exposure to contaminants in sediments by ingestion, inhalation, and dermal contact, and from indirect exposure by consuming foodstuffs that have grown in contaminated sediments or meat from animals that consumed plants in contaminated areas. The water pathways consists of surface water ingestion, using alluvial groundwater data for the assessment in reach DP-2 and DP Spring data in reach DP-4. Reaches DP-1, DP-3, and DP-4 are characterized as ephemeral, as described in the integrated technical strategy (LANL 1999, 63254,). Aquatic exposure pathways are not assessed for ephemeral reaches because the episodic availability of water can not sustain chronic exposures.

5.1.2 Comparison with Core Document Risk Approach

Chapter 6 of the "Core Document for Canyons Investigations" ("the core document") (LANL 1997, 55622) proposes risk assessments of sediments, surface water, groundwater, and air particulates. These media were proposed for evaluation in nine exposure scenarios over three land uses. The continued Los Alamos National Laboratory (the Laboratory) land use includes a construction-worker scenario and an on-site-worker scenario. The recreational land use has both a trail-user scenario and a camper scenario. The American Indian land use consists of scenarios for residential use, ranching, hunting, and traditional uses, and use of the Rio Grande and Cochiti Lake.

The assessment in this report uses scenarios for a trail user, a resource user (incorporating aspects of a ranching or hunting scenario), and a construction worker. These scenarios are considered to be inclusive of realistic present-day potential exposure activities in DP Canyon. The bases of primary and secondary exposures are the contaminant concentrations in sediments and surface water in reach DP-2, and groundwater emerging at DP Spring. Other scenarios proposed in the core document presently do not occur in DP Canyon and will not be evaluated in this interim report.

Development of an American Indian land-use scenario is proposed in the core document. The intent of that land-use scenario is to uniquely define the parameters of exposure pathways that reflect the activities of the local American Indian populations. However, the American Indian scenario is not sufficiently developed to be applied in this report. An approximation of the American Indian scenario could be achieved by combining a residential scenario with the resource-user scenario, although a residential scenario is not included in this report because it is not a reasonable present-day scenario for DP Canyon. Residences are adjacent to the head of DP Canyon, but the fruit-, vegetable-, meat-, and water-ingestion pathways that characterize the residential scenario are not complete.

Each exposure scenario evaluated in this report is applied over the entire area of each reach. This means that an average contaminant concentration is calculated for the sampled sediments in each reach and that value is used for the potential risk estimate. The method of averaging is addressed in Section 5.1.7. This method is in contrast to the approach proposed in the core document, which involves using different-

size exposure areas for different scenarios. The trail-use, resource-use, and construction activity would likely occur along a whole reach or larger areas. Therefore, it is reasonable to use the whole-reach averages as a means for estimating exposure. Scale issues related to the other scenarios in the core document will be addressed when those scenarios are evaluated in future assessments.

5.1.3 Technical Approach

The initial screen of human-health risks for this report is conducted by comparing the maximum values for each of the chemicals of potential concern (COPCs) with preliminary remediation goal (PRG) values (Perona et al. 1998, 62049). Contaminants with maximum values exceeding PRGs are considered further using distribution analysis, area-weighted averaging and volume-weighted averaging. The PRGs are generated by using the parameters associated with each of the scenarios, as described in Section 5.1.4, and computing the contaminant concentration that would result in a threshold risk. This is consistent with the US Environmental Protection Agency (EPA) manual "Risk Assessment Guidance for Superfund: Volume I—Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals) (RAGS)" (EPA 1991, 58234). PRG concentrations for chemical carcinogens are based on a risk of 10^{-6} or 1 in 1 million. The noncarcinogen PRGs are based on a hazard quotient (HQ) of 1. The radiological criteria are based on dose and not on the carcinogenic effects of ionizing radiation; the radiation dose limit used in this document is 15 mrem/yr (EPA 1997, 58693). This is more conservative than the dose limit of 25 mrem/yr proposed by the US Nuclear Regulatory Commission for unrestricted use of a site (10 CFR 20, "Standards for Protection of Radiation") and the limit of 100 mrem/yr in US Department of Energy (DOE) Order 5400.5, "Radiation Protection of the Public and the Environment." Additionally, DOE has a policy of reducing all radiation exposures to levels that are as low as reasonably achievable (ALARA).

The dose conversion factors used in this assessment for americium-241, cesium-137, plutonium-239, strontium-90, tritium, uranuim-234, and uranium-235+D are taken from the manual for implementing residual radioactive material guidelines using RESRAD (Yu et al. 1993, 58695). These dose conversion factors are referenced to the DOE publications "External Dose-Rate Conversion Factors for Calculation of Dose to the Public" (DOE 1988, 58691) and "Internal Dose Conversion Factors for Calculation of Dose to the Public" (DOE 1988, 58692). The dose conversion factor for plutonium-239 is applied to the plutonium-239,240 results because available data indicate that plutonium-239 is much more abundant than plutonium-240 in sediments at the Laboratory (Gallaher et al. 1997, 59165).

An example of the use of PRGs in this report follows. Given the description of the trail-user scenario in Section 5.1.4, the concentration of plutonium-239 in the sediments that results in an exposure of 15 mrem/yr is 440 pCi/g, which constitutes the PRG. The measured maximum value for plutonium-239,240 in DP Canyon is 48 pCi/g. Therefore, the PRG is more than 9 times the measured maximum value. Based on this initial screening assessment using maximum sample results, plutonium-239,240 does not pose an unacceptable potential human-health risk to the present-day trail user. Further assessments using average values are performed for COPCs when the maximum value is greater than the PRG.

Approaching risk characterization in this manner supports site management decisions about present-day risks and the possible need for remediation of sediments and water. This is a deterministic approach that uses the contaminant concentration data to make individual contaminant assessments. Where contaminants are collocated, the percentage of PRGs can be summed within contaminant categories (radionuclides, chemical carcinogens, noncarcinogens) to estimate integrated potential exposures. Performing stochastic uncertainty and sensitivity analyses, if warranted, is deferred to a future cumulative assessment for the Los Alamos Canyon watershed.

5.1.4 Exposure Assessment

5.1.4.1 Soil and Sediment Pathways

The following exposure scenarios were developed using standard EPA default parameter values, when available. These values are consistent with the parameters for reasonable maximum exposure assessments. When EPA default parameters were not available, professional judgement was used in selecting conservative values from other publications or setting site-specific assumptions. Soil ingestion rates are taken from RAGS (EPA 1991, 58234). The averaging time of 30 yr for the trail user and resource user and the construction work year of 250 days are also taken from RAGS. Soil inhalation and adult intake rates for fruit, vegetables, and meat are taken from the exposure factors handbook (EFH) (EPA 1990, 58694). The proportion of meat (75%) for the resource user is taken from EFH. The trail-use and resource-use exposure frequencies and durations (75 days/yr, 1 hr/day), the proportion of fruits and vegetables from a reach (10%), the average construction time of 1 yr, and the 8-hr work day are based on professional judgement.

The initial evaluations are comparisons between COPC maxima and PRGs for each exposure scenario. If the sample maxima exceed any PRGs, the next step in the assessment is to compare the area-and volume-weighted averages of the sample data to the PRGs. Using averages is warranted because the exposure scenarios can reasonably be expected to occur over large areas. Estimated averages are very likely to exceed actual exposure concentrations because the COPC averages in the investigation reaches are assumed to occur throughout the canyon. In fact, the investigation approach is biased toward sampling contaminated sediments, as described in Section 3.3. Consequently, the contaminant profile for the canyon is overestimated.

Trail-User Scenario

The trail user is defined as an adult who uses a given reach 75 days/yr during a 30-yr period. Each visit to the reach has a duration of 1 hr. During each hike, the individual ingests 100 mg of soil and inhales 0.25 mg of soil as suspended dust.

Resource-User Scenario

The resource-user scenario employs the same temporal parameters (1 hr/day, 75 days/yr, 30 yr), as the trail-user scenario and adds the consumption of fruits, vegetables, and meat. The parameters used for adult consumption of fruits, vegetables, and meat are 51 kg/yr, 73 kg/yr, and 36.5 kg/yr, respectively (EPA 1990, 58694). Resource users are assumed to obtain 10% of their fruits and vegetables (5.1 kg/yr and 7.3 kg/yr) and 75% of their meat (27 kg/yr) from the reach. These consumption rates are integrated over 30 yr. The fruits and vegetables are assumed to grow in sediments that have been inundated by post-1942 floods, and the animals that provide meat are assumed to range and graze exclusively in areas that have been inundated, as well.

Construction-Worker Scenario

The construction-worker scenario assumes a 250-day work year with 8-hr days. The duration of the scenario is 1 yr, and all activities are assumed to occur within geomorphic units that have been inundated by post-1942 floods and have contaminant profiles equivalent to the COPC averages. The individual is assumed to ingest soil at a rate of 480 mg/day and to inhale soil as airborne dust at a rate of 2 mg/day. Possible construction activities in DP Canyon under present-day land-use conditions include the construction or maintenance of roads and the excavation of trenches (such as for sewer lines).

5.1.4.2 Water Pathways

The approach to screening water data is to evaluate the potential for an unacceptable exposure using conservative assumptions. A total intake is calculated for each water COPC using residential parameters of 2 L/day and 350 days/yr and the COPC concentration that results in a potential cancer risk of 1e-6 (an HQ=1), or a dose of 15 mrem/yr. For carcinogens, the averaging time of 30 yr for adult exposure was also used. Adult exposure factors are typically associated with the ages of 6 yr and older. Then the rate of consumption for water at the maximum contaminant concentration was computed for trail-user, resource-user, and construction-worker scenarios. For example; the concentration of plutonium-239,240 in water that results in a dose of 15 mrem/yr is 6.1 pCi/L. The total intake of plutonium-239 activity is 6.1 pCi/L × 2 L/day × 350 days/yr × 30 yr, or 128,100 pCi. The trail-user scenario is defined as 75 reach visits/yr for 30 yr. The total activity of 128,100 pCi from the residential scenario can be divided by the product of the maximum water sample activity of 0.25 pCi/L, 75 days, and 30 yr to compute the water intake rate at the maximum activity that results in an equivalent total plutonium-239 intake. In this example, 128,100 pCi is divided by 0.25 × 75 × 30 (pCi/L × day/yr × yr). The result of 230 L/day means that the trail user must consume 230 L of water at the maximum activity of 0.25 pCi/L for 75 days/yr for 30 yr to receive a dose of 15 mrem/yr from the water.

5.1.5 Sediment COPC Screening and Evaluation

Section 3.1 provides an analysis of the contaminant data from DP Canyon sediment samples and a selection of the COPCs that warrant further consideration in site management decisions. There are 32 organic chemicals, 9 inorganic chemicals, and 8 radionuclides recommended for further evaluation (Table 5.1-1). A screening assessment of the COPCs using maximum values and PRGs is presented in Figure 5.1-1. The lines of equality in these plots separate the plot regions into two areas. Points that plot to the right of the lines of equality are maximum COPC values that are less than their PRGs. Points that plot to the left of the lines of equality exceed PRGs and are evaluated further. The trail-user scenario PRGs are exceeded by six organic contaminants. The resource-user scenario PRGs are exceeded by 6 organic, 1 metal, and two radionuclide contaminants. One organic and three radionuclide contaminants exceed the construction-worker scenario PRGs. In addition, benzo(g,h,i)perylene is detected in DP Canyon. Toxicity criteria are not presently available for this contaminant, preventing a comparison with PRGs. This issue is discussed below. Another contaminant, DDE, is present in some samples. Common practice is to sum the DDE results with DDT results and use the reference values for DDT. The sum of the maximum values for DDT and DDE is 0.2, which is well below the DDT PRGs. Consequently, DDT and DDE are not considered further.

Polycyclic aromatic hydrocarbons (PAHs) are commonly found in association with petroleum products and are caused by incomplete combustion of organic substances. PAHs for which EPA has published toxicity values are generally classified for carcinogenic potential as either class B2 (possible human carcinogen) or class D (inadequate data to determine carcinogenicity). The EPA cancer classification for benzo(a)pyrene is class B2. The EPA cancer classification for benzo(g,h,i)perylene is class D. Other common PAHs that share a class D carcinogenicity classification include acenaphthene, anthracene, fluoranthene, fluorene, naphthalene, and pyrene.

Table 5.1-1
Screening Assessment DP Canyon Contaminant Values and Exposure Scenario PRGs

COPC	DP Canyon Maximum Value[a]	Trail-User Soil PRG	Resource-User Soil PRG	Construction-Worker Soil PRG
Radionuclides				
Americium-241	71	420	160	**23**
Cesium-137+D[c]	442	510	**71**	**19**
Plutonium-238	2.8	480	170	26
Plutonium-239,240[d]	48	440	150	24
Strontium-90+D	33	11000	**12**	610
Tritium	3	2300000	3100	1100000
Uranium-234	1.8	3300	720	150
Uranium-235+D	0.11	1400	570	57
Inorganic Chemicals				
Antimony	1.4	890	48	77
Cadmium	0.667	3100	6.6	200
Chromium	20	78	78	88
Cobalt	4.8	7600	360	290
Copper	36	87000	250	7700
Lead	210	400	400	400
Mercury	0.25	660	**0.22**	57
Selenium	1.3	11000	6.7	960
Zinc	170	560000	330	57000
Organic Chemicals				
α-Chlordane	0.25	7.3	7.3	29
γ-Chlordane	0.18	7.3	7.3	29
4,4'-DDT	0.12	9.0	9.0	33
4,4'-DDE	0.082			
Aroclor-1260 (PCB)	1	**0.63**	**0.63**	3.5
Acenaphthene	0.24	32000	32000	6100
Anthracene	0.62	160000	160000	30000
Benz(a)anthracene	3	**1.7**	**1.7**	9.7
Benzo(a)pyrene	3.2	**0.14**	**0.14**	**0.84**
Benzo(b)fluoranthene	3.8	**1.7**	**1.7**	9.7
Benzo(g,h,i)perylene	5	N.A.[e]	N.A.	N.A.
Benzo(k)fluoranthene	1.4	17	17	97
Benzoic acid	0.38	150000	1500000	370000
Bis(2-ethylhexyl)phthalate	1.7	90	90	500
Carbazole	0.5	63	63	350
Chrysene	3.3	170	170	970

Note: Values for organic and inorganic chemicals are expressed in milligrams per kilogram; values for radionuclides are expressed in picocuries per gram.

Table 5.1-1 (continued)

COPC	DP Canyon Maximum Value[a]	Trail-User Soil PRG	Resource-User Soil PRG	Construction-Worker Soil PRG
Organic Chemicals (continued)				
Dibenz(a,h)anthracene	0.98	**0.17**	**0.17**	0.97
Dibutyl phthalate	2.1	53000	53000	10000
Dimethyl phthalate	4.2	400000	400000	80000
Di-n-octylphthalate	0.16	11000	11000	2000
Butyl benzyl phthalate	4.2	110000	110000	20000
Fluoranthene	4.4	22000	22000	4000
Fluorene	0.066	22000	22000	4000
Heptachlor Epoxide	0.11	0.14	0.14	0.78
Indeno(1,2,3-cd)pyrene	3.8	**1.7**	**1.7**	9.7
2-Methylnaphthalene	0.046	2200	2200	400
Naphthalene	0.62	2200	2200	400
Phenanthrene	3.2	16000	16000	3000
Pyrene	12	16000	16000	3000
Acetone	0.024	53000	53000	10000
Toluene	0.008	110000	110000	20000
2,4,6-Trichlorophenol	9.3	110	110	640

[a] Maximum values are rounded to two significant figures.

[b] Bolded values indicate PRGs that are exceeded by the maximum result.

[c] D = daughters.

[d] PRGs for plutonium-239,240 are calculated using the dose conversion factor for plutonium-239.

[e] N.A. = not available.

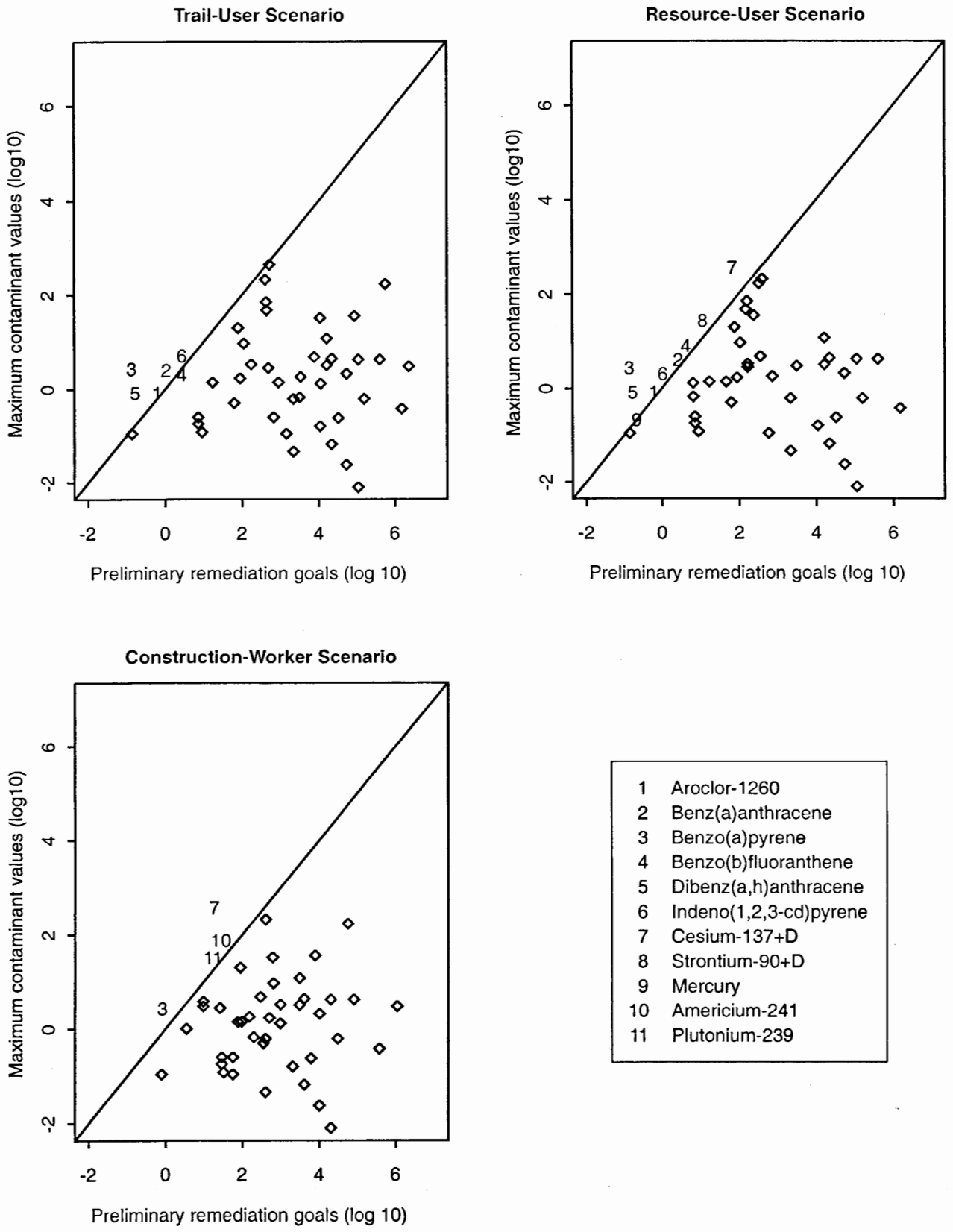


Figure 5.1-1. Comparisons of maximum values with PRGs by scenario

Benzo(g,h,i)perylene was detected in 9 of 46 samples. This organic chemical does not have specific published toxicity criteria. EPA has published noncarcinogenic oral toxicity values (reference doses) for acenaphthene, anthracene, fluoranthene, fluorene, naphthalene, and pyrene. These reference dose values are generally associated with an allowable chemical intake that is orders of magnitude larger than those for potent PAH carcinogens such as benzo(a)pyrene and dibenz(a,h)anthracene when these are evaluated at a target risk level of one excess cancer per million. For example, compare the soil PRGs for these PAHs presented in Table 5.1-1.

Although EPA has not published a chemical-specific toxicity value for benzo(g,h,i)perylene, the significance of this PAH relative to the other PAHs with which it is associated in the environment can be inferred from the comparison of soil criteria, evaluation of co-occurrence, and comparison of sample values. The human-health impacts associated with exposure to PAHs in the environment can be assessed in the absence of specific information on benzo(g,h,i)perylene by comparing to the same PRGs as the other detected class-D PAHs. Soil criteria associated with the PAHs for which EPA has published slope factor and/or unit risk values are likely to be protective for concomitant exposure to PAHs for which toxicity values have not been derived. The minimum PRG for other class-D PAHs in Table 5.1-1 is 400 mg/kg for naphthalene. Therefore, because the maximum result for benzo(g,h,i)perylene is only 5 mg/kg, it was dropped as a COPC for the assessment in this report.

5.1.6 Water COPC Screening

Water exposure from ingestion is included for the alluvial groundwater in reach DP-2 and DP Spring in reach DP-4. Table 5.1-2 presents the results. For radionuclides and chemical carcinogens, the trail-user and resource-user scenarios are the limiting values because their averaging times are 30 yr and the construction-worker scenario has an averaging time of 1 yr. Averaging times are not used for noncarcinogens. Consequently, the construction-worker scenario is more restrictive because of the 250 days/yr versus 75 days/yr for the trail-user and resource-user scenarios.

In addition to the COPCs presented in Table 5.1-2, calcium, lithium, magnesium, potassium, and sodium were detected in the water samples at concentrations higher than the background screening values. These elements are essential nutrients and are not considered further in this assessment.

5.1.7 COPC Data Evaluation

One metal, four radionuclides and six organic contaminants exceeded PRGs, using maximum sample values. Data for these COPCs were reviewed for the distribution of values relative to the PRGs. Additionally, two weighted averages were calculated for each reach, using the detected values for the COPCs. One is an area-weighted average that uses present-day estimates of average contaminant concentrations in the uppermost sediment packages in each geomorphic unit, as presented in Section 3.3, and unit areas, as presented in Section 2.3. The other is a volume-weighted average that uses vertically weighted concentration estimates where sediment packages are superimposed, using estimated average thicknesses of each package as presented in Section 3.3, and then computes a volume-weighted average concentration to represent the reach. In the area-weighted average all human exposure is assumed to be restricted to the area containing contaminated sediments. In the volume-weighted average all human exposure is assumed to be restricted to depths where contamination is above background values, with no mixing with underlying uncontaminated materials. Thus, both averages overestimate exposure.

Table 5.1-2
Water Consumption Rates Resulting in Risks or Doses of Potential Concern

Radionuclides	pCi/L for 15 mrem/yr	Max Value (pCi/L)	Trail User and Resource User (L/day)	Construction Worker (L/day)
Plutonium-239,240	6.1	0.25	182	1600
Strontium-90+D	140	210	5.00	45
Tritium	330000	280	8800.00	79000
Uranium-234	76	1.7	330.00	3000
Uranium-235+D	80	0.24	2500	22000
Inorganic Chemicals	**mg/L for HQ = 1**	**Max Value (mg/L)**	**Trail User and Resource User (L/day)**	**Construction Worker (L/day)**
Barium	2.6	0.21	116	35
Boron	3.3	0.067	460	140
Iron	11	6.7	15	4.6
Manganese	1.7	0.87	18	5.5
Organic Chemicals	**mg/L for risk 1e-6**	**Max Value (mg/L)**	**Trail User and Resource User (L/day)**	**Construction Worker (L/day)**
Bis(2-ethylhexyl)phthalate	0.0061	0.036	**1.6**	14
Dichloroethane(1,2)	0.00094	0.0076	**1.2**	10

These two estimates are necessary to support the dose assessment for the three scenarios. The present-day trail user is exposed to the area-weighted average. In addition to pathways for the trail user, the present-day resource user also consumes fruits, vegetables, and meat animals that graze on plants growing in the contaminated sediments. Because plant roots uptake contaminants through the entire thickness of contaminated sediments, the resource user is exposed to the volume-weighted estimate of the contaminant concentrations. The construction worker who is assumed to dig through the sediments would also be exposed to the volume-weighted concentration.

5.1.8 Assessment Results

Noncarcinogenic COPCs

Mercury was the only noncarcinogen with a maximum value exceeding a PRG. Mercury was detected in 26 of 44 samples. The data are presented in Figure 5.1-2. Three of the detected values exceed the Laboratory upper tolerance limit (UTL) background value of 0.1 mg/kg. A single sample result exceeds the resource-user scenario PRG for mercury of 0.22 mg/kg. This is the lowest PRG for mercury, of the three scenarios. The PRGs for trail user and construction worker are 660 mg/kg and 57 mg/kg, respectively. Based upon these data, mercury was dropped as a COPC for DP Canyon for human-health assessments because the concentrations do not persistently exceed screening values.

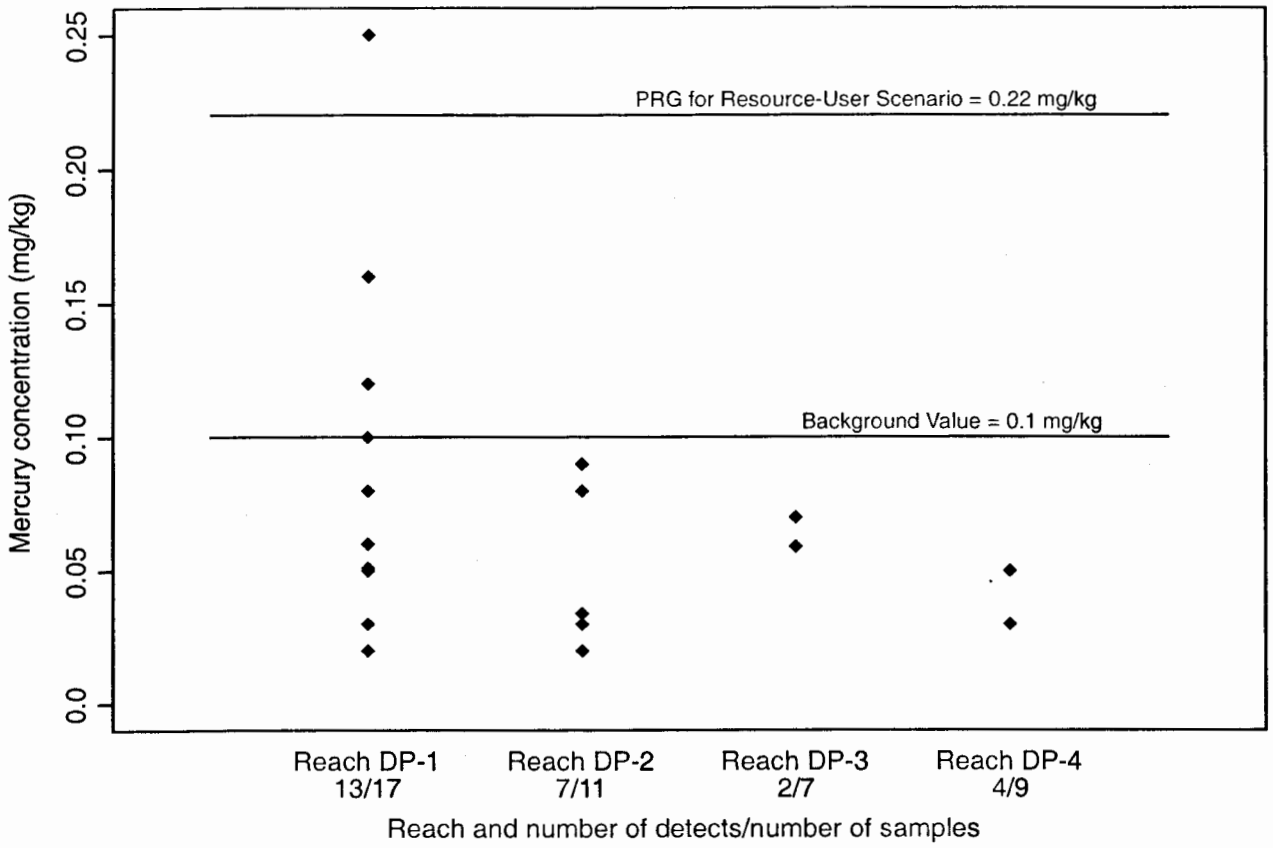


Figure 5.1-2. Mercury in sediment, showing detected values by reach

Chemical Carcinogen and Radionuclide COPCs

The assessment results for chemical carcinogen and radionuclide COPCs are presented in Figures 5.1-3 through 5.1-6. The distinction is made between these two groups of COPCs because the chemical carcinogen assessment is risk-based and the radionuclide assessment is dose-based. Each figure presents a reach and consists of three parts. The first part is a schematic cross section showing the relative locations of sediment packages in relation to the active channel (c1) and the ground surface. The identifier "c" refers to coarse sediments, and the identifier "f" refers to fine sediments.

The second part of the reach presentations is a table that shows the ratio of each COPC's average concentration of detected sample results to its PRG. Because chemical carcinogens and radionuclides are summed separately, a value of 1 in the table indicates a potential risk of 1e-6 for chemical carcinogens, or a dose of 15 mrem/yr for radionuclides. The PRG ratios are summed for the chemical carcinogens and for the radionuclides. The trail-user ratios are based upon the surface area averages for the sampled sediments in the reach. The resource-user and construction-worker scenario ratios are based upon the volume-weighted averages for the sampled sediments in the reaches. The individual PRG ratios in the tables show which COPCs dominate the PRG sums.

Part 1. Schematic cross section for DP-1 West

	c2 f	c3 f	f1
c1 c	c2 c	c3 c	

Schematic cross section for DP-1 Central

	c3 f	f1
c1 c	c3 c	

Schematic cross section for DP-1 East

	c2 f	c3 f	f1
c1 c	c2 c	c3 c	

f = fine sediment.
c = coarse sediment.

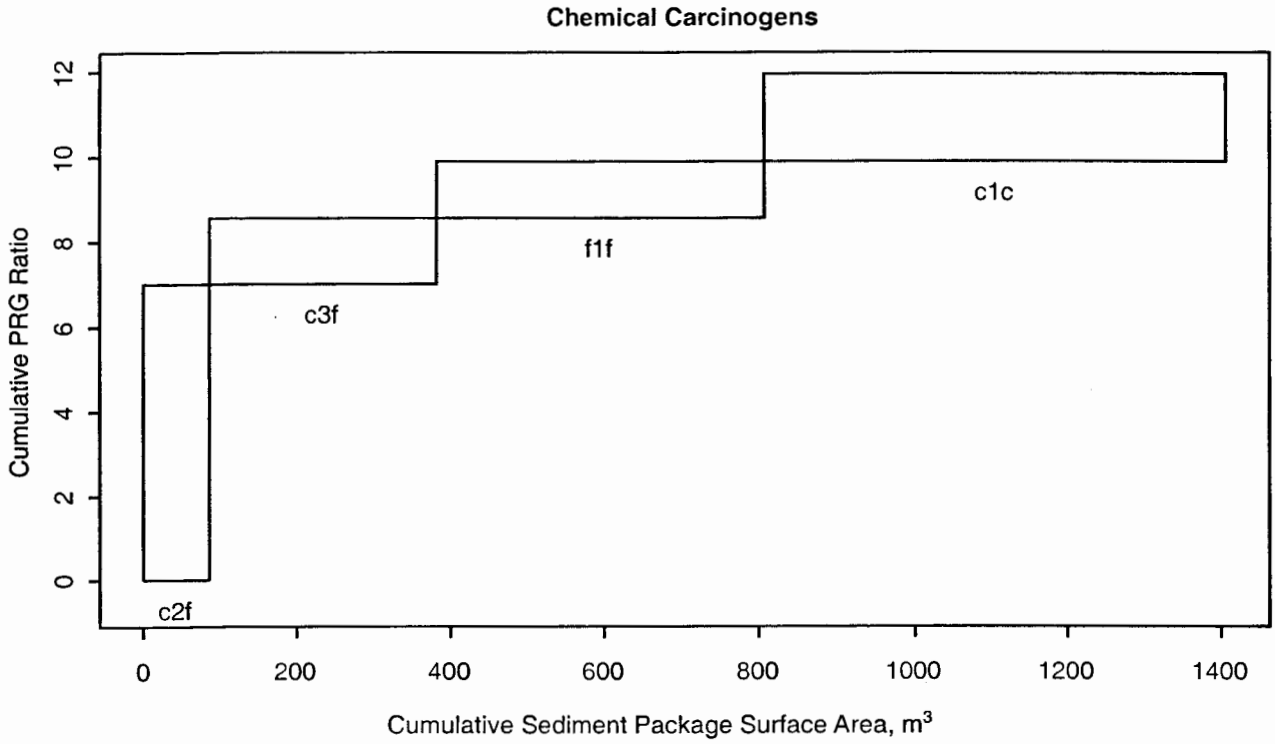
Part 2. Ratios of average COPC concentrations to PRGs by exposure scenario

Analyte	Trail User[a]	Resource User[b]	Construction Worker[b]
Aroclor1260	0.25	0.28	0.050
Benz(a)anthracene	0.38	0.36	0.063
Benzo(a)pyrene	4.6	4.6	0.76
Benzo(b)fluoranthene	0.56	0.53	0.093
Dibenz(a,h)anthracene	5.8	5.8	1.0
Indeno(1,2,3-cd)pyrene	0.43	0.42	0.074
Chemical Carcinogen Sum	**12**	**12**	**2.1**
Am-241	0.00040	0.0010	0.0073
Cs-137	0.00056	0.0039	0.014
Pu-239	0.00013	0.00037	0.0023
Sr-90	0.000017	0.015	0.0003
Radionuclide Sum	**0.0011**	**0.020**	**0.024**

[a] Based upon surface aggregate averages.
[b] Based upon volume aggregate averages.

Figure 5.1-3. Dose Calculation Results for Reach DP-1

Part 3. Reach DP-1 trail-user scenario showing surface sediment package contributions to summed PRG ratios



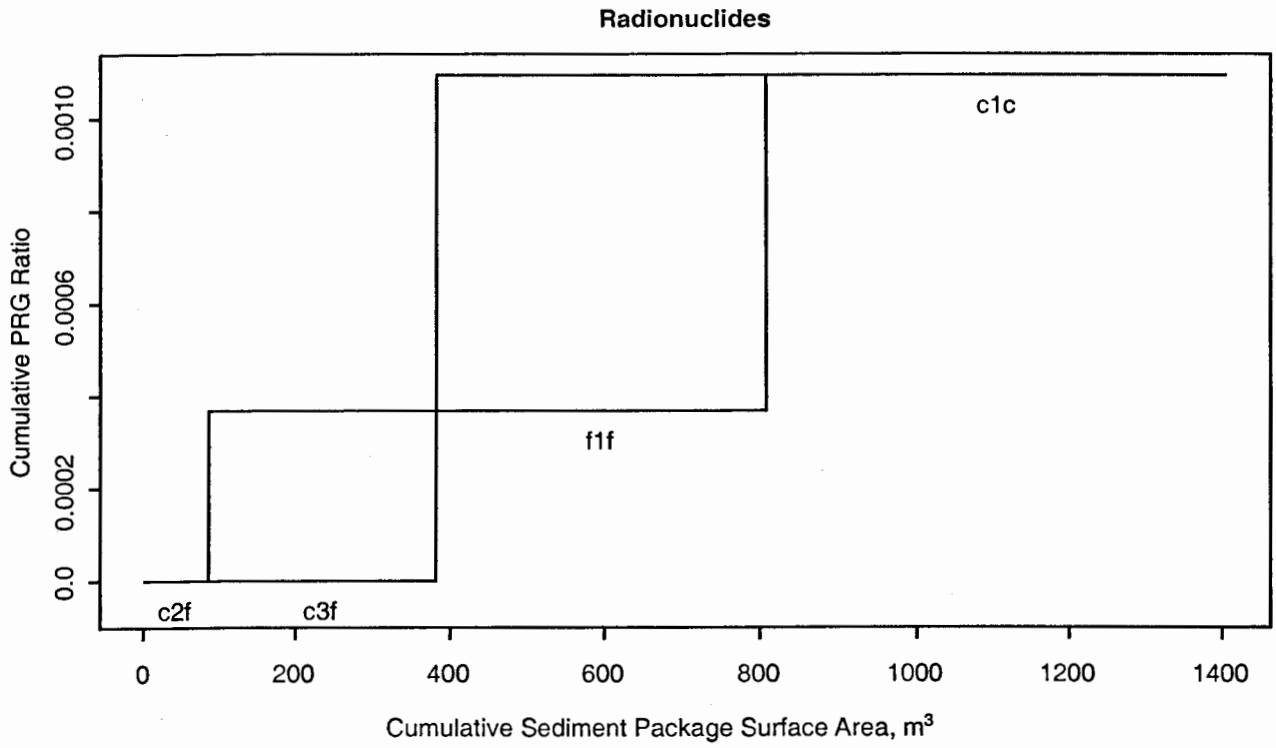


Figure 5.1-3 (continued). Dose Calculation Results for Reach DP-1

Part 1. Schematic cross section

	c2 f	c3 f_{a+b}	f1
c1	c2 c	c3 c_{a+b}	

c = coarse sediment.
f = fine sediment.

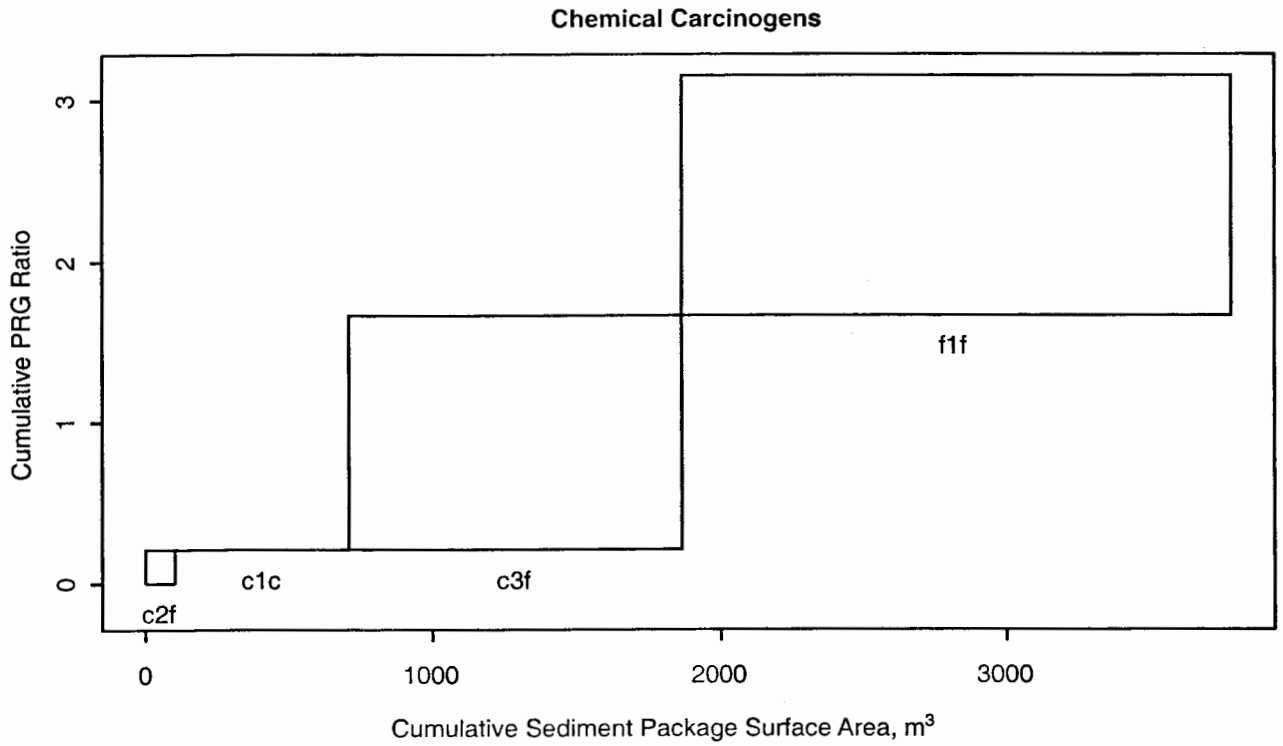
Part 2. Ratios of average COPC concentrations to PRGs by exposure scenario

Analyte	Trail User[a]	Resource User[b]	Construction Worker[b]
Aroclor1260	0.19	0.19	0.034
Benz(a)anthracene	0.17	0.16	0.028
Benzo(a)pyrene	2.4	2.1	0.34
Benzo(b)fluoranthene	0.25	0.23	0.040
Dibenz(a,h)anthracene	0.00000	0.00000	0.00000
Indeno(1,2,3-cd)pyrene	0.16	0.16	0.028
Chemical Carcinogen Sum	**3.1**	**2.8**	**0.47**
Am-241	0.013	0.025	0.18
Cs-137	0.054	0.46	1.70
Pu-239	0.0059	0.021	0.13
Sr-90	0.00048	0.34	0.0066
Radionuclide Sum	**0.073**	**0.84**	**2.0**

[a] Based upon surface aggregate averages.
[b] Based upon volume aggregate averages

Figure 5.1-4. Dose Calculation Results for Reach DP-2

Part 3. Reach 2 trail-user scenario showing surface sediment package contributions to summed PRG ratios



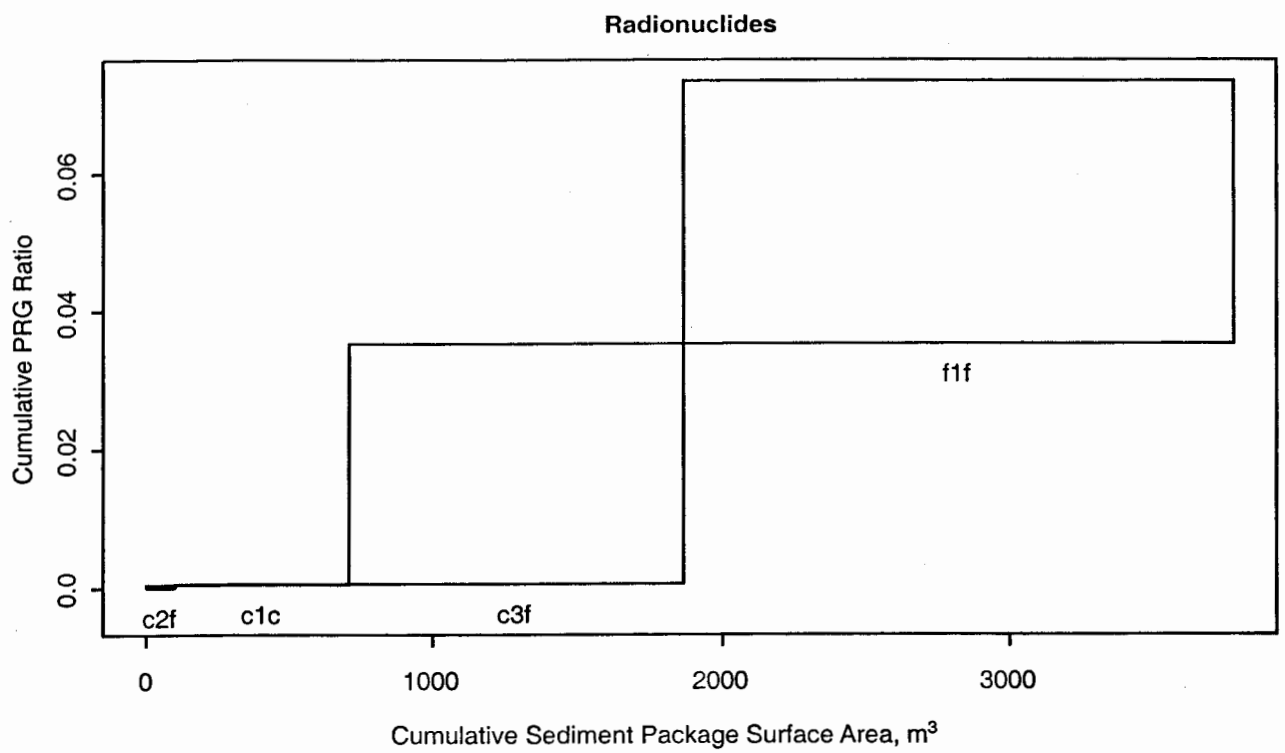


Figure 5.1-4 (continued). Dose Calculation Results for Reach DP-2

Part 1. Schematic cross section

	c2 f	c3 f_{a+b}	f1	f2
c1	c2 c	c3 c_{a+b}		

c = coarse sediment.
f = fine sediment.

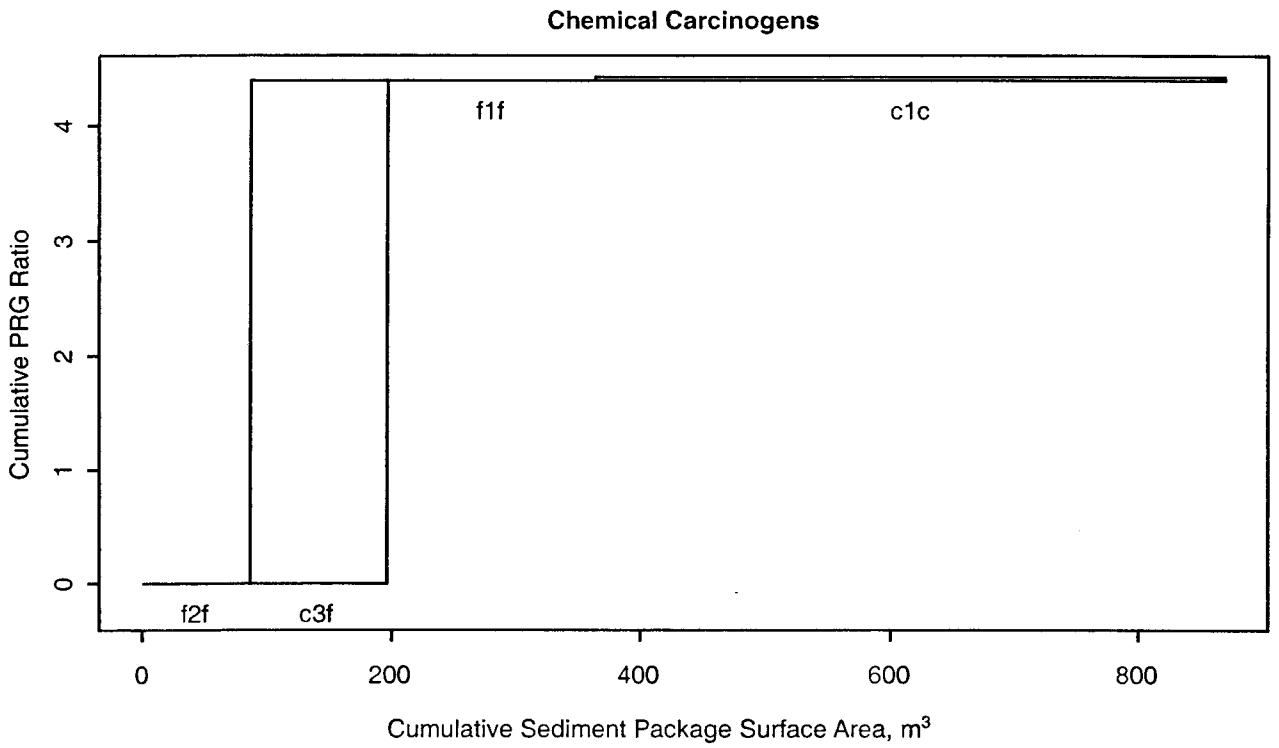
Part 2. Ratios of average COPC concentrations to PRGs by exposure scenario

Analyte	Trail User[a]	Resource User[b]	Construction Worker[b]
Aroclor1260	0.12	0.12	0.021
Benz(a)anthracene	0.065	0.11	0.019
Benzo(a)pyrene	4.00	4.00	0.67
Benzo(b)fluoranthene	0.10	0.17	0.030
Dibenz(a,h)anthracene	0.00000	0.00000	0.00000
Indeno(1,2,3-cd)pyrene	0.14	0.14	0.025
Chemical Carcinogen Sum	**4.4**	**4.5**	**0.76**
Am-241	0.028	0.062	0.43
Cs-137	0.030	0.28	1.1
Pu-239	0.0065	0.0092	0.058
Sr-90	0.00013	0.17	0.0034
Radionuclide Sum	**0.060**	**0.53**	**1.5**

[a] Based upon surface aggregate averages.
[b] Based upon volume aggregate averages.

Figure 5.1-5. Dose Calculation Results for Reach DP-3

Part 3. Reach 3 trail-user scenario showing surface sediment package contributions to summed PRG ratios



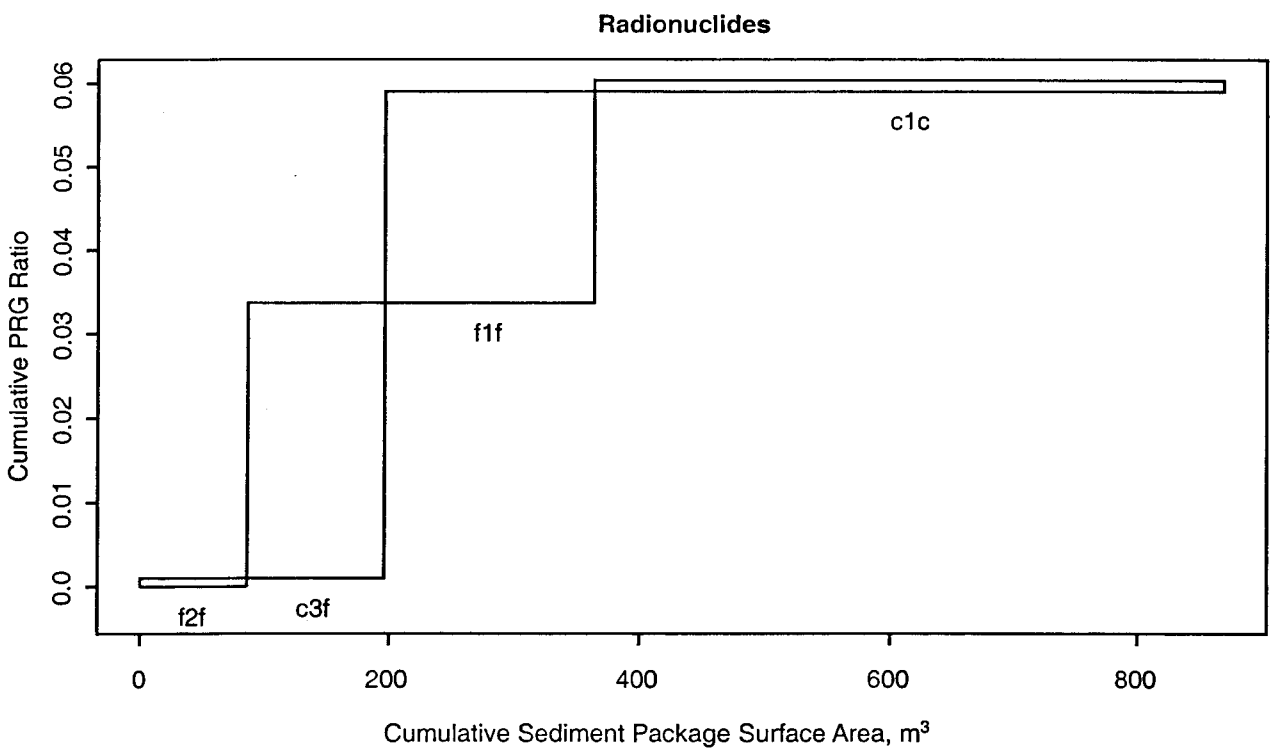
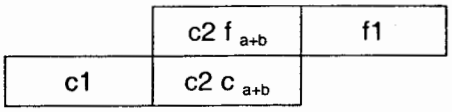


Figure 5.1-5 (continued). Dose Calculation Results for Reach DP-3

Part 1. Schematic cross section



c = coarse sediment.
f = fine sediment.

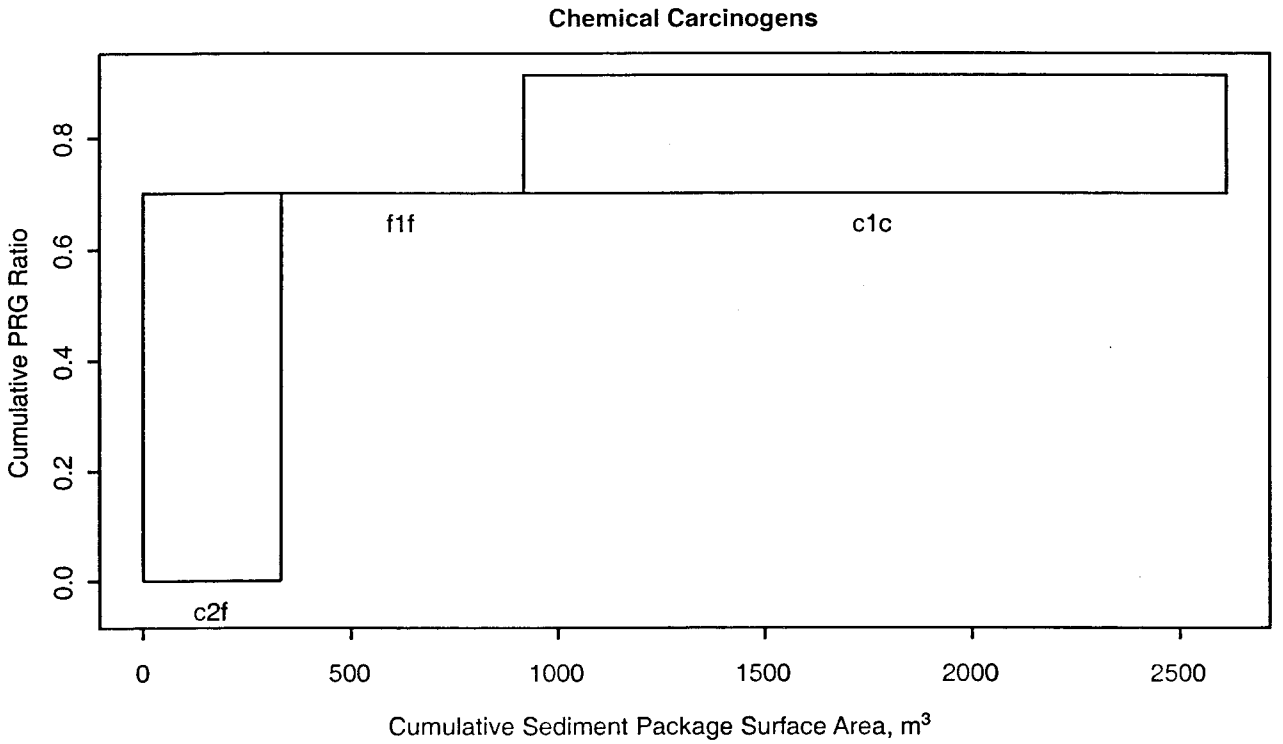
Part 2. Ratios of average COPC concentrations to PRGs by exposure scenario

Analyte	Trail User[a]	Resource User[b]	Construction Worker[b]
Aroclor-1260	0.063	0.063	0.011
Benz(a)anthracene	0.043	0.036	0.0062
Benzo(a)pyrene	0.59	0.48	0.080
Benzo(b)fluoranthene	0.056	0.046	0.0081
Dibenz(a,h)anthracene	0.00	0.00	0.00
Indeno(1,2,3-cd)pyrene	0.16	0.11	0.018
Chemical Carcinogen Sum	**0.91**	**0.73**	**0.12**
Am-241	0.0068	0.0097	0.067
Cs-137	0.027	0.14	0.54
Pu-239	0.0036	0.0072	0.045
Sr-90	0.00023	0.16	0.0031
Radionuclide Sum	**0.037**	**0.32**	**0.66**

[a] Based upon surface aggregate averages.
[b] Based upon volume aggregate averages

Figure 5.1-6. Dose Calculation Results for Reach DP-4

Part 3. Reach 4 trail-user scenario showing surface sediment package contributions to summed PRG ratios



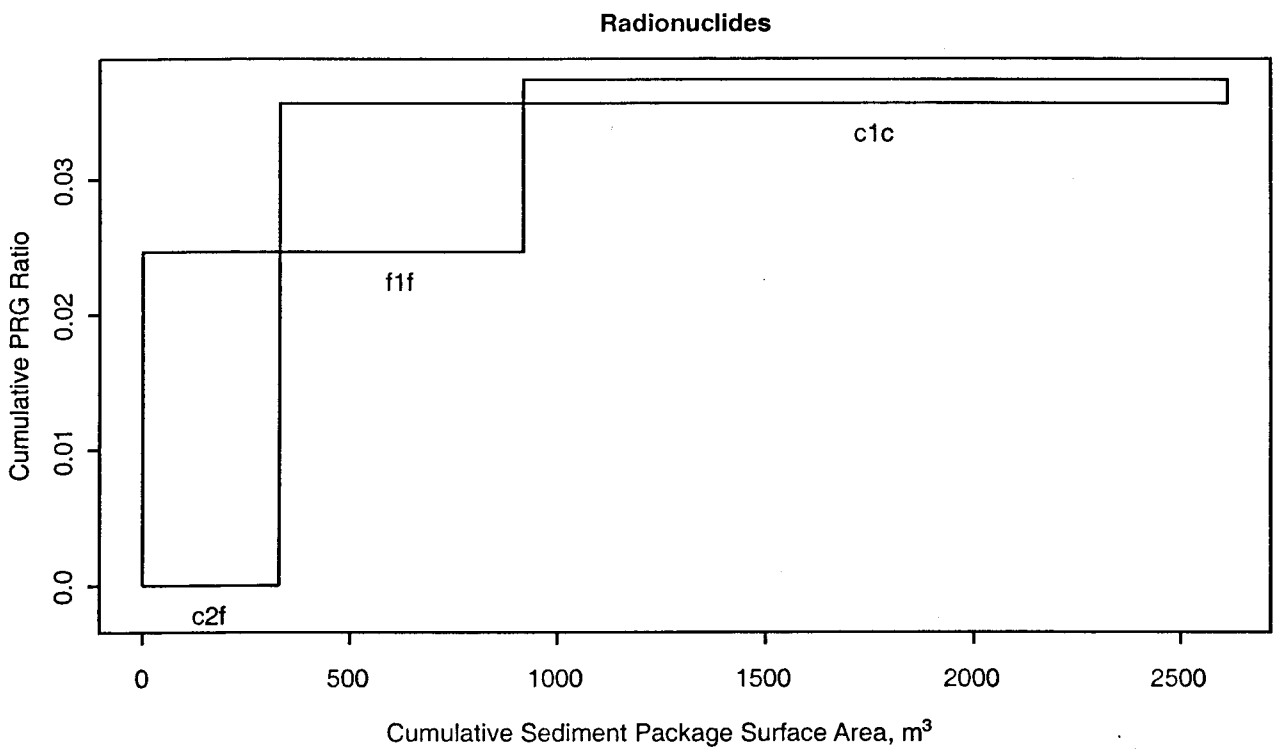


Figure 5.1-6 (continued). Dose Calculation Results for Reach DP-4

The third part of the reach presentations is a graphic that shows the contributions of the sampled sediment packages to the PRG ratio sums. The upper panel of the figure presents information about the chemical carcinogens and the lower panel presents information for the radionuclides. The sediment packages are arranged in order of size, from smallest to largest. For each reach, only the trail-user scenario is presented. This scenario was chosen because it is the most likely present-day scenario. Relations among the sediment packages are similar across the three exposure scenarios. If one sediment package dominates the PRG ratio sum for the trail-user scenario, it also dominates the PRG ratio sums for the resource-user and construction-worker scenarios. The disadvantage to using the trail-user scenario plots is that the subsurface sediment packages are not represented. The companion plots for resource user and construction worker are provided in Appendix F of this report.

Evaluating these results across the four sampling reaches shows that the reach with the highest potential risk to human health is reach DP-1. The sum of the chemical carcinogen PRG ratios for the trail user and resource user in this reach is 12, of which 87 percent is due to dibenz(a,h)anthracene and benzo(a)pyrene. These contaminants are PAHs, are common in urbanized areas, and are interpreted to be derived from the Los Alamos townsite. The PRG ratio sum of 12 is equivalent to a human-health risk estimate of 1e-5 cancer risk. This value falls midway between 1e-6, which EPA uses as a lower bound for potential concern, and 1e-4, above which EPA typically requires risk management or mitigation.

Reach DP-2 is the investigation reach that received effluent from the PRS 21-011(k) outfall. The sum of the PRG ratios for this reach ranges from 0.47 to 3.1 for the chemical carcinogens. The radionuclide sum of PRG ratios are 0.073 for the trail-user scenario, 0.84 for the resource-user scenario and 2.0 for the construction-worker scenario. The construction-worker dose is raised by the potential exposure to the external gamma radiation associated with the cesium-137 contamination. The PAHs dominate the chemical carcinogen sums, similar to reach DP-1, with benzo(a)pyrene contributing 77 and 75 % to the trail-user and resource-user scenarios, respectively. Present conceptual understanding of the DP Canyon system is that the PAH signatures in reaches DP-2, DP-3, and DP-4 are due to transport from reach DP-1 and not from Laboratory releases.

Reach DP-3 is similar to reach DP-2 in that the chemical carcinogen sums of PRG ratios are dominated by benzo(a)pyrene. The values are slightly higher for reach DP-3, but these differences are negligible compared to the variability of the data. The radionuclide sums of PRG ratios are 0.060 for the trail user, 0.53 for the resource user, and 1.5 for the construction worker. Again, the higher value for the construction worker is associated with the potential exposure to external gamma radiation from cesium-137.

Reach DP-4 shows lower PRG ratio sums that are dominated by benzo(a)pyrene for the chemical carcinogens and cesium-137 for the radionuclides. The exception is stronium-90, whose contribution to the resource-user dose is equivalent to the contribution from cesium-137. The magnitudes of these sums indicate a potential human-health risk estimate in the range of 0.1e-6 to 0.9e-6 for the chemical carcinogens and a dose of 0.5 to 10 mrem for the radionuclides.

The third part of each reach presentation shows the relative contributions of the sampled sediment packages to the PRG ratio sums for chemical carcinogens and radionuclides. Trail-user scenario plots are provided in this section and plots for the resource user and construction worker are provided in Appendix F. For all reaches, the largest contributions to the ratio sums come from the fine-grained sediments. These results suggest that the contaminants are preferentially bound to the smaller particles. Reaches DP-1, DP-3, and DP-4 have individual sediment packages that store most of the contaminant inventory. These packages are c2f, c3f, and c2f, respectively. These packages are also small in size. Similar plots, using volume estimates instead of area estimates (Appendix F), show that the volumes of these packages are also relatively small. Reach DP-2 results show the contaminants are associated with

two fine-sediment packages, c3f and f1f. This is at least partially due to the geometry of this reach. Reach DP-2 has a relatively broad canyon bottom where flood waters have deposited overbank sediments over a wide area. Narrower inner canyons confine the other reaches.

Water Pathways

The assessment of alluvial groundwater and DP Spring water shows that most COPCs are at concentrations well below potential chronic human-health concerns. Fourteen samples of alluvial groundwater were analyzed for semivolatile organic compounds (SVOCs). Two of those samples had detectable bis(2-ethylhexly)phthalate. The higher value of 0.36 mg/L represents a potential human-health risk of 1e-6, given an intake of 1.6 L/day, 75 days/yr for 30 yr. Ten samples were analyzed for 1,2-dichloroethane. A single sample had a detectable concentration of 0.0076 mg/L, resulting in a screening consumption rate of 1.2 L/day for the trail-user and resource-user scenarios.

5.1.9 Summary and Uncertainty Analysis

In conclusion, the highest potential risks in DP Canyon occur in reach DP-1, and potential adverse human-health effects are dominated by chemical carcinogens. Reach DP-1 is impacted by drainage from the Los Alamos townsite and is up-canyon from the historic effluent discharges from Laboratory facilities into the canyon. Consistent with urban impacts, PAHs are the dominant contributors to potential risk to this reach. The highest estimated potential human-health risk for the evaluated pathways is a PRG ratio sum of 12, or a risk of 1.2e-5, which is associated with the trail-user and resource-user scenarios. This is an order of magnitude below the typical EPA threshold for mandatory risk management or mitigation. The highest potential radiation dose occurs in reach DP-2 for the construction-worker scenario with a PRG ratio sum of 2.0. This is equivalent to a dose of 30 mrem/yr.

Contaminant signatures for the reaches down-canyon from reach DP-1 are all dominated by PAHs. All PRG sums are in the lower part of the potential risk and dose ranges for considering risk management or mitigation. Based upon these data, immediate remedial action is not warranted.

Several aspects of the investigation and the data assessment approach were designed to overestimate risks and doses. The field investigation focused on sediments that were most likely to have been impacted by post-1942 inundation and contaminant deposition. Consequently, the contaminant averages are overestimates because the uncontaminated sediments in the canyon were not fully characterized and do not contribute to the calculations. Land-use scenarios are also conservative. The actual exposures due to trail use, resource use, or construction are likely to be much less. Examples of exposure overestimates in the scenarios include hiking in the canyon for 75 days/yr for 30 yr and obtaining 75% of dietary meat from animals that are raised on the contaminated sediments in the canyon. The construction-worker scenario is assumed to have a 1-yr duration and to occur only within the contaminated sediments.

The assessment of contaminants in alluvial groundwater and spring water show that there are no chronic human-health risks, based upon these data. While the maximum sample results for 1,2-dichloroethane and bis(2-ethylhexyl) phthalate exceed the screening criteria by up to a factor of 1.7, evaluation of the data show that these contaminants are not persistently present in the alluvial water. Bis(2-ethylhexyl) phthalate was present in 2 of 14 samples and 1.2-dichloroethane was present in 1 of 10 samples. Additionally, the exposure scenarios are designed to overestimate the risks. The data set is limited and should be augmented with additional sampling to confirm these initial results.

5.2 Preliminary Ecological Screening Assessment

5.2.1 Scope and Objectives

The main objective of ecological risk screening is to determine if there is unacceptable current-day risk to ecological receptors from COPCs in DP Canyon sediment or water. Another objective of ecological risk screening is to evaluate the adequacy of existing data to estimate ecological risk associated with Laboratory releases. To accomplish these goals the ecological risk screening process developed for Laboratory PRSs will be applied to the DP Canyon sediment and water data. Application of the screening process must recognize two factors that are not typically relevant for PRSs. First, the spatial scale of the contaminated sediments and water covers an area much larger than a typical PRS. Thus, consideration of the home range of screening ecological receptors is important for properly assessing the exposure to these species. A second and related factor is that this screening assessment is limited to the post-1942 canyon-bottom sediments, alluvial groundwater and DP Spring water. Thus, impacts related to source PRSs are not considered, nor is any impact to ecological receptors beyond the confluence of DP Canyon with Los Alamos Canyon. Lastly, the DP Canyon assessment is a multimedia screening assessment, and considers the combined effects of contaminated water and sediment on ecological receptors. These complicating factors for the assessment will be considered as the Laboratory's screening-level ecological risk assessment process is applied and the results are interpreted. Any deviations in the generic ecological screening assessment required by the nature of the DP Canyon physical setting or project objectives will be clearly noted and discussed.

5.2.2 Technical Approach

There are three parts of the ecological screening assessment as presented in Ryti et al. (1999, 63303) and followed in this report: the scoping evaluation, the screening evaluation, and risk interpretation. The scoping evaluation includes (1) the data assessment step, which identifies the list of COPCs for each medium; and (2) the problem formulation step for the specific reaches under investigation. The basis for DP Canyon-specific problem formulation is found in the scoping checklist (Section F-1.0 in Appendix F of this report). The scoping checklist is a useful tool for organizing existing ecological information and for focusing the site visit on the information needed to develop the site conceptual model (SCM). The scoping checklist also provides the basis for evaluating the adequacy of the data for ecological risk screening.

The screening evaluation includes the comparison of maximum media concentrations to the final ecological screening levels (ESLs). The final ESLs are media-specific concentrations that are intended to represent the lowest concentration of a COPC associated with no adverse ecological effects over an array of ecological receptors. Derivation of final ESLs is a complex process dependent on numerous equations and information sources; see Section 4.5, "Screening Level Ecological Risk Assessment Methods" (Ryti et al. 1999, 63303) for information about how the final ESLs are derived. When there is a single medium, the screening evaluation simply compares the site concentrations of COPCs to the ESLs to establish an initial list of contaminants of potential ecological concern (COPECs). Because DP Canyon has multiple contaminated media, COPCs will be eliminated from further assessment only if the maximum concentration is much less than the ESLs or is not different from background concentrations for that media. The background comparison is needed because sediments were sampled in DP Canyon, but most of these sediments apparently do not support any aquatic receptors as was assumed in establishing the sediment ESL values. Thus, most of the sediment sample data will be compared to soil ESLs as this represents a more appropriate current exposure condition. Aquatic receptors include organisms like filamentous green algae and fish that require water for their survival, and thus occasional inundation from storm events is not sufficient to maintain these types of aquatic organisms. This is why a distinction will be

made between active channel sediments that are frequently wet and floodplain deposits that are rarely wet. The media and exposure pathways will be discussed in more detail in the problem formulation section below (Section 5.2.3.2). The final ESLs are from the June 1999 version of the ECORISK database (LANL 1998-1999, ER ID Package 186).

The second step in the Laboratory's screening evaluation is the calculation of HQs and hazard indices (HIs) for all COPCs and all multimedia screening receptors. The multimedia receptors do not include species that are dependent on a single media for their survival, and such species include truly aquatic receptors (e.g., algae and fish) and terrestrial plants/invertebrates. In addition, for terrestrial plants/invertebrates it is assumed that the toxicity studies include contaminants in soil pore water, which makes an additional assessment of water unnecessary for these species. The HQ can be thought of as the ratio of the calculated exposure dose to the receptor (based on contaminant levels in the reach) to a dose that has been determined to be acceptable (based on toxicity studies for the receptor). An HI is a sum of HQs, across contaminants with like effects, for a given screening receptor. For this report, radionuclides are considered contaminants with a common effect (radiological dose), and all other chemicals will be considered to have potentially additive effects. Chemicals may interact through potentiation, synergism, or antagonism, and thus combined chemical effects may be greater or less than simple additivity. Because it is not known how the effects of chemicals combine, the simplest assumption of additivity was made for the screening assessment. The potential effects of other chemical interactions, in particular synergy, will be considered in the uncertainty analysis because the ESL formulae in Ryti et al. (1999, 63303) use a 0.3 factor to account for multiple chemical effects within a medium. However, this report eliminates the 0.3 factor to permit a standard HI calculation.

An HQ or HI greater than 1 is considered an indicator of potential adverse impacts, and the chemical constituents resulting in an HQ or HI greater than 1 are identified as COPECs. HQ calculations require toxicity, bioconcentration, and bioaccumulation information for all chemicals for all receptors. This report will use the latest receptor-specific ESLs to support the HQ/HI analysis. Because the June 1999 nonradionuclide ESLs are calculated from a HQ = 0.3, the nonradionuclide ESLs are divided by 0.3 to calculate the media-, contaminant-, and receptor-specific HQ. For example, see equations 4.4.1-4 to 4.4.1-8 in "Screening Level Ecological Risk Assessment Methods" (Ryti 1999, 63303). The 0.3 factor was applied to account for additive effects of COPCs within a media.

The equations used to calculate HQ and HI for nonradionuclides are presented as Equations 5.2-1 through 5.2-8. Equation 5.2-7 shows the case where a receptor is potentially exposed to contaminated soil and water; these receptors include robin, kestrel, deer mouse, desert cottontail, shrew, and red fox. Equation 5.2-8 shows the case where a receptor is potentially exposed to contaminated sediment and water; these species include the bat and swallow. Note that the equations used to calculate the HQ and HI for radionuclides are identical except that the 0.3 dividend is dropped, because the final radionuclide ESLs have no such factor.

The third step in the screening evaluation, the uncertainty analysis, follows COPEC identification, and describes the key sources of uncertainty in the screening assessment. The uncertainty analysis can result in adding chemical constituents to or removing them from the list of COPECs. This report contains a qualitative uncertainty analysis to help understand potential data gaps associated with evaluating ecological risk.

The last part of the screening assessment interprets screening results in the context of a risk management decision. This primarily involves an assessment of the imminent substantial endangerment for ecological receptors based on the results of the scoping and screening evaluations. This risk interpretation section will also make recommendations on the need for additional data in DP Canyon to support an ecological risk assessment.

$$HQ_{soil,i,j} = \frac{C_{soil,j}}{\frac{ESL_{soil,i,j}}{0.3}} \quad \text{(Eq. 5.2-1)}$$

$$HQ_{sediment,i,j} = \frac{C_{sediment,j}}{\frac{ESL_{sediment,i,j}}{0.3}} \quad \text{(Eq. 5.2-2)}$$

$$HQ_{water,i,j} = \frac{C_{water,j}}{\frac{ESL_{water,i,j}}{0.3}} \quad \text{(Eq. 5.2-3)}$$

$$HI_{soil,i} = \sum_{j=1}^{n} HQ_{soil,i,j} \quad \text{(Eq. 5.2-4)}$$

$$HI_{sediment,i} = \sum_{j=1}^{n} HQ_{sediment,i,j} \quad \text{(Eq. 5.2-5)}$$

$$HI_{water,i} = \sum_{j=1}^{n} HQ_{water,i,j} \quad \text{(Eq. 5.2-6)}$$

$$HI_i = HI_{soil,i} + HI_{water,i} \quad \text{(Eq. 5.2-7)}$$

$$HI_i = HI_{sediment,i} + HI_{water,i} \quad \text{(Eq. 5.2-8)}$$

Where: $C_{soil,j}$ is the concentration of the jth COPC in soil (mg/kg),

$C_{sediment,j}$ is the concentration of the jth COPC in sediment (mg/kg),

$C_{water,j}$ is the concentration of the jth COPC in water (µg/L),

$ESL_{sediment,i,j}$ is the ESL for ith receptor and the jth COPC in sediment (mg/kg),

$ESL_{soil,i,j}$ is the ESL for ith receptor and the jth COPC in soil (mg/kg),

$ESL_{water,i,j}$ is the ESL for ith receptor and the jth COPC in water (µg/L),

$HQ_{sediment,i,j}$ is the HQ for ith receptor and the jth COPC in sediment (unitless),

$HQ_{soil,i,j}$ is the HQ for ith receptor and the jth COPC in soil (unitless),

$HQ_{water,i,j}$ is the HQ for ith receptor and the jth COPC in water (unitless),

$HI_{sediment,i,j}$ is the HI for ith receptor in sediment (unitless),

$HI_{soil,i,j}$ is the HI for ith receptor in soil (unitless),

$HI_{water,i,j}$ is the HI for ith receptor in water (unitless),

n is the number of COPCs in each media, and

HI_i is the multimedia HI for ith receptor (unitless).

5.2.3 Scoping

5.2.3.1 Data Assessment

The approach taken to characterize the sediments in DP Canyon was designed to provide information on the nature and extent of contamination. By using laboratory analytical data and information on known contaminant sources, the COPC list for DP Canyon sediments was established (Section 3.1). COPCs were selected based on statistical and graphical analysis of the data. The main uncertainties associated with the sediment sample data are the elevated detection limits for some SVOC and inorganic chemical analyses. The main uncertainty for the water sample data is the lack of water samples from the persistent bedrock pools located in reaches DP-1 and DP-3. Storm water samples collected in reach DP-1 are not viewed to adequately represent water that has collected in the bedrock pools, because of the likely chemical changes in pools as suspended sediments settle and water evaporates from these pools. It is also not known if any water in these pools is derived from bedrock recharge and not directly associated with storm events.

5.2.3.2 Problem Formulation

The purpose of the screening-level ecological risk problem formulation for the canyons is to provide information to (1) determine if there are complete exposure pathways to ecological receptors; (2) determine how the sediments and water should be aggregated spatially for screening and establish the functional/operational boundaries of the assessment; and (3) gather information to develop the SCM (e.g., what are the contaminant sources, dominant transport pathways and exposure routes, and potential receptors).

The following information is summarized from the ecological scoping checklist, which is provided in Section F-1.0 in Appendix F. The ecological scoping checklist was prepared from site visits to DP Canyon. Terrestrial ecological receptors are abundant throughout DP Canyon, where the dominant plants include ponderosa pine, piñon pine, juniper, shrub oak, forbs, and grasses. Some areas of DP Canyon also have riparian plants (e.g., willows). Many areas, especially noted in parts of reach DP-2, show evidence of burrowing mammals, which represents both a potentially exposed animal population and a mechanism for contaminant redistribution (Section 4.3.3). DP Spring and the short section of canyon bottom (estimated to be 50 ft in length) directly downstream from the spring has nearly perennial water flow. Surface water flow in reach DP-2 is intermittent, and there are persistent bedrock pools in reaches DP-1 and DP-3. Surface water flow in the remainder of DP Canyon is ephemeral. Most of this ephemeral water is surface water runoff from storm events, which is derived from a large portion of the Los Alamos townsite that is paved or covered with buildings. Truly aquatic organisms like filamentous green algae were noted during the site visit in bedrock pools in reach DP-1 and in DP Spring, but no aquatic invertebrates were noted during the site visits. However, aquatic invertebrates are expected to occur in DP Canyon, but happened to be absent or cryptic at the specific times of the site visits. Thus, there are aquatic receptors and potential exposure to terrestrial receptors from contaminated water. Physical disturbance is minimal throughout DP Canyon, but there is abundant concrete and asphalt debris in reach DP-1. No obvious effects of physical disturbance or contaminants on vegetation were noted in any of the DP Canyon reaches during the site visit. For example, grasses and forbs are abundant in reach DP-2 and form a nearly continuous cover over the inactive channel and floodplain deposits. Evidence of wildlife was noted during site visits, including mountain lion tracks in reach DP-3.

Threatened and endangered (T&E) species are potential receptors for contaminant releases in DP Canyon sediments. Specifically, the Mexican spotted owl and the peregrine falcon may forage in DP

Canyon (Koch 1999, 63599). Los Alamos Canyon is considered to have nesting habitat for both these species; therefore the probability for foraging in DP Canyon is considered high. Thus, the kestrel screening receptor with an all-flesh diet will serve as a surrogate for these avian threatened and endangered (T&E) receptors in the screening calculations.

Sediment data were collected on a reach basis, and within reaches samples were collected from a variety of geomorphic units and sediment facies. The reaches were selected to reflect the range in contaminant concentrations present within DP Canyon sediments and to represent west-to-east geographic variations in the size of contaminated geomorphic units.

Water data were collected from two alluvial wells and from DP Spring. The alluvial groundwater is assumed to be representative of the base flow in reach DP-2, based the revised alluvial groundwater conceptual model discussed in Section 4.4. Storm water sample data are assumed to be not relevant to evaluating exposure from PRS releases, and are thus not included in the screening assessment. Water data are viewed to be adequate for screening, except that no water samples were collected from the persistent bedrock pools located in reaches DP-1 and DP-3. This data gap will be discussed in the uncertainty analysis.

Historical contaminant releases that affected the sediments in DP Canyon could have occurred from a series of potential release sites (PRSs) in the DP Canyon watershed, as summarized in Section 1.3.2; that information will not be repeated here. The most significant contaminant source in the watershed was the radioactive liquid waste outfall at TA-21 [PRS 21-011(k)].

For ecological risk screening, the primary impacted media are (1) surface soil in the canyon floodplain and abandoned channel surfaces (c2 and c3 geomorphic units); (2) sediment in the active channel surfaces (c1 geomorphic units); and (3) surface water derived from seeps, springs, snow melt runoff, or storm water runoff. Another contaminated medium is the shallow alluvial groundwater in parts of DP Canyon, which is known to contain dissolved contaminants (e.g., strontium-90). Materials that have been termed "sediments" in the other parts of this report are divided here into soil and sediment to better account for the different ecological receptors exposed to "sediments" and the different transport pathways for "sediments." Thus, the term "soil" is used in the reminder of this section to refer to inactive channel and floodplain deposits. Flowing water occurs only in a limited part of the active channel deposits in DP Canyon. Even so, all active channel deposits are considered sediments, and therefore potentially harbor truly aquatic receptors (like filamentous green algae). Floodplain and inactive channel deposits have well-developed terrestrial plant and animal populations, and have no evidence of truly aquatic species. Thus, only active channel sediments (floodplain or inactive channel sediments) and water are viewed as complete exposure pathways to truly aquatic species. It is important to recognize that the aquatic species in DP Canyon represent a fairly simple food web as expressions of surface water are limited both spatially and temporally. Terrestrial animals and plants can also be exposed to contaminants in surface water or soil. Terrestrial receptors are assumed to be the primary receptors to COPCs in soil.

The most important transport mechanism for contaminants in channel and floodplain units is erosion of sediment deposits by surface water runoff, particularly during floods. Uncontaminated surface water could become contaminated by entrainment of contaminated sediments or dissolution of soluble contaminants during floods. Another transport mechanism is the suspension of dry particulates by eolian processes, which makes air a secondary contaminated media. Contaminated shallow alluvial groundwater, which can emerge as surface water, is available to ecological receptors that are found in or use surface water in the stream channel.

The ecological SCMs for terrestrial receptors is provided as Figure 5.2-1. The SCM for aquatic receptors is presented as Figure 5.2-2. The SCM identifies the exposure pathways that represent major, minor, unlikely, or no pathway to ecological receptors. Exposure pathways to terrestrial receptors can occur through air (respiration of vapors, inhalation or deposition of particulates); surface soil (root uptake and rain splash on plants, food web transport to plants and animals, incidental ingestion of soil, dermal contact with contaminated soil, and external radiation); and alluvial groundwater, surface water, or active channel sediments (root uptake and rain splash on plants, food web transport to animals, incidental ingestion of water and sediment, dermal contact with contaminated water or sediment, and external radiation from sediment). The major soil-related exposure pathways are expected to be plant uptake, food web transport, and external gamma radiation exposure. The major sediment/water-related exposure pathway is expected to be plant uptake. The importance of the water/sediment pathways is unclear because of the limited temporal and or spatial extent of surface water over the 3.5 km length of DP Canyon. Exposure to vapors is viewed to be an unlikely pathway based on the low volatile organic compound (VOCs) concentrations measured in sediment and water and the rapid loss of volatile organic chemicals expected in active geomorphic settings. Exposure to airborne particulates is likely a minor pathway because of the limited amount of contamination on the ground surface and the dense plant cover in some reaches. Lastly, the remaining pathways that are related to exposure to surface soil (incidental ingestion of contaminated soil and dermal contact) and surface water/sediment (food web transport, incidental ingestion of contaminated sediment/water, dermal contact, and external gamma radiation exposure) are expected to be minor because of the limited amount of contamination expressed at the ground surface.

Typically, all complete exposure pathways should be at least qualitatively evaluated in the screening process. However, soil ESLs do not include exposure to vapors or particulates in air nor do the soil ESLs account for exposure through dermal contact. Water ESLs do not account for bioaccumulation, but the sediment ESLs include two wildlife species that will be used to evaluate the importance of bioaccumulation from sediment to insects. The importance of these pathways will be discussed in the uncertainty analysis.

5.2.4 Screening Evaluation

The screening evaluation consists of the three steps, which includes final ESL comparisons, multimedia exposure assessment, and uncertainty analysis.

5.2.4.1 Comparison to Final ESLs

To determine which of the COPCs should be retained for the multimedia exposure assessment, the maximum concentration in each media was compared to the final media-specific ESL value. All COPCs having a maximum concentration greater than the final media-specific ESL were retained for the multimedia exposure assessment. The final media-specific ESLs are from the June 1999 version of the ECORISK database (LANL 1998-1999, ER ID Package 186).

The ESL comparison is summarized for inorganic chemicals and radionuclides in Table 5.2-1, and the summary for the organic chemicals is provided in Table 5.2-2. The maximum concentration in soil is based on the samples collected from inactive channel and floodplain geomorphic units. The maximum value for sediment is based on the maximum concentration of COPCs in the active channel. Only inorganic chemicals and radionuclides detected above the background value and organic chemicals detected in the active channel sediments are considered sediment COPCs for the screening assessment. Lastly, the maximum water result is based on samples collected from the two alluvial groundwater wells and DP Spring. For the screening assessment, both filtered and unfiltered water samples were considered to establish the maximum value.

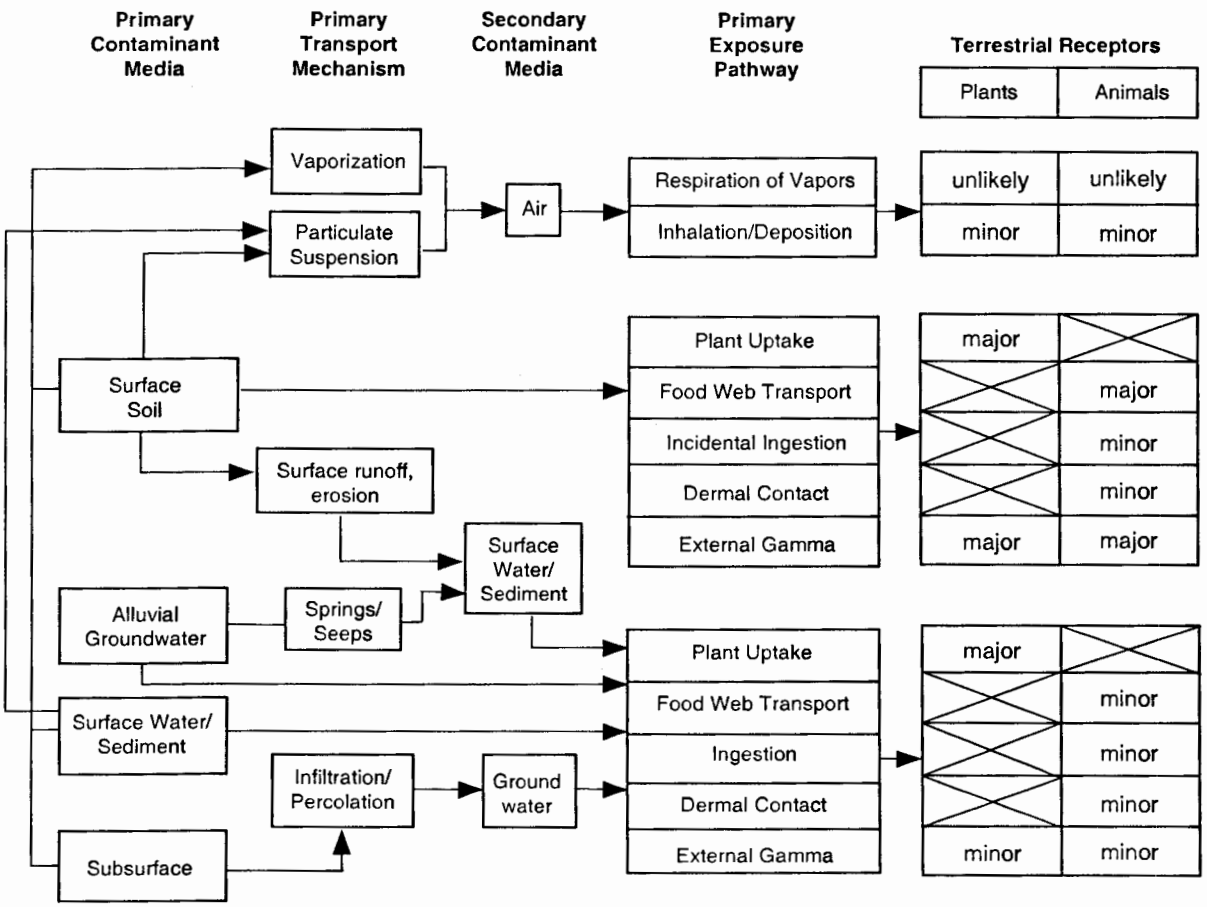


Figure 5.2-1. Site conceptual model for terrestrial ecological receptors

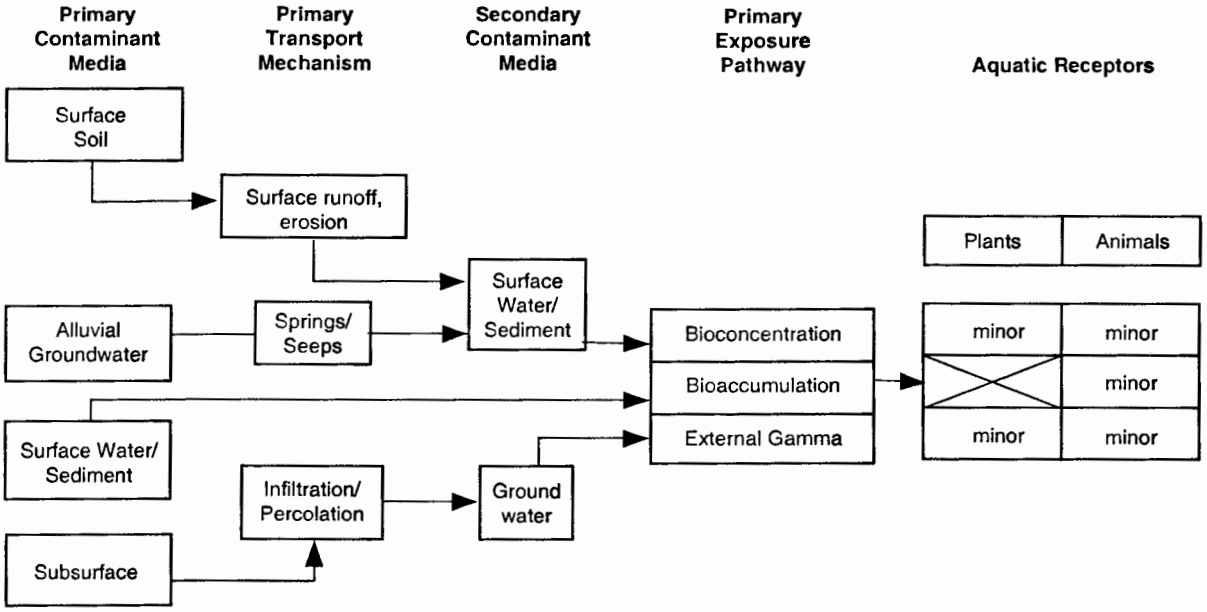


Figure 5.2-2. Site conceptual model for aquatic ecological receptors

Table 5.2-1
Final ESL Comparison Summary for Inorganic Chemicals and Radionuclide COPCs

Analyte	Soil Maximum (mg/kg or pCi/g)	Final Soil ESL (mg/kg or pCi/g)	Sediment Maximum (mg/kg or pCi/g)	Final Sediment ESL (mg/kg or pCi/g)	Water Maximum (µg/L or pCi/L)	Final Water ESL (µg/L or pCi/L)	Retain for Multimedia Assessment
Inorganics							
Antimony	1.4	0.1	0.96	0.23	—[a]	—	Yes
Barium	—	—	—	—	210	3.8	Yes
Boron	—	—	—	—	67	37	Yes
Cadmium	0.67	0.3	<BV[b]	[c]	—	—	Yes
Calcium	8080	N.A.[d]	12000	N.A.[c]	110000	110000	Yes
Chromium, total[e]	20.4	0.1	<BV	[c]	—	—	Yes
Cobalt	4.8	0.1	<BV	[c]	—	—	Yes
Copper	36.1	3.9	11.4	28	—	—	Yes
Iron	—	—	—	—	6700	N.A.	Yes[f]
Lead	207	6	21.7	34	—	—	Yes
Lithium	—	—	—	—	13.5	14	Yes
Magnesium	—	—	—	—	6900	82000	No
Manganese	—	—	—	—	870	59	Yes
Mercury[g]	0.25	0.004	<BV	[c]	—	—	Yes
Potassium	—	—	—	—	17700	53000	No
Selenium	1.3	0.1	<BV	[c]	—	—	Yes
Sodium	—	—	—	—	110000	680000	No
Uranium, estimated[h]	6.1	1.5	<BV	[c]	1.3	1.8	No
Zinc	166	3	<BV	[c]	130	17	Yes
Radionuclides							
Americium-241	71	2.4	[i]	[c]	—	—	Yes
Cesium-137	442	78	1.11	1	—	—	Yes
Plutonium-238	2.79	2.4	<BV	(3)	—	—	Yes
Plutonium-239,240	48.3	2.5	0.084	0.01	0.25	4	Yes
Strontium-90	32.8	40	<BV	[c]	208	46	Yes
Tritium	3	3000	<BV	[c]	280	20000000	No
Uranium-234	1.84	2.8	<BV	[c]	1.73	4.4	Yes
Uranium-235	—	—	—	—	0.057	4.8	No

Note: Cells in black shading indicate analytes where the maximum is greater than the final ESL.

[a] BV = background value.

[b] A dash in the table means the analyte is not a COPC in that medium.

[c] Not a COPC in active channel sediments.

[d] N.A. = ESL is not available.

[e] Assumed that total chromium is present as hexavalent chromium.

[f] Retained for multimedia assessment due to lack of ESLs for all media.

[g] Assumed that mercury is present as methyl mercury.

[h] Uranium was evaluated to account for toxic effects of uranium metal in addition to the radiological effects of uranium isotopes.

[i] Not detected.

Table 5.2-2
Final ESL Comparison Summary for Organic Chemical COPCs

Analyte	Soil Maximum (mg/kg)	Final Soil ESL (mg/kg)	Sediment Maximum (mg/kg)	Final Sediment ESL (mg/kg)	Water Maximum (µg/L)	Final Water ESL (µg/L)	Retain for Multimedia Assessment
PCBs and Pesticides							
Aroclor-1260	1	0.01	[a]	[b]	—[c]	—	Yes
α-Chlordane	0.25	0.6	[a]	[b]	—	—	No
γ-Chlordane	0.18	0.6	[a]	[b]	—	—	No
4,4'-DDE	0.0042	0.0005	[a]	[b]	—	—	Yes
4,4'-DDT	0.12	0.0008	[a]	[b]	—	—	Yes
Heptachlor Epoxide	0.11	N.A.[d]	[a]	[b]	—	—	Yes[e]
Semivolatile Organics							
Acenaphthene	0.24	0.7	[a]	[b]	—	—	No
Anthracene	0.62	67	0.069	0.00038	—	—	Yes
Benz(a)anthracene	3	1	1.2	0.1	—	—	Yes
Benzo(a)pyrene	3.2	0.5	0.74	0.35	—	—	Yes
Benzo(b)fluoranthene	3.8	2.2	1.7	2.9	—	—	Yes
Benzo(g,h,i)perylene	5	3.8	0.27	0.29	—	—	Yes
Benzo(k)fluoranthene	1.4	4	0.083	0.24	—	—	No
Benzoic Acid	0.38	2.4	[a]	[b]	—	—	No
Bis(2-ethylhexyl)phthalate	1.7	0.07	0.8	0.41	36	1.3	Yes
Butylbenzylphthalate	0.5	100	[a]	[b]	—	—	No
Carbazole	0.5	N.A.	0.27	N.A.	—	—	Yes[e]
Chrysene	3.3	1	0.99	0.5	—	—	Yes
Dibenz(a,h)anthracene	0.98	0.7	[a]	[b]	—	—	Yes
Dimethyl phthalate	0.076	39	[a]	[b]	—	—	No
Di-n-butylphthalate	2.1	0.04	[a]	[b]	—	—	Yes
Di-n-octylphthalate	0.16	49	[a]	[b]	—	—	No
Fluoranthene	4.4	7.9	2.2	2.9	—	—	Yes
Fluorene	0.066	8.7	[a]	[b]	—	—	No
Indeno(1,2,3-cd)pyrene	3.8	3.8	0.55	0.078	—	—	Yes
2-Methylnaphthalene	0.046	1.7	(2)	(3)	—	—	No
Naphthalene	0.62	0.06	(2)	(3)	—	—	Yes
Organics, diesel range	680	N.A.	320	N.A.	—	—	No
Phenanthrene	3.2	34	1.1	0.85	—	—	Yes
Pyrene	12	4.7	3.6	0.57	—	—	Yes
2,4,6-Trichlorophenol	9.3	N.A.	[a]	[b]	—	—	Yes[e]

Note: Cells in black shading indicate analytes where the maximum is greater than the final ESL.

Table 5.2-2 (continued)

Analyte	Soil Maximum (mg/kg)	Final Soil ESL (mg/kg)	Sediment Maximum (mg/kg)	Final Sediment ESL (mg/kg)	Water Maximum (µg/L)	Final Water ESL (µg/L)	Retain for Multimedia Assessment
Volatile Organics							
Acetone	0.006	0.5	f	b	—	—	No
2-Butanone	—	—	—	—	—	—	No
1,2-Dichloroethane	—	—	—	—	7.6	1100	No
Toluene	0.002	21	f	b	—	—	No

[a] Not detected.

[b] Not a COPC in active channel sediments.

[c] A dash in the table means the analyte is not a COPC in that medium.

[d] N.A. = ESL is not available

[e] Retained for multimedia assessment due to lack of ESLs for all media.

[f] Not measured in active channel sediments, but volatile organic chemicals are expected to be lost rapidly from this geomorphic setting.

Graphical comparisons of the maximum media concentrations to the final ESL are provided in Figures 5.2-3, 5.2-4, and 5.2-5. These scatter plots show the maximum concentration of the COPC versus the final ESL, and also show a reference line of equality. Points that plot above the line of equality represent COPCs that are retained for the multimedia exposure assessment. The relative magnitude of the difference can be noted by determining the distance that the point is above or below the line of equality. The soil COPC plot (Figure 5.2-3) shows that the maximum values are roughly equally distributed above and below the line of equality, and Tables 5.2-1 and 5.2-2 show that 3 radionuclides, 2 pesticides, 11 SVOCs, and 2 VOCs had maximum values less than the soil ESL. The sediment COPC plot (Figure 5.2-4) shows that most of the maximum values are above the line of equality, and Tables 5.2-1 and 5.2-2 show that two inorganic chemicals and three SVOCs had maximum values less than the sediment ESL. The water COPC plot (Figure 5.2-5) shows that the maximum values are roughly equally distributed above and below the line of equality, and Tables 5.2-1 and 5.2-2 show that four inorganic chemicals, four radionuclides, and one VOC had maximum values less than the water ESL. In addition to the COPCs plotted on Figures 5.2-3, 5.2-4, and 5.2-5, four COPCs (iron, Heptachlor Epoxide, carbazole, and 1,2,4-trichlorophenol) that are missing final ESLs for all media are retained for the multimedia exposure assessment. The category of diesel range organics (DROs) has no ESL and is not retained for the multimedia exposure assessment because the individual constituents (e.g., various SVOCs) do have ESLs and will be evaluated. Two COPCs were retained for the multimedia exposure assessment, even though the maximum values were less than the final ESL. Uranium-234 is retained for the multimedia exposure assessment because the maximum concentration was about 60% of the final soil ESL, which is viewed to be large fraction of the ESL for a COPC detected in multiple media. Fluoranthene was retained because the maximum value in both sediment and soil were greater than 50% of the ESL, thus warranting evaluation in the multimedia exposure assessment. Lastly, uranium (see discussion in Section 3.2) was not retained for the multimedia exposure assessment because the maximum value is less than the total uranium background value.

6.0 CONCLUSIONS AND RECOMMENDATIONS

This section summarizes conclusions from this investigation, highlights key remaining uncertainties related to contamination in DP Canyon, and recommends possible additional assessments, data collection, and remedial action. The human-health and ecological screening assessments are intended to identify any need for immediate remedial action or additional data collection from the standpoint of present-day risk. The human-health risk assessment considers recreational, resource-user, and construction-worker scenarios and considers the potential risk resulting from exposure to contaminated sediments and alluvial groundwater. More comprehensive risk assessments will be presented in a future report for the Los Alamos Canyon watershed that will incorporate the results of ongoing groundwater investigations, surface water investigations, and any additional sediment investigations, and may consider other land-use scenarios.

6.1 Nature and Sources of Contaminants

The primary chemicals of potential concern (COPCs) in the sediments of DP Canyon are organic compounds apparently derived from the Los Alamos townsite, and radionuclides that were discharged from the potential release site (PRS) 21-011(k) outfall at Technical Area (TA) 21 between 1952 and 1986. Radionuclides detected above background values are americium-241; cesium-137; plutonium-238; plutonium-239,240; and strontium-90. Numerous organic and inorganic compounds typically found in highest concentrations in reach DP-1, west of PRS 21-011(k), and not well-correlated with the radionuclides in DP-2, DP-3, and DP-4, indicate a different source for these contaminants, likely storm water runoff from the Los Alamos townsite. There are PRSs located within the DP Canyon watershed in the Los Alamos townsite, but they are mostly subsurface sources at some distance from DP Canyon that are not expected to be major contributors to DP Canyon contamination.

Storm water runoff samples indicate that contaminants associated with suspended solids are directly related to contaminants in the active channel sediments. The storm water contaminant chemistry is not, however, directly related to the contaminant chemistry of the alluvial groundwater. Physical and geochemical processes play a role in altering storm water chemistry prior to and during recharge to the alluvial groundwater. The primary contaminant in found in the alluvial groundwater is strontium-90, which is derived from water/sediment interaction in reach DP-2 where alluvial monitoring wells are located.

6.2 Present Distribution of Contaminants

The horizontal and vertical extent of contaminated sediments is well defined in the investigation reaches. Radioactive contamination in sediment is dispersed by floods throughout the portion of DP Canyon below PRS 21-011(k) and into Los Alamos Canyon below the confluence. High confidence in the extent of contamination results from cesium-137 concentrations sufficiently high to allow the extent of contamination to be determined using radiological field instruments. Correlations between cesium-137 and other key radionuclides also allows their extent to be inferred from the same radiological field instruments.

Concentrations of the key radionuclides in sediment are highly variable within reaches, but mean concentrations between reaches are often comparable. The highest radionuclide concentrations generally occur in fine-grained sediments, but are also found in relatively coarse-grained sediments near the source of contamination, where they probably were deposited concurrently with or soon after the peak contaminant releases from the PRS 21-011(k) outfall (sometime between 1952 and 1961). These sediments likely have been subjected to minimal transport, explaining why relatively high concentrations are still associated with coarse-grained sediment.

Organic contaminants and to a lesser extent inorganic contaminants in sediment are dispersed throughout the entire length of DP Canyon beginning at the head of the canyon in reach DP-1 West. The highest concentrations generally occur within the DP-1 subreaches and decrease down-canyon. The spatial distribution of the organic contaminants suggests that runoff from the Los Alamos townsite is a likely source. No additional significant sources are discernable within the investigation reaches. These contaminants generally exhibit good correlation with fine-grained sediments, but show poor correlation with the radionuclides, suggesting different sources of contamination.

Strontium-90 contamination is present throughout the alluvial groundwater system. The occurrence of alluvial groundwater and strontium-90-contaminated sediments begins in reach DP-2. Alluvial groundwater periodically discharges to the stream channel at the east end of DP-2 and flows down-canyon towards DP Spring, where spring water also contains strontium-90. It is unknown at present whether additional, more complex groundwater pathways exist between reach DP-2 and DP Spring. The fate of the water discharged from the spring is uncertain, although data suggest that strontium-90 from DP Canyon is present in alluvial monitoring well LAO-2 near the confluence with Los Alamos Canyon. Future groundwater sampling and an ongoing tracer study may help resolve some of the uncertainty.

6.3 Preliminary Human-Health Risk Results

The preliminary human-health pathways assessment presented in Section 5.1 evaluated COPCs using trail-user, resource-user, and construction-worker scenarios. The trail-user scenario represents the most feasible and common present-day use. The construction-worker scenario assesses higher rates of exposure and direct exposure to buried sediments, and applies to excavation activities known to occur infrequently within DP Canyon. The resource-user scenario is included as a conservative measure to assess secondary exposure pathways via consumption of fruits, vegetables, and meat affected by the contaminated sediments. Resource use is not known to occur within DP Canyon.

The purpose of this assessment was to identify any contaminant concentrations that represent unacceptable risk to human health. The assessment indicated that the highest potential sediment risks from chemical carcinogens occur in reach DP-1. These risks are estimated to be on the order of 1 in 100,000 (1×10^{-5}). As a point of reference, the US Environmental Protection Agency (EPA) typically requires management or mitigation for risks greater than 1 in 10,000 (1×10^{-4}) and typically considers risk of 1 in 1 million (1×10^{-6}) to be below concern. The risk estimates for sediments in reaches DP-2, DP-3, and DP-4 ranged from 1 in 10 million to 5 in 1 million. The estimated doses from radionuclides are highest in Reach DP-2 at 30 mrem/yr and DP-3 at 20 mrem/yr, both for the construction-worker scenario. Elsewhere, the estimated doses ranges from 0.02 to 10 mrem/yr. Based upon these risk and dose estimates, expedited response to manage or mitigate potential human-health risk from sediments is not warranted. The environment, safety and health (ESH) excavation review process will be relied upon to provide up-to-date information to construction managers and safety officers planning excavation activities within potentially contaminated areas in DP Canyon. The need for posting as an additional protective measure will be evaluated through discussions with ESH safety personnel and the US Department of Energy (DOE).

The contaminant signatures for the reaches down-canyon from reach DP-1 are all dominated by polycyclic aromatic hydrocarbons (PAHs). The likely source of these contaminants is from DP-1, where the highest concentrations of these contaminants were measured. PAHs typically are associated with urban and industrial areas. A likely source for reach DP-1 is runoff from the Los Alamos townsite.

The assessment of contaminants in alluvial groundwater and spring water show that there are no chronic human-health risks, based upon these data. While the maximum results for bis(2-ethylhexyl)phthalate and 1,2-dichloroethane exceed the screening criteria by up to a factor of 1.6, these contaminants were detected in 2 of 14 samples and 1 of 10 samples, respectively. These rates of detection indicate that the

contaminants are present episodically, if actually present at all, and not laboratory contaminants, and are very unlikely to pose a chronic exposure. The data set is limited and should be augmented with additional sampling to confirm these initial results. Additionally, the surface water pools in reach DP-1 have not been sampled, and should be further evaluated for their contribution to risk.

6.4 Preliminary Ecological Risk Results

Several chemicals of potential ecological concern (COPECs) have been identified in DP Canyon sediments and water, and further assessments of ecological risk will be performed in a future Los Alamos Canyon watershed report. The site visits to DP Canyon documented abundant plants and animals, which implies that there are no obvious contaminant-related ecological impacts in DP Canyon. Thus, there is no need for immediate remedial action to mitigate obvious ecological impacts.

As discussed in the revised conceptual model, most of the DP Canyon COPECs are associated with sources in the Los Alamos townsite and not with Laboratory operations. Many of these COPECs are estimated to represent a potential hazard to individual ecological receptors. Effects to ecological populations or to individuals of broadly ranging species from DP Canyon COPECs have not been assessed.

The ecological risk screening assessment did not identify any radionuclide COPECs. Because radionuclides have known Laboratory sources, the elimination of radionuclides as COPECs also suggests that immediate remedial action is not needed to correct obvious Laboratory ecological impacts in DP Canyon.

Ecological risk uncertainties should be addressed through further evaluation of the toxicity information used as the basis for the ecological screening level (ESL) and hazard quotient/hazard index (HQ/HI) analysis. Clearly, better information is needed on the inorganic chemicals, where many of the toxicity reference values (TRVs) are based on soluble metal salts rather than on forms expected to persist in the environment.

One obvious data gap for the DP Canyon investigation is the lack of water samples from seasonally persistent surface-water pools in reaches DP-1 and DP-3. This information will provide better information for the screening ecological risk assessment, and also support the assessment of contaminant sources for DP Canyon COPCs.

6.5 Future Remobilization and Transport of Contaminated Sediments

Floods constitute the primary transport mechanism for contaminants in DP Canyon and, under natural conditions, floods will continue to redistribute these contaminants. Future effects of floods can be estimated based on the geomorphic record of the effects of floods that have occurred during the past 45 yr. Each flood redistributes part of the contaminant inventory within the watershed and also mixes contaminated sediment with uncontaminated sediment derived from upper portions of the watershed. For example, mixing sediment from different sources has reduced the concentration of the cesium-137 over time. Concentrations of cesium-137 in sediment transported during floods were highest during the early period of releases of radioactive effluent from PRS 21-011(k), between 1952 and 1961, and have dropped rapidly following reductions in the discharge of cesium-137 after 1961. Cesium-137 concentrations in sediment have been stable or have declined since that time; therefore, concentrations can be expected to remain stable or to decline during the next several decades.

Most of the radionuclide COPCs contained within sediments in DP Canyon are located in geomorphic units that are adjacent to the active channel and that are considered very susceptible to remobilization by lateral bank erosion during the next 30 to 50 yr. Because of this high susceptibility for remobilization, it should be considered that much of the radionuclide inventory in DP Canyon could be transported into Los Alamos

Canyon during the next 50 yr. For cesium-137 and strontium-90, which have relatively short half-lives of approximately 30 yr, radioactive decay will yield significantly less inventory transported into Los Alamos Canyon over this time frame. It is also worth noting that, because of radioactive decay, the concentration and inventory of these radionuclides has already been reduced by approximately 50% from original levels.

Currently it is not possible to quantitatively predict (1) the rate that contaminants will be transported out of DP Canyon and into Los Alamos Canyon, (2) contaminant concentrations within sediments carried by future floods (except in the short term), or (3) the effects of possible remedial actions on contaminant loads in floods. Quantitative predictions would require a defensible model that could incorporate the remobilization of contaminated sediment from a variety of geomorphic units, which have variable sediment residence times; the mixing of sediment from both contaminated and uncontaminated sources; and the redistribution of this sediment by floods with varying recurrence intervals. Such a model should allow an evaluation of the effects of various remedial actions over a variety of time scales and be tailored for the parameter of interest (i.e., concentration or mass). Because of the probabilistic nature of floods, a probabilistic sediment transport model would be most appropriate. Therefore, if it is foreseen that remedial actions may be warranted in the future to reduce either the concentrations or mass of radionuclides leaving DP Canyon, development of a probabilistic sediment transport model tailored to the conditions in DP and Los Alamos Canyons should be pursued.

6.6 Summary of Recommendations

The assessments of potential human-health and ecological risk presented in this report indicate that contamination levels in the sediments and alluvial groundwater in DP Canyon do not pose an unacceptable risk or require remedial action to mitigate present-day risk. Additional risk assessments that incorporate direct characterization data from bedrock pools and, where appropriate, incorporate concentrations and inventory of contaminants at hillslope PRSs, still will need to be conducted.

The long-term impact to Los Alamos Canyon from contaminated sediments currently stored in DP Canyon is uncertain. Under current conditions in the watershed, floods will continue to transport contaminated sediments into Los Alamos Canyon. Decision criteria concerning the long-term transport of contaminants within Los Alamos Canyon and toward the Rio Grande are not yet defined. Thus, it is uncertain if remedial action may be required to reduce either the concentrations of contaminants in sediments or the total mass (inventory) of contaminants transported downstream over various time frames. It is also uncertain whether remediating contaminated alluvial groundwater will be necessary, given that the contaminants posed no unacceptable risk under the evaluated land-use scenarios.

Any future remedial actions focused on removing radiological contamination could utilize field instrumentation to guide remediation. Data from geomorphic assessments should also be utilized to focus contaminant removal on geomorphic units and sediment facies with high concentrations and high inventory per unit volume, as well as those most susceptible to remobilization during floods. In addition, if better quantitative predictions concerning off-site transport are necessary, development of a defensible sediment transport model should be pursued that could also evaluate the effects of a variety of possible remedial actions.

Additional alluvial groundwater monitoring will be conducted in DP Canyon in conjunction with groundwater monitoring in Los Alamos Canyon. Surface water characterization, including surface-water pools in DP Canyon, will also be conducted as part of the ongoing characterization activities in the Los Alamos Canyon watershed. A tracer study is also planned to help develop a better understanding of the travel and residence times for groundwater within the DP Canyon geohydrologic system. This monitoring program will enhance understanding of the fate and transport of contaminated alluvial groundwater and support any possible future remedial action required for groundwater.

7.0 REFERENCES

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ER ID numbers are assigned by the Laboratory's ER Project to track all material associated with Los Alamos National Laboratory potential release sites. These numbers can be used to locate copies of the documents at the ER Project's Records Processing Facility and, where applicable, within the ER Project reference library. The references cited in this report can be found in the volumes of the reference library titled "Reference Set for Canyons."

Copies of the reference library are maintained at the New Mexico Environment Department Hazardous and Radioactive Materials Bureau, the Los Alamos Area Office of the US Department of Energy, and the ER Project Office. This library is a living document that was developed to ensure that the administrative authority has all the necessary material to review the decisions and actions proposed in this report. However, documents previously submitted to the administrative authority are not included in the reference library.

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Appendix A

Acronyms and Unit Conversions

ALARA	as low as reasonably achievable
BKG	background data
BV	background value
COPC	chemical of potential concern
COPEC	chemical of potential ecological concern
CRDL	contract required detection limit
CRQL	contract required quantitation limit
CVAA	cold vapor atomic absorption
DOE	US Department of Energy
DP Spr	DP Spring
DRO	diesel range organic
EDL	estimated detection limit
EFH	exposure factors handbook
EPA	US Environmental Protection Agency
EQL	estimated quantitation limit
ER	environmental restoration
ESL	ecological screening level
FB	field blank
FD	field duplicate
FIMAD	Facility for Information Management, Analysis, and Display
GC	gas chromatograph
HI	hazard index
HQ	hazard quotient
HSWA	Hazardous and Solid Waste Amendments (Act)
ICPES	inductively coupled plasma emission spectroscopy
IDL	instrument detection limit
LANL	Los Alamos National Laboratory
LCS	laboratory control sample
LOAEL	lowest observed adverse effect level
MDA	material disposal area
MDA	minimum detectable activity
MDL	method detection limit
MS	mass spectrometry
NFG	national functional guideline
NOAEL	no observed adverse effect level
OM	organic matter

PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PRS	potential release site
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
RAGS	risk assessment guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RFI	RCRA facility investigation
RN	request number
SAL	screening action level
SCM	site conceptual model
SOP	standard operating procedure
SOW	statement of work
SVOC	semivolatile organic compound
SW	surface water
T&E	threatened and endangered
TA	technical area
TAL	target analyte list
THV	threshold value
TPH	total petroleum hydrocarbons
TPU	total propagated uncertainty
TRV	toxicity reference value
USGS	US Geological Survey
USRADS	ultrasonic ranging and data system
UTL	upper tolerance limit
VOC	volatile organic compound
WRS	Wilcoxon Rank Sum
WQCC	Water Quality Control Commission
WWTP	wastewater treatment plant

Metric to English Conversions

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

Appendix B

Characterization of Geomorphic Units

This appendix presents supplemental information on the characteristics of the geomorphic units in DP Canyon reaches. Figures and tables for this appendix are placed at the end of the appendix; the figures appear first, followed by the tables.

B-1.0 THICKNESS OF POST-1942 SEDIMENT DEPOSITS

The thickness of post-1942 sediment was measured in each DP Canyon reach to calculate the volume of sediment in the geomorphic units and to develop a radionuclide inventory. Thickness measurements focused on the relatively fine-grained facies because higher concentrations of radionuclides were expected in these sediments than in the coarser-grained facies. In addition, the thickness of post-1942 fine-grained deposits can be determined with greater confidence than the thickness of associated coarse-grained deposits because of the general absence of clear stratigraphic markers in the coarse-grained deposits and the difficulty in confidently determining the contact with underlying pre-1943 sediment. Table B-1.0-1 presents the estimated average thicknesses of fine- and coarse-grained sediments.

B-2.0 PARTICLE SIZE AND ORGANIC MATTER DATA

Each layer that was sampled for potential contaminants was also sampled for particle size distribution to evaluate possible relations between contaminant levels and size characteristics. All samples were analyzed by the Soil Characterization and Quaternary Pedology Laboratory of the Desert Research Institute, following procedures recommended by the US Geological Survey (USGS) for geological applications (Janitzky 1986, 57674).

Data on organic matter content were also obtained on the samples collected for analysis of potential contamination to evaluate potential relations between contaminant concentrations and organic matter. Analyses followed a loss-on-ignition method, in which, after drying the samples at low temperature to remove water, the percentage of sample lost by combustion after heating at 400°C for four hours was calculated.

Tables B-2.0-1 through B-2.0-4 show data on particle size distribution and organic matter content for DP Canyon sediment samples. Tables B-2.0-5 through B-2.0-8 show particle size and organic matter data for each geomorphic unit. Percentages of sand, silt, and clay size fractions are calculated from the <2-mm-size fraction. For the <2-mm-size fraction, the median particle size class and the median particle size are shown, to facilitate comparison of the particle size characteristics of the different samples and geomorphic units. Because particle size distributions traditionally are shown on semi-logarithmic plots, the median particle size is calculated by extrapolating between boundaries of size classes using a logarithmic transformation. Percentages of gravel in the coarse-grained samples may be lower than in the actual sampled layer for some samples because only gravel that would fit into the sample bottles (<5 cm) was collected. Average gravel percentages for the coarse-grained facies thus may be underestimated, although gravel percentages for fine-grained facies generally are accurate.

The relations of key radionuclide concentrations to various particle size parameters and organic matter content for each reach were examined using a series of scatter plots. Particle size parameters include the median particle size and the percent finer than each break between size classes (e.g., percent clay [<2-micron-size fraction] and percent clay plus fine silt [<15 micron-size fraction]). Unique symbols in each scatter plot distinguish the different geomorphic units and sediment facies. Figures B-2.0-1 through B-2.0-18 are plots that compare contaminant concentration to median particle size, percent clay, percent silt plus clay (<0.0625 mm or <62.5 microns), and organic matter content for various radiological and

nonradiological contaminants. These plots illustrate which geomorphic units within each reach share similar relations of particle size to contaminant concentration.

B-3.0 RADIOLOGICAL FIELD MEASUREMENTS

B-3.1 Instrument Calibration and Use

B-3.1.1 Gross Gamma Radiation Walkover Surveys

CHEMRAD of Oak Ridge, Tennessee, conducted a gross gamma radiation walkover survey in reach DP-2 using Ludlum Model 44-2 detectors (1-in. by 1-in. sodium iodide [NaI] probes) with Ludlum Model 3 scaler/rate meters (single channel analyzers). The surveys were conducted by walking slowly with the probe held approximately 1 ft from the ground surface. Gross gamma radiation measurements (counts per minute [cpm]) were collected every second and were located with the ultrasonic ranging and data system (USRADS). The survey was guided by the lead geomorphologist with the objective of providing information on the gross gamma activity of the various geomorphic units and delineating lateral extent of unit boundaries. USRADS relies on a local triangulation network of receivers that records ultrasonic signals emitted from the location of the NaI probe.

Before and after each day's use, each instrument's response was checked by measuring a known cesium-137 source for 1 min and comparing the result with the acceptable range (average ±20%). At the same time, five 1-min instrument calibration measurements were collected at a local field site; the average of these readings was compared with an acceptable range (average ±3 sigma). The calibration measurements were taken each day at the same place in an area that was not likely to have been radioactively contaminated by Laboratory activities. During these measurements, source-to-detector geometry was kept as consistent as possible. Scaler/rate meter battery voltage, operating high voltage, threshold setting, and window configuration (as appropriate for the scaler/rate meter) were also checked twice daily.

B-3.1.2 Gross Gamma Radiation Fixed-Point Surveys

Gross gamma radiation was measured at fixed locations in reaches DP-2, -3, and -4 using a Ludlum Model 44-10 detector encased in a lead- and copper-lined, polyethylene shield with a Ludlum Model 2221 scaler/rate meter. Fixed-point radiation measurements were not conducted in DP-1 subreaches because little or no radioactive contamination was suspected in those areas.

Measurement locations were chosen to include all geomorphic units identified in reaches DP-2, -3, and -4, except the c1 unit in DP-2 and DP-3. The data provided very useful input to the sample-site selection process because they provided a quantitative way to determine which stratigraphic horizons contained the highest gross gamma values (assumed to be predominantly from cesium-137). Gamma radiation measurements were made in vertical exposures (either stream banks or hand-dug) starting at the surface and progressing downward at 10-cm intervals. The measurement time was 1 min because this length of time provided a sufficient number of counts for statistical purposes (>5000 counts).

It should be stressed that field radiation measurements vary with soil moisture content because the attenuation of particles emitted by radioactive decay varies with soil density. Wet soils are more dense than dry soils; therefore, wet soil yields a lower count than dry soil with the same radionuclide concentration. Thus, field measurements made at different locations with different moisture content may not be directly comparable, although the relative radiation levels in different locations still can be determined.

Before and after each day's use, each instrument's response was checked by measuring a known cesium-137 source for 1 min (for beta and gamma radiation response) and comparing the results with the acceptable range (average ±20%). At the same time, each instrument was used to take five 1-min instrument-calibration measurements at a local field site, as discussed for the gross gamma walkover survey. Scaler/rate meter battery voltage, operating high voltage, threshold setting, and window configuration were also checked twice daily.

B-3.2 Results

B-3.2.1 Reach DP-2

B-3.2.1.1 Gross Gamma Radiation Walkover Survey

Gross gamma radiation data were obtained in May 1999 from 9052 points in reach DP-2 using 1-sec count times and the USRADS location system. The measurement locations are shown on Figure 2.2-1. The raw data are archived in the Facility for Information Management, Analysis, and Display (FIMAD). Much of the survey area contained gross gamma values above background, which was approximately 3503 cpm. The highest value of 35,280 cpm was not from sediment characterized as part of this investigation but from an area near PRS 21-011(k).

B-3.2.1.2 Fixed-Point Gross Gamma Survey

Fixed-point radiation data were obtained from 16 sites in reach DP-2 (Figures B-3.2-1 and B-3.2-2; Table B-3.2-1). Background values for gross gamma radiation in the reach DP-2 sediments are represented by the measurements made at locations DP2-2 (6215 to 6959 cpm) and DP2-14 (7107 to 8081 cpm). DP2-2 and DP2-14 are locations in pre-1943 alluvium and should contain no Laboratory-derived contamination. Gross gamma radiation in reach DP-2 ranged from 5823 to 108,326 cpm. These fixed-point measurements, in combination with analytical results for cesium-137, provided a basis for distinguishing between relatively low-contamination c3a units from relatively high-contamination c3b units within reach DP-2.

The highest gamma radiation measurement in DP Canyon was 108,326 cpm within coarse-grained sediments in a c3b unit in reach DP-2 (fixed-point measurement site DP2-1). The cesium-137 concentration at that location (21-05501) is 134 pCi/g. The highest cesium-137 concentration from all DP Canyon sediment samples is 442 pCi/g (sample location 21-10954) from fine-grained sediments at fixed-point measurement location DP2-18. The gross gamma radiation measurement associated with that sample was 33,396 cpm. It is notable that the highest gross gamma measurement does not correspond with the highest cesium-137 concentration. This could be due to the varying instrument response associated with the volume of contaminated sediments in addition to the contaminant concentration, indicating that the volume of sediments contaminated with cesium-137 is greater at location DP2-1 than at DP2-18. The field measurements, still considered an accurate indication of the sections with higher cesium-137 levels, validated the use of the field instruments in defining geomorphic mapping units (i.e., distinguishing c3a from c3b based on higher levels of gamma radiation in c3b).

B-3.2.2 Reach DP-3

Fixed-Point Gross Gamma Radiation Surveys

Fixed-point radiation data were obtained from 31 sites in reach DP-3 (Figures B-3.2-3 and B-3.2-4; Table B-3.2-2). Background values for gross gamma radiation in reach DP-3 sediments are best represented by

measurements made at locations DP3-27 (6302 to 6933 cpm) and DP3-29 (6105 to 6709 cpm). As in reach DP-2, these fixed-point measurements, combined with analytical results for cesium-137, provided a basis for distinguishing between relatively low-contamination c3a units from relatively high-contamination c3b units within reach DP-3.

B-3.2.3 Reach DP-4

Fixed-Point Gross Gamma Radiation Surveys

Fixed-point radiation data were obtained from 17 sites in reach DP-4 (Figures B-3.2-5 and B-3.2-6; Table B-3.2-3). Background values for gross gamma radiation in reach DP-4 sediments are represented by measurements made at location DP4-1 (6980 to 7864 cpm). As in reaches DP-2 and DP-3, these fixed-point measurements, combined with analytical results for cesium-137, provided a basis for distinguishing between relatively low-contamination c2a units from relatively high-contamination c2b units.

B-4.0 SEDIMENT AND ALLUVIAL GROUNDWATER SAMPLING EVENTS

Sediment sampling in this investigation generally was conducted in two phases, which focused on sequentially reducing uncertainties about the nature and extent of contamination in each reach and on testing components of the conceptual model. Table B-4.0-1 shows the chronology of sediment sampling events in upper DP Canyon and the primary goals of each sampling event. Alluvial groundwater sampling at LAUZ-1 and LAUZ-2 and at DP Spring was conducted quarterly for one year. Full-suite analyses were conducted in all four quarters. Samples were collected in August and November 1998, and February and May 1999. One additional sampling event was conducted to confirm the detection of a volatile organic compound, which occurred during the August 1998 sampling event. Storm water samples were collected on August 22, 1997, and October 26, 1998.

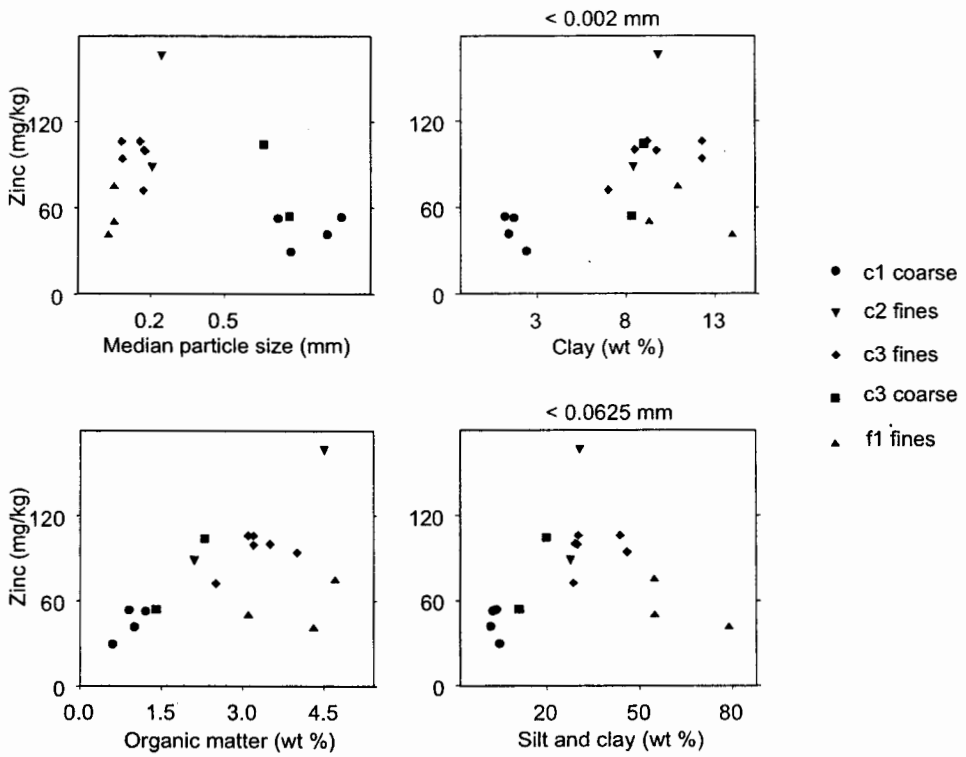


Figure B-2.0-1. Scatter plots showing relations of zinc concentration to median particle size, clay content, silt and clay content, and organic matter content in reach DP-1.

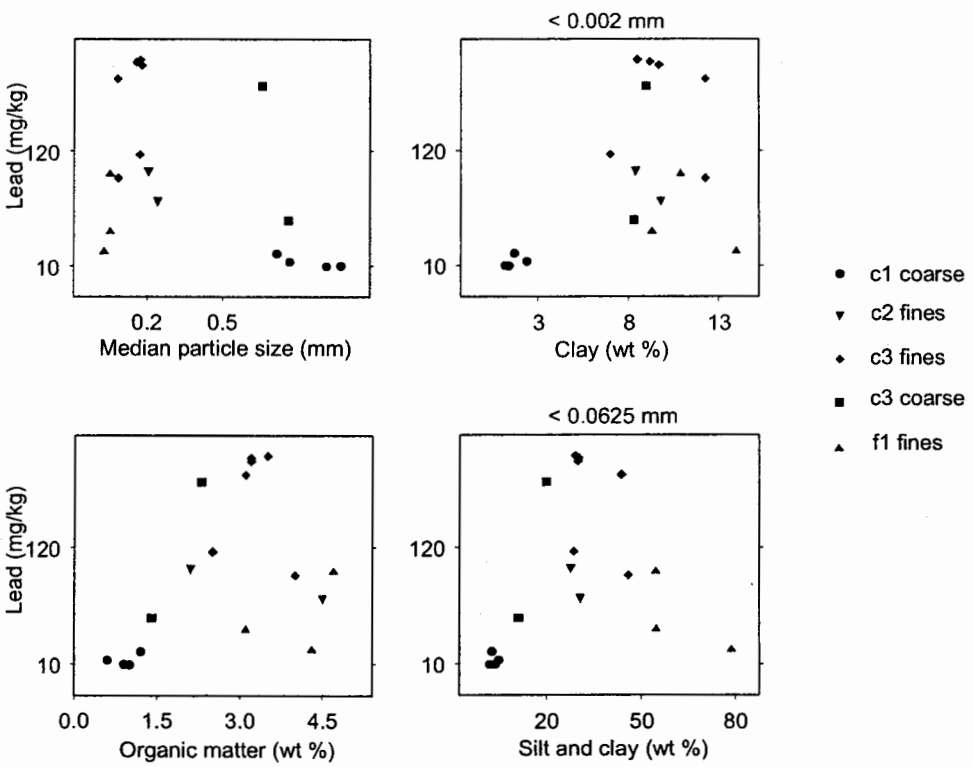
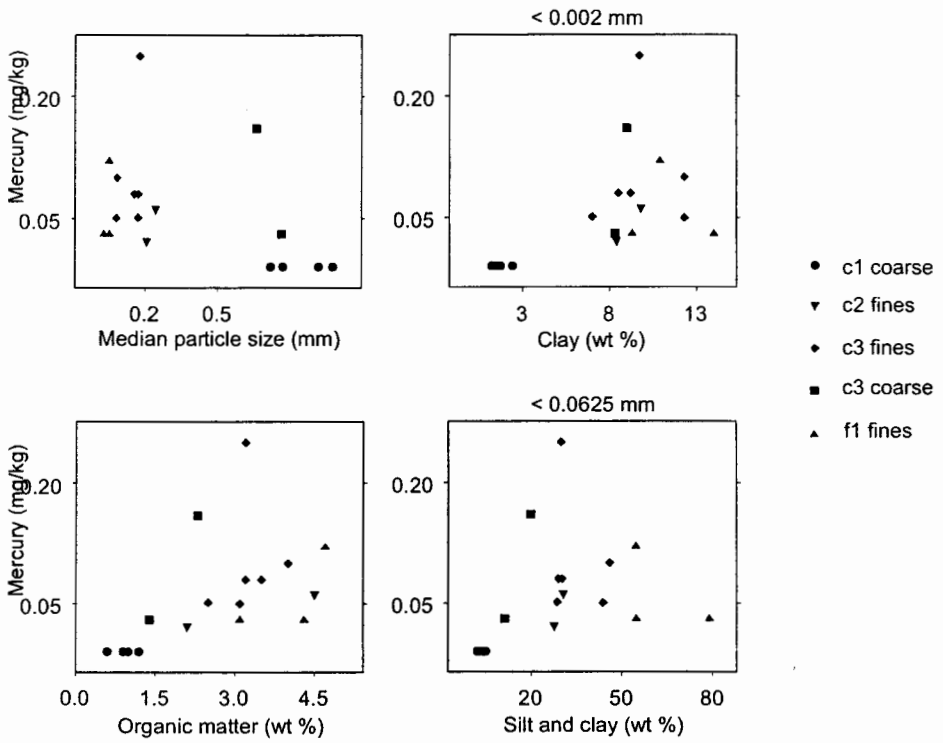


Figure B-2.0-2. Scatter plots showing relations of lead concentration to median particle size, clay content, silt and clay content, and organic matter content in reach DP-1.



Note that non-detected values are not distinguished from detected results on these plots

Figure B-2.0-3. Scatter plots showing relations of mercury concentration to median particle size, clay content, silt and clay content, and organic matter content in reach DP-1.

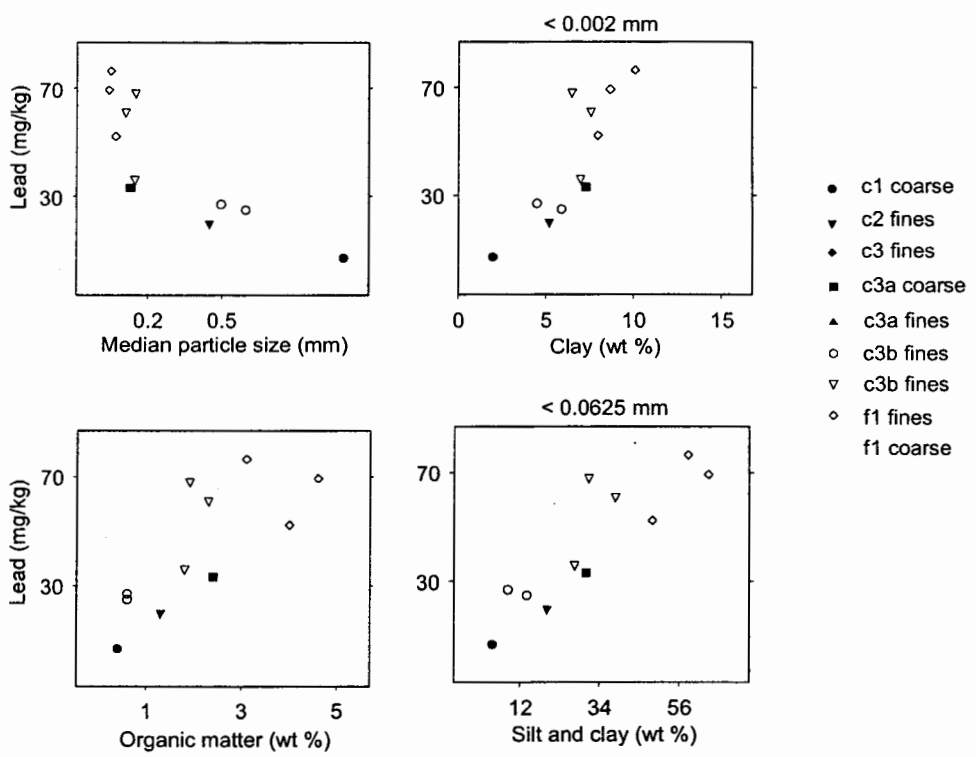


Figure B-2.0-4. Scatter plots showing relations of lead concentration to median particle size, clay content, silt and clay content, and organic matter content in reach DP-2.

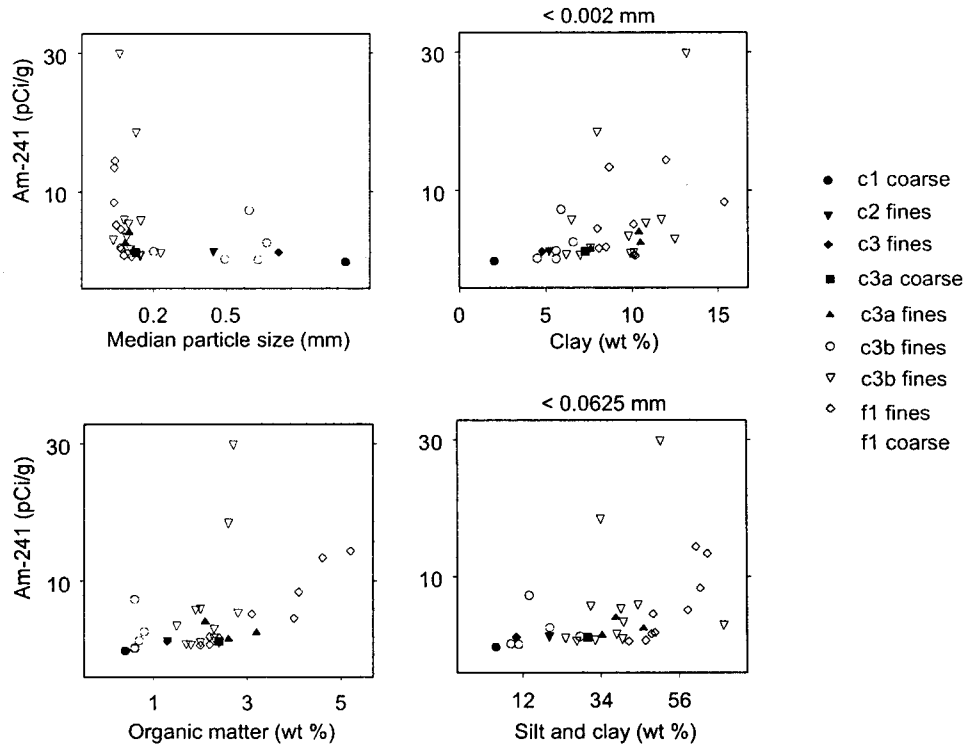


Figure B-2.0-5. Scatter plots showing relations of amerecium-241 concentration to median particle size, clay content, silt and clay content, and organic matter content in reach DP-2.

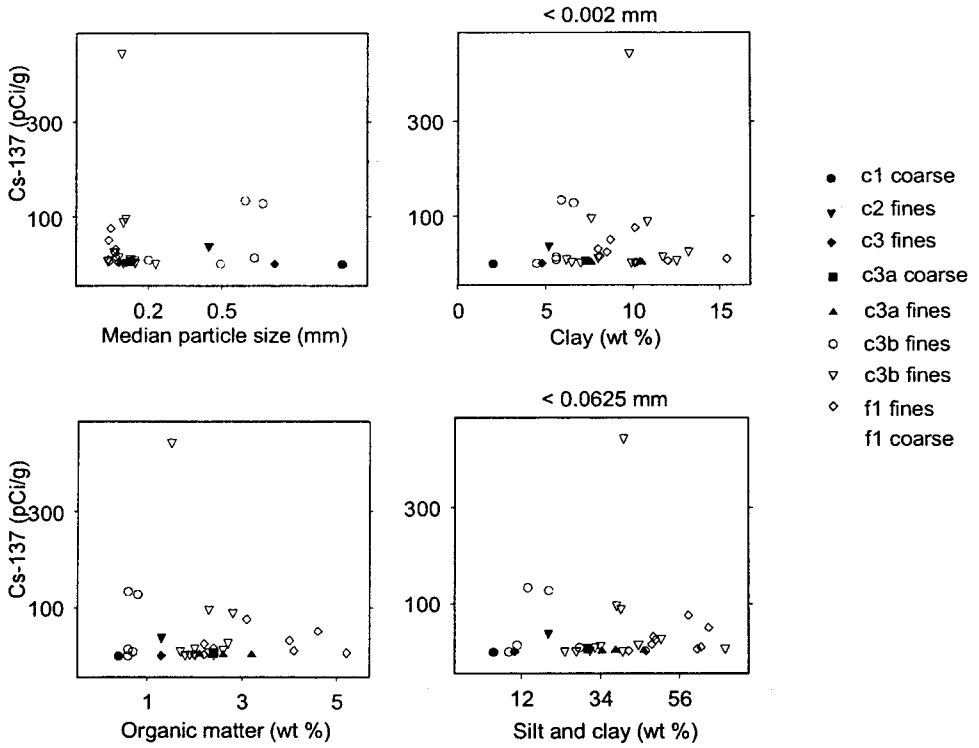


Figure B-2.0-6. Scatter plots showing relations of cesium-137 concentration to median particle size, clay content, silt and clay content, and organic matter content in reach DP-2.

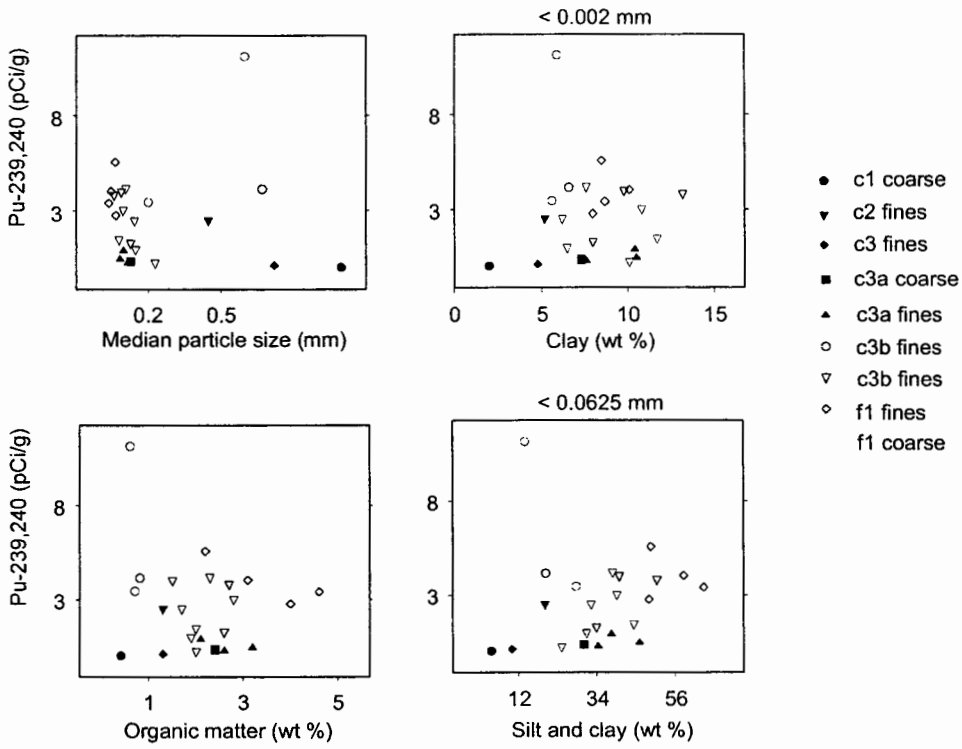


Figure B-2.0-7. Scatter plots showing relations of plutonium-239,240 concentration to median particle size, clay content, silt and clay content, and organic matter content in reach DP-2.

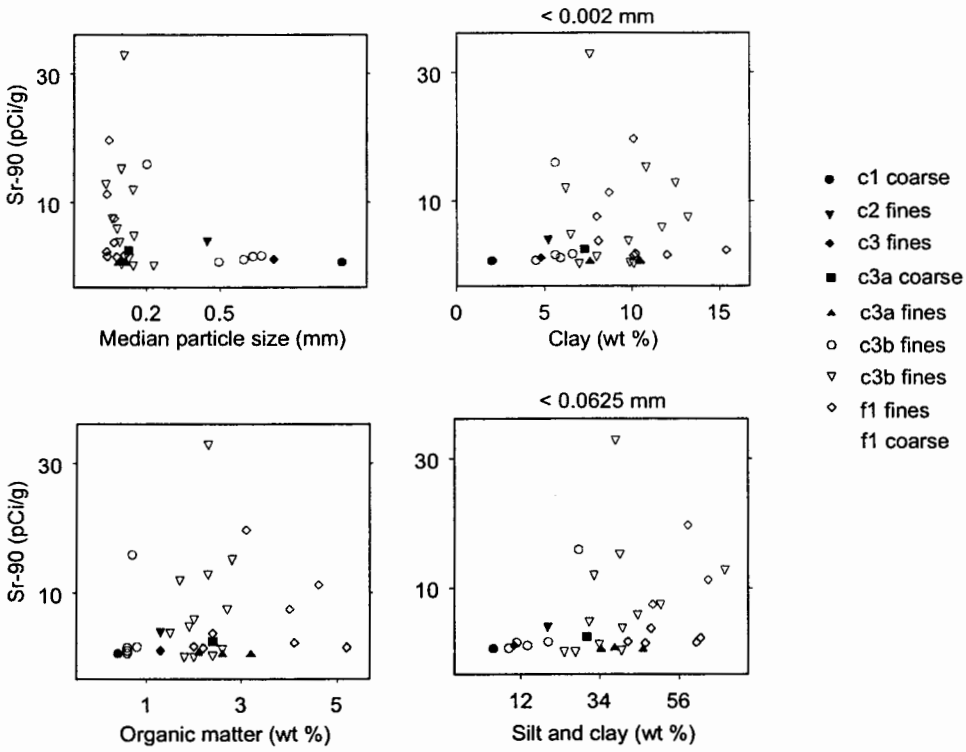


Figure B-2.0-8. Scatter plots showing relations of strontium-90 concentration to median particle size, clay content, silt and clay content, and organic matter content in reach DP-2.

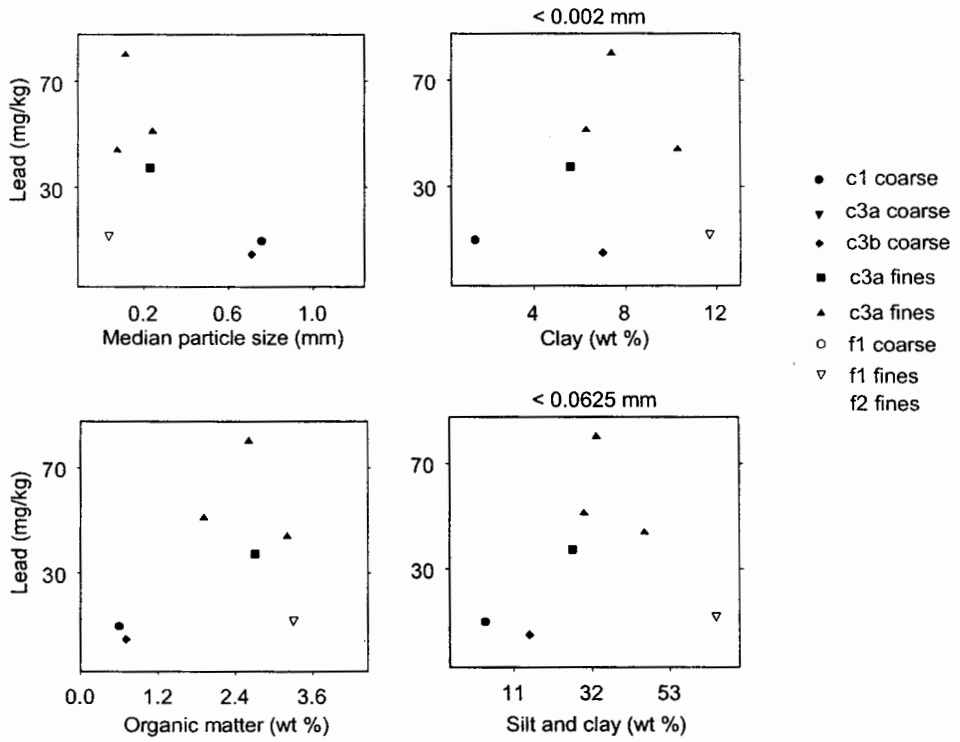


Figure B-2.0-9. Scatter plots showing relations of lead concentration to median particle size, clay content, silt and clay content, and organic matter content in reach DP-3.

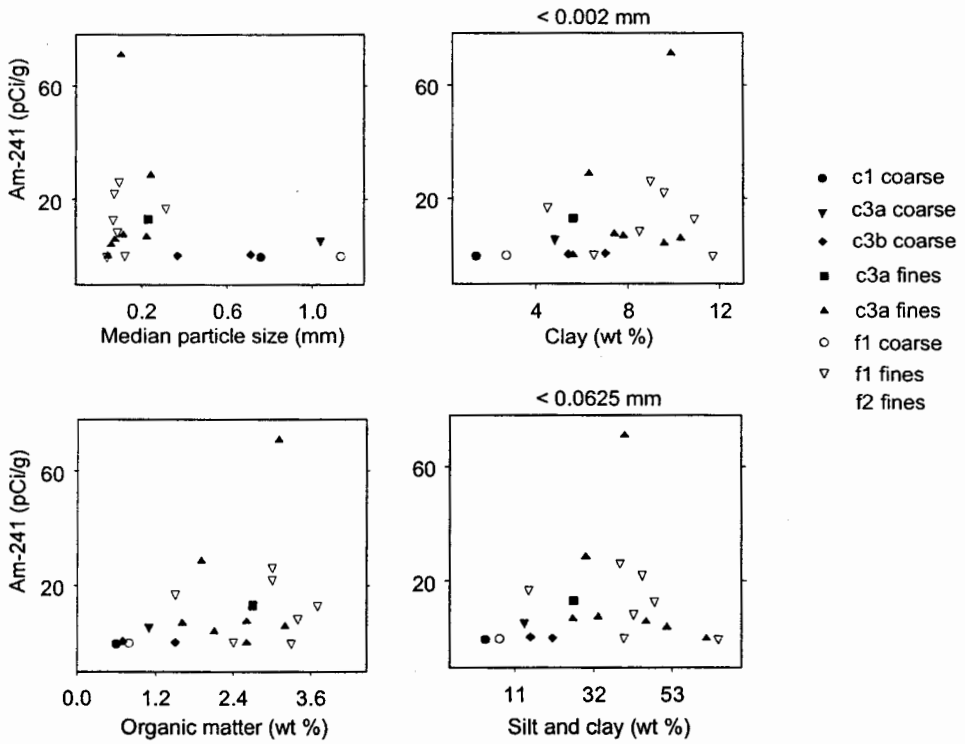


Figure B-2.0-10. Scatter plots showing relations of americium-241 concentration to median particle size, clay content, silt and clay content, and organic matter content in reach DP-3.

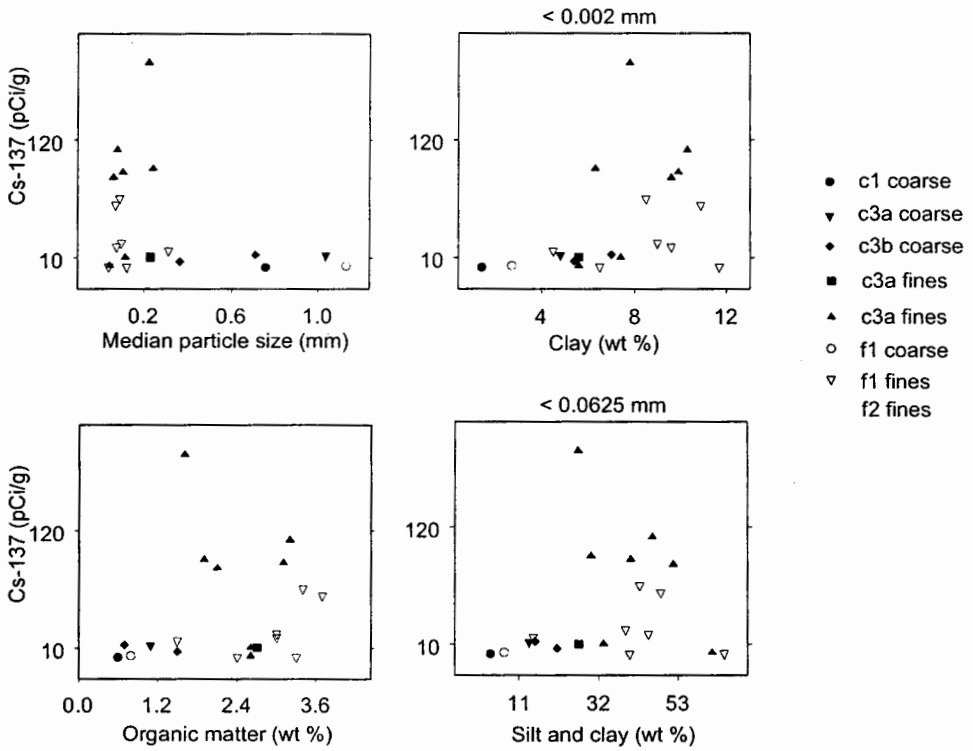


Figure B-2.0-11. Scatter plots showing relations of cesium-137 concentration to median particle size, clay content, silt and clay content, and organic matter content in reach DP-3.

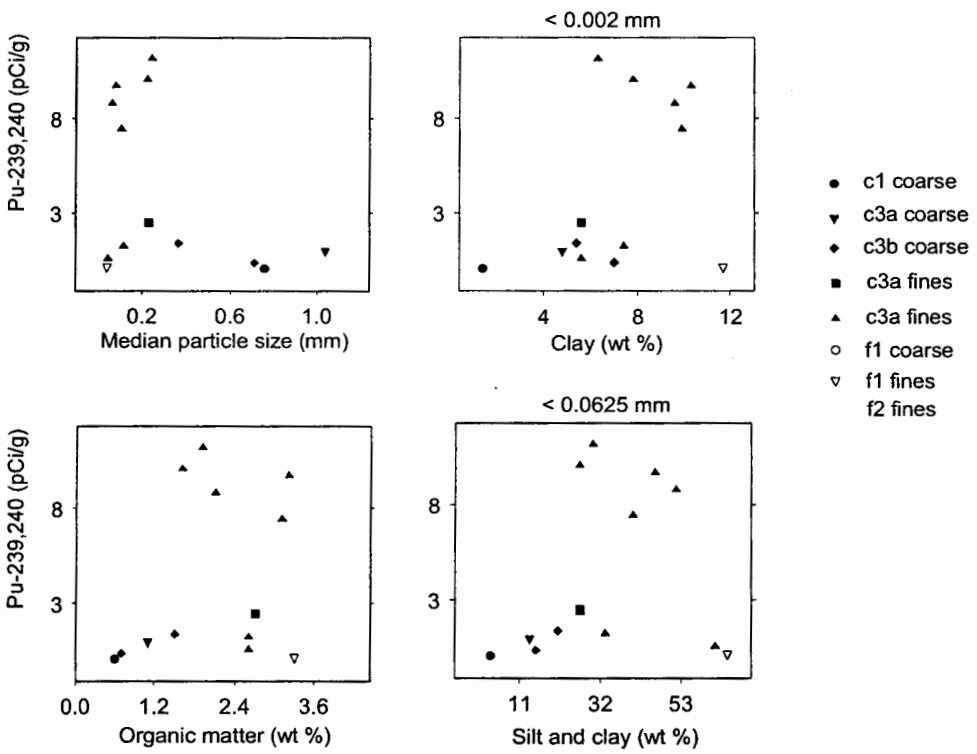


Figure B-2.0-12. Scatter plots showing relations of plutonium-239,240 concentration to median particle size, clay content, silt and clay content, and organic matter content in reach DP-3.

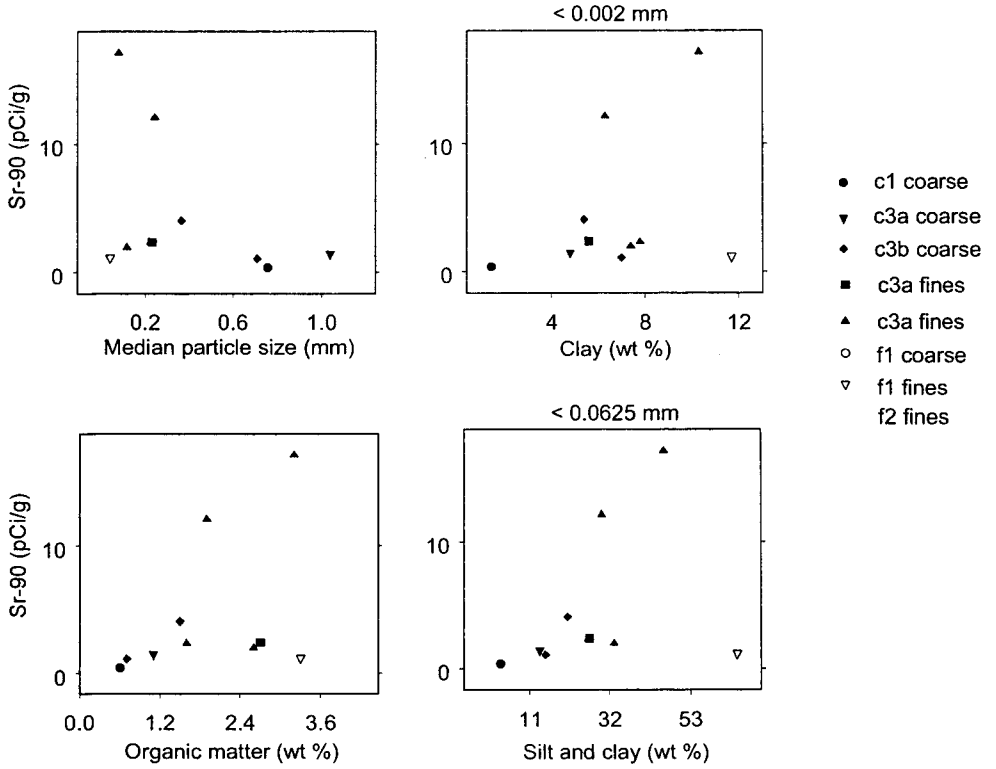


Figure B-2.0-13. Scatter plots showing relations of strontium-90 concentration to median particle size, clay content, silt and clay content, and organic matter content in reach DP-3.

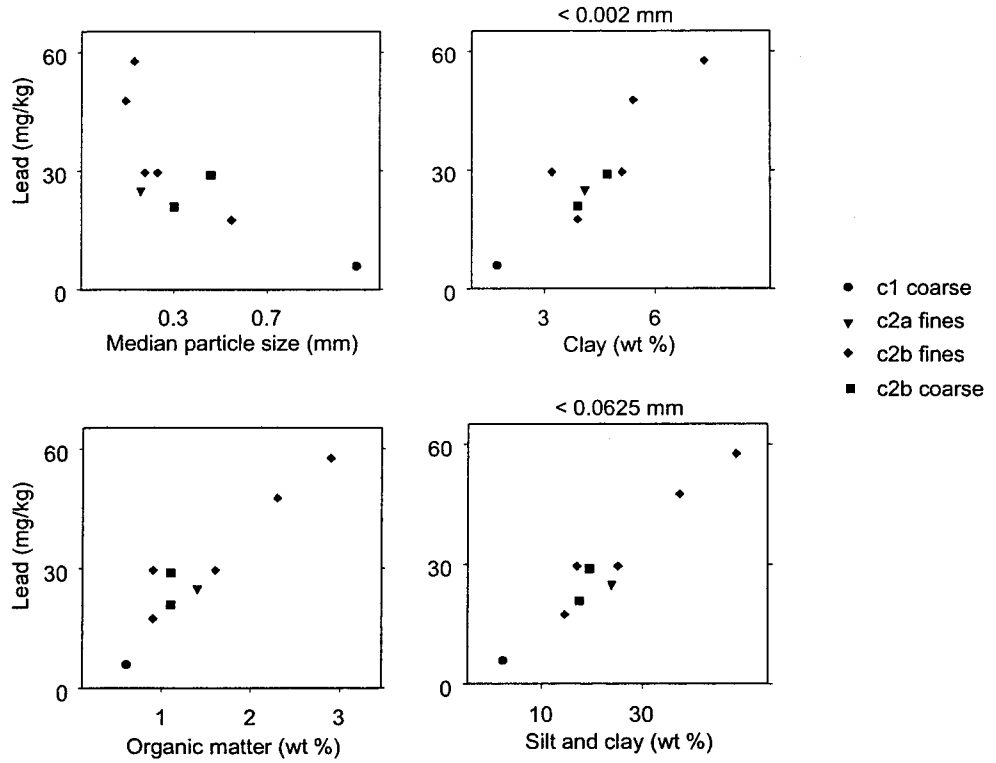


Figure B-2.0-14. Scatter plots showing relations of lead concentration to median particle size, clay content, silt and clay content, and organic matter content in reach DP-4.

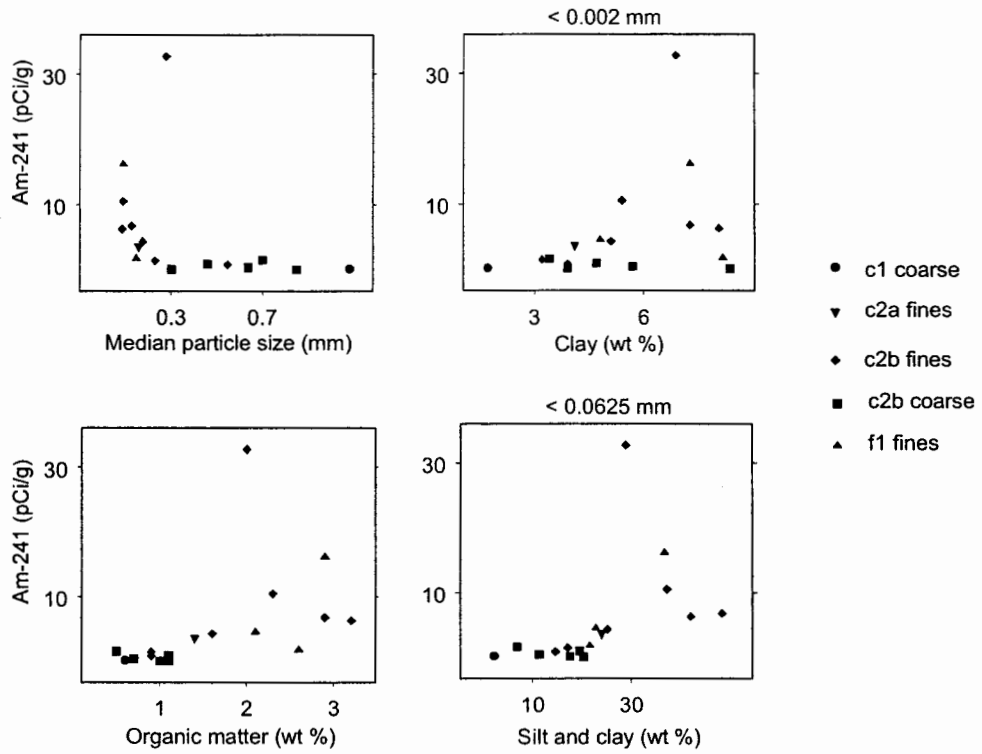


Figure B-2.0-15. Scatter plots showing relations of americium-241 concentration to median particle size, clay content, silt and clay content, and organic matter content in reach DP-4.

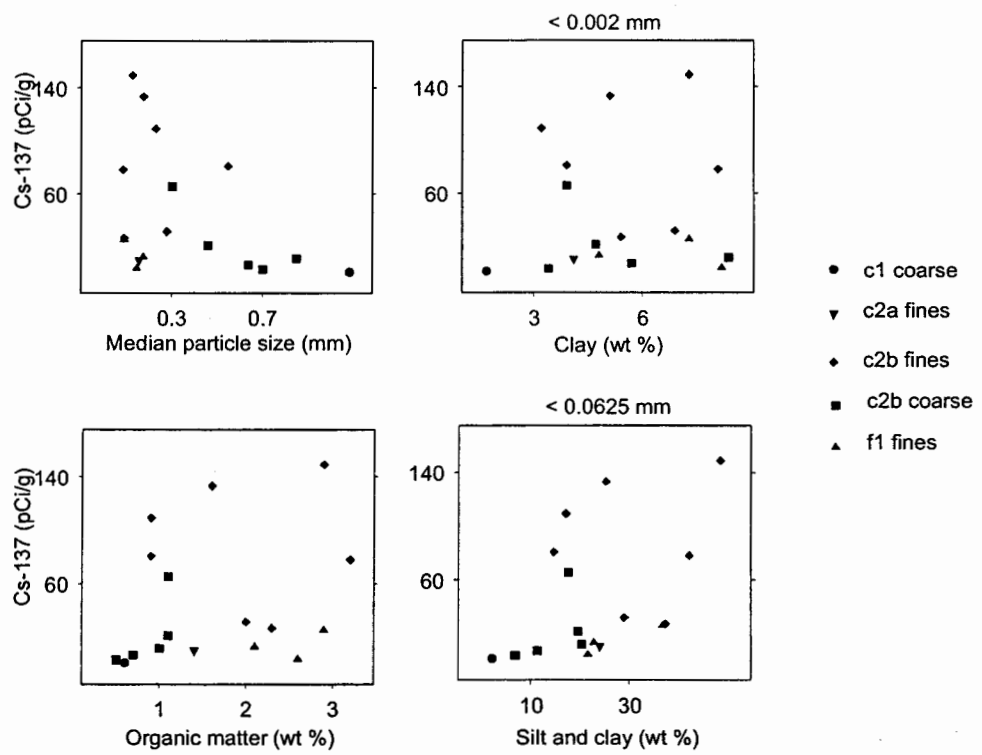


Figure B-2.0-16. Scatter plots showing relations of cesium-137 concentration to median particle size, clay content, silt and clay content, and organic matter content in reach DP-4.

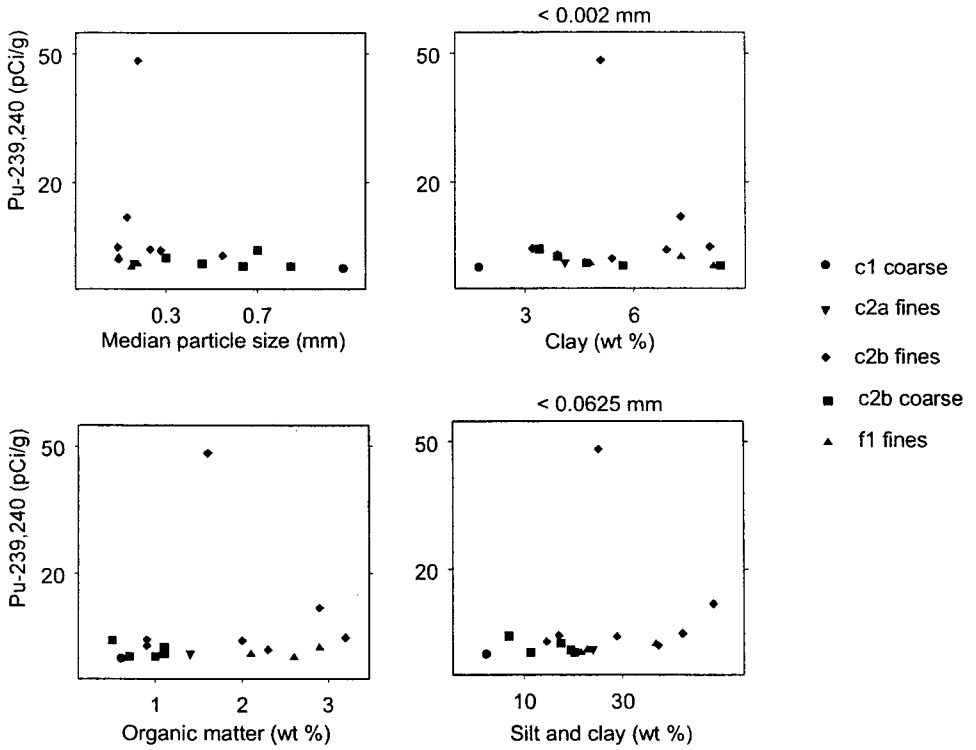


Figure B-2.0-17. Scatter plots showing relations of plutonium-239,240 concentration to median particle size, clay content, silt and clay content, and organic matter content in reach DP-4.

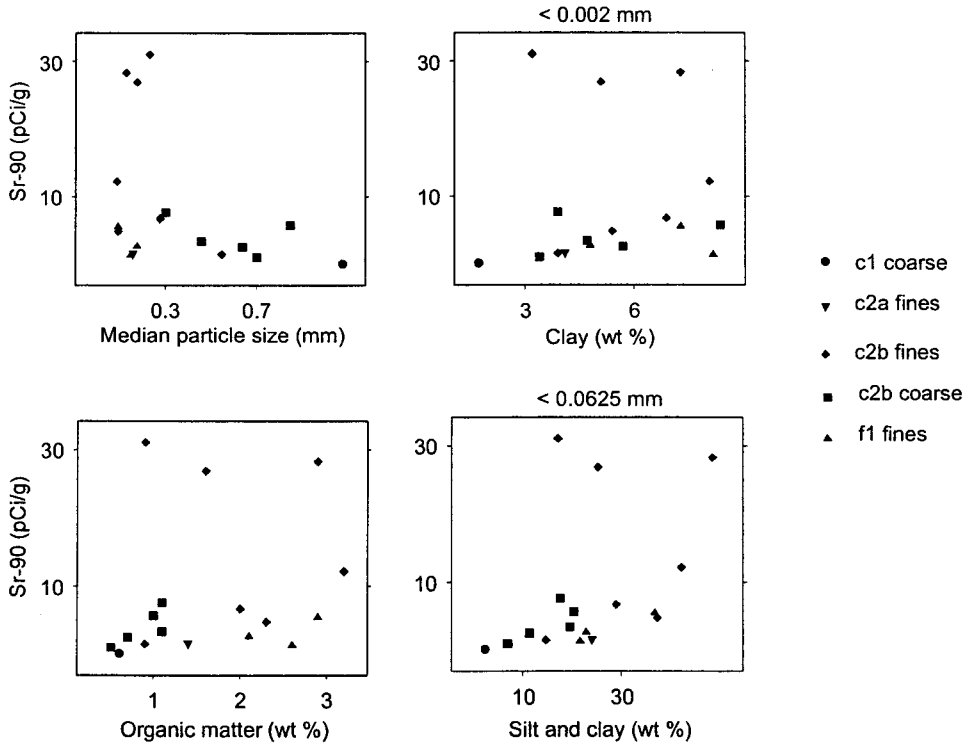


Figure B-2.0-18. Scatter plots showing relations of strontium-90 concentration to median particle size, clay content, silt and clay content, and organic matter content in reach DP-4.

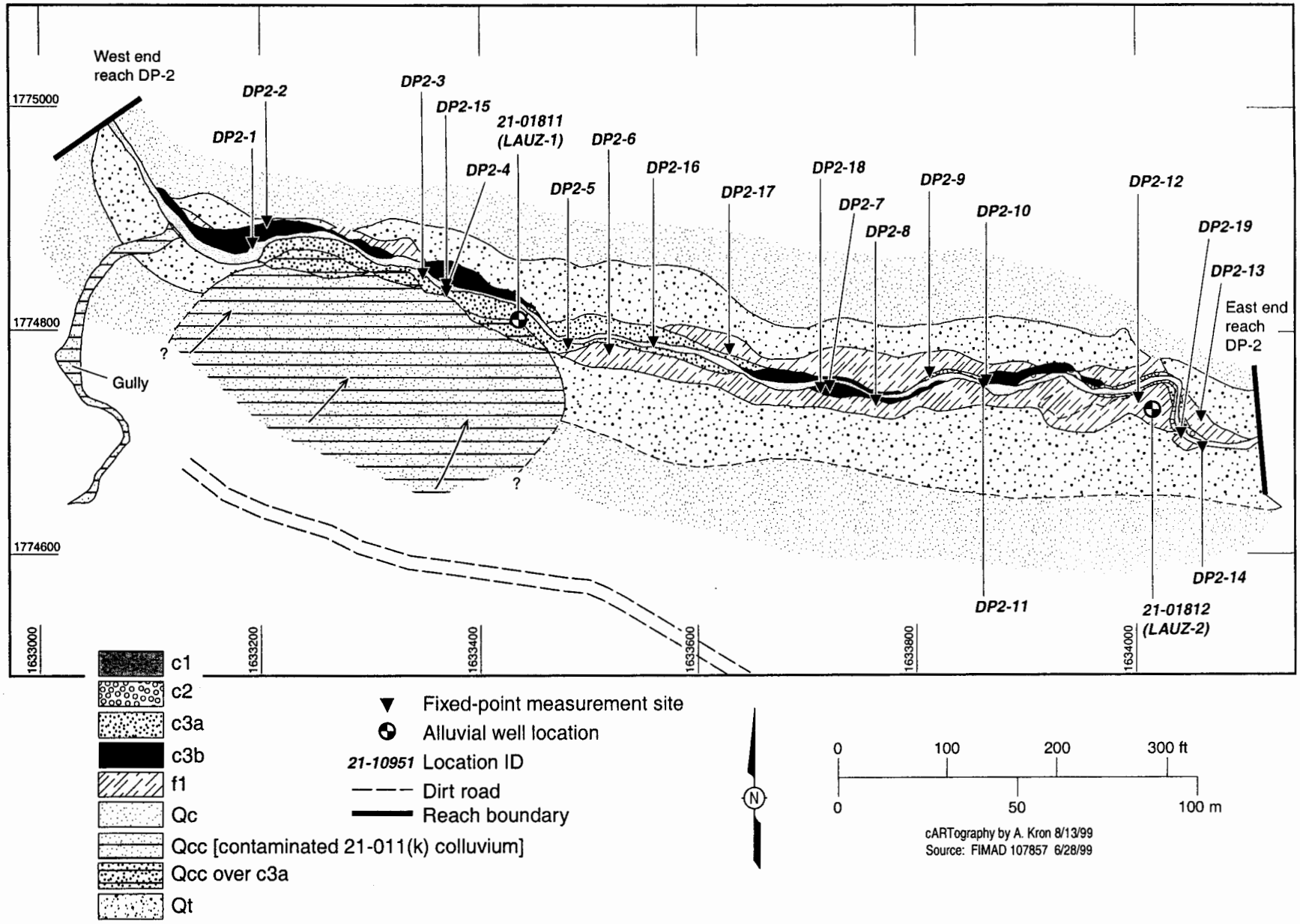


Figure B-3.2-1. Reach DP-2 geomorphology and fixed-point measurement sites

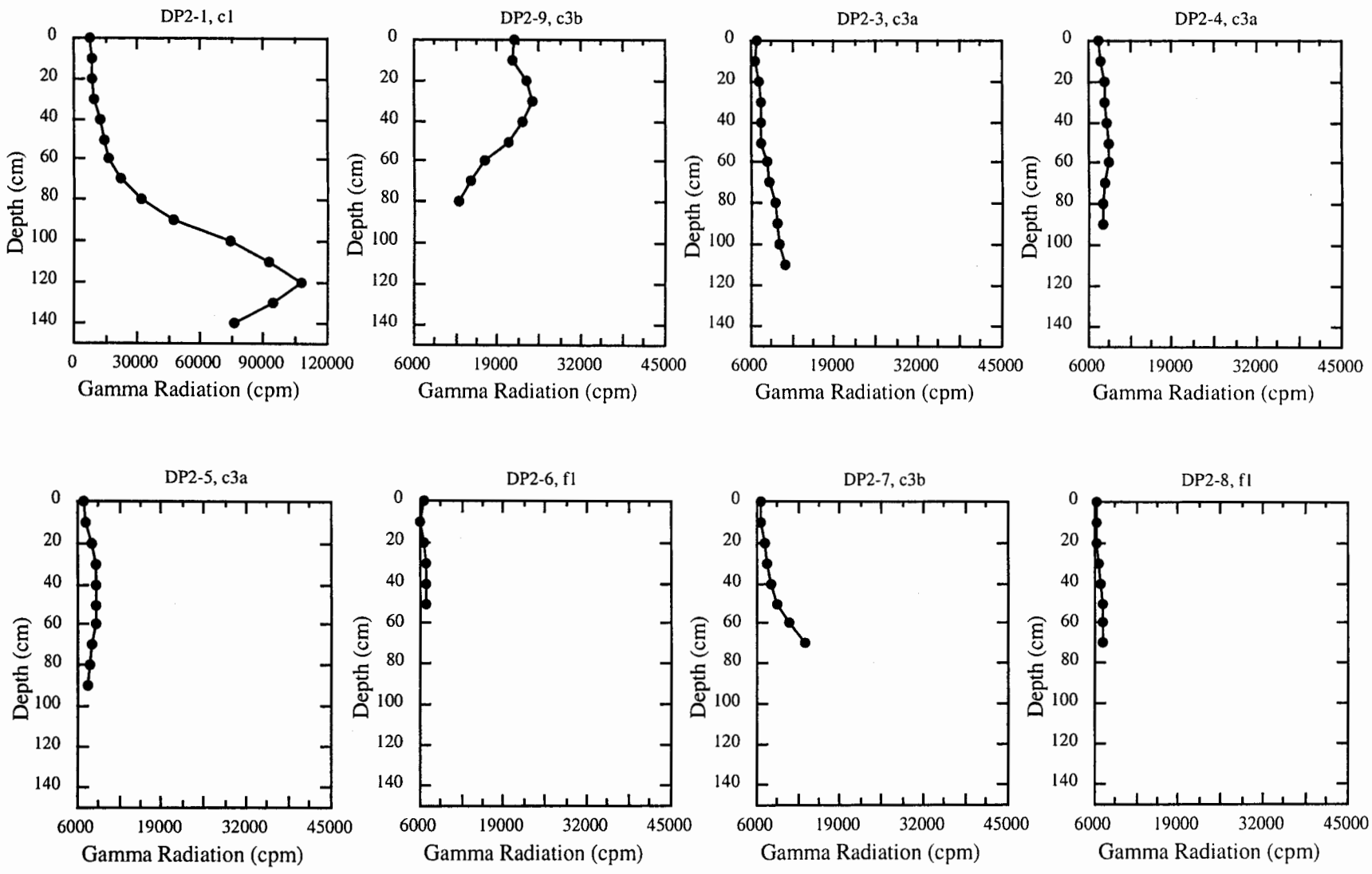


Figure B-3.2-2. Fixed-point gross gamma profiles for reach DP-2

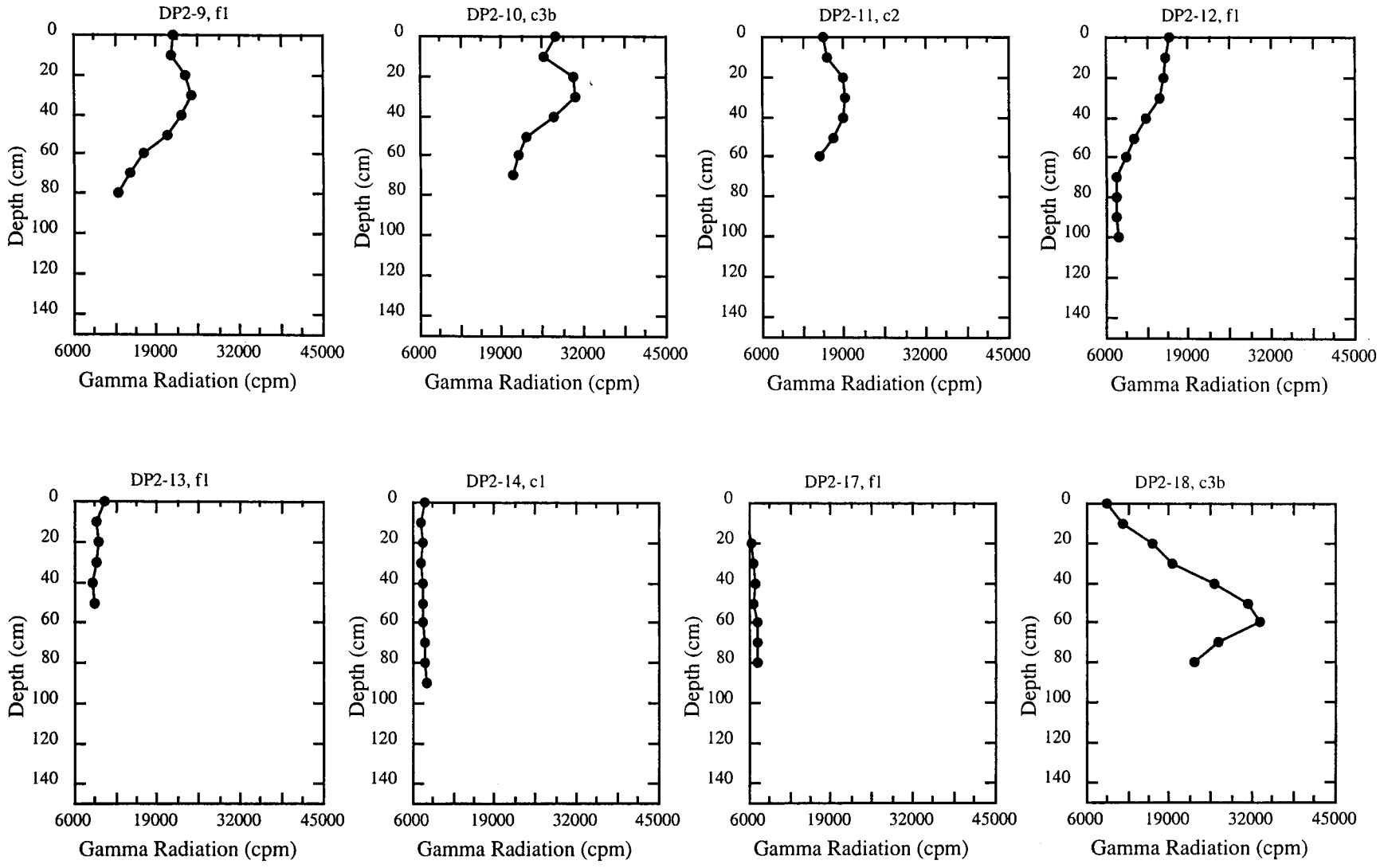


Figure B-3.2-2 (continued). Fixed-point gross gamma profiles for reach DP-2

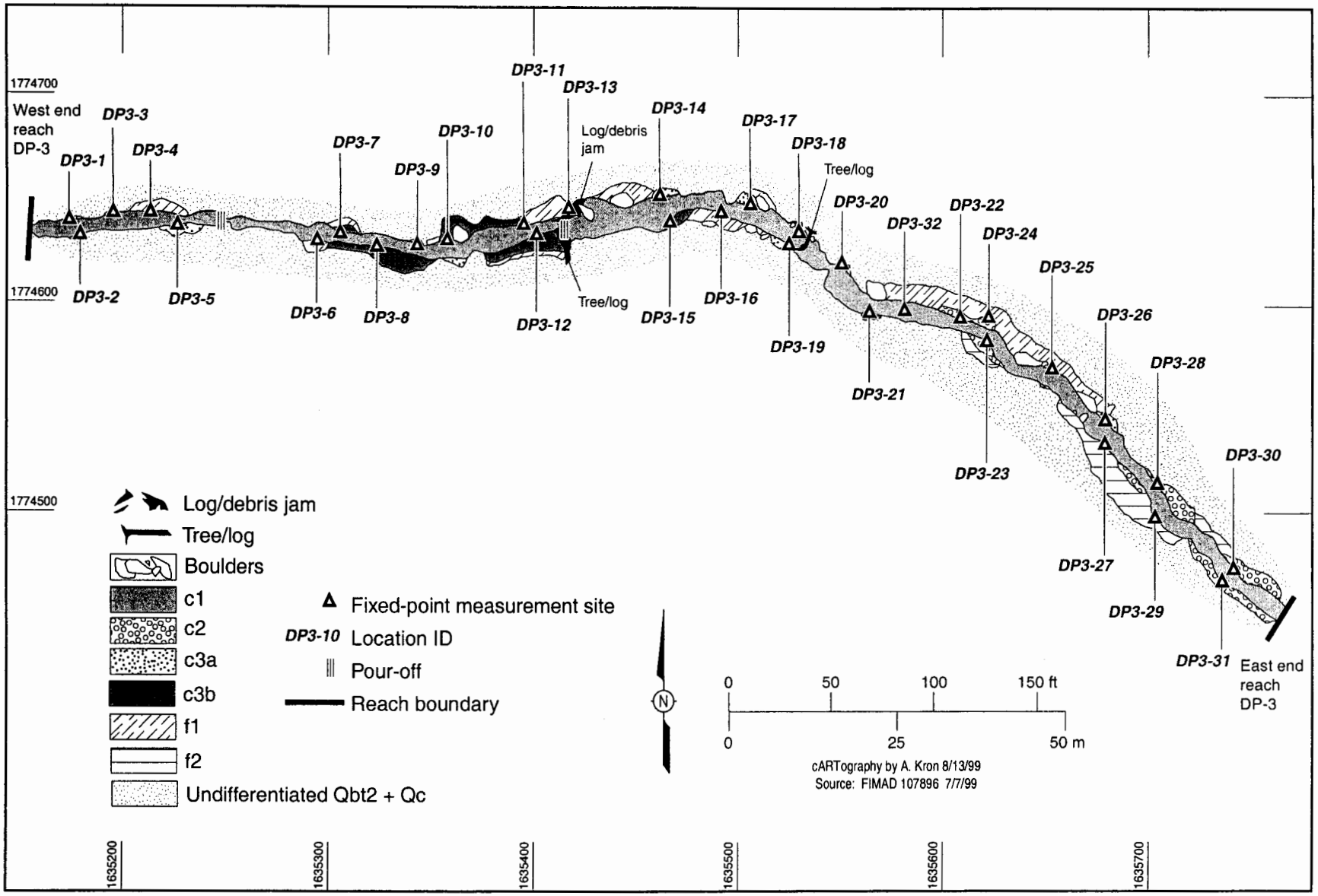


Figure B-3.2-3. Reach DP-3 geomorphology and fixed-point measurement sites

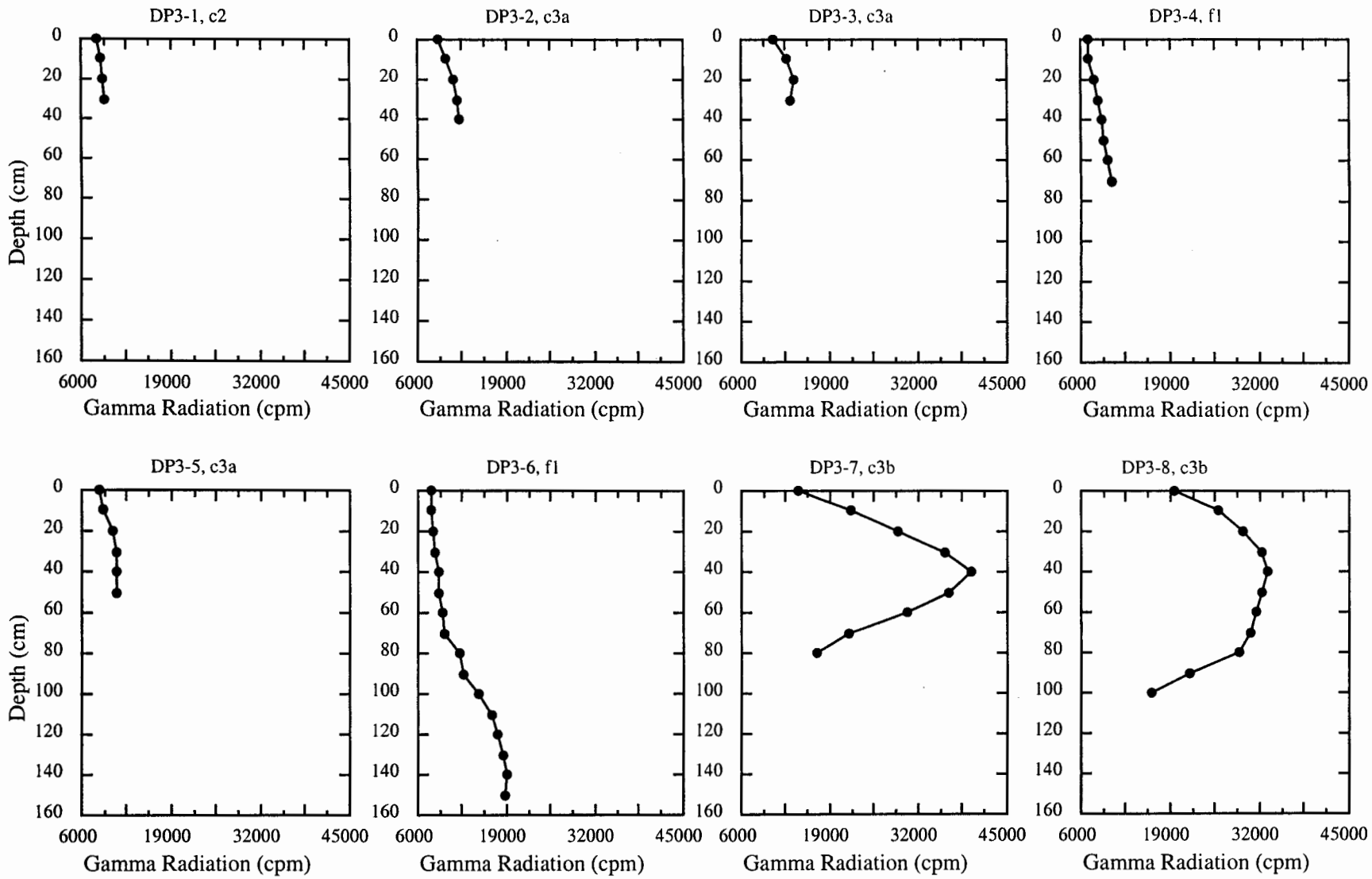


Figure B-3.2-4. Fixed-point gross gamma profiles for reach DP-3

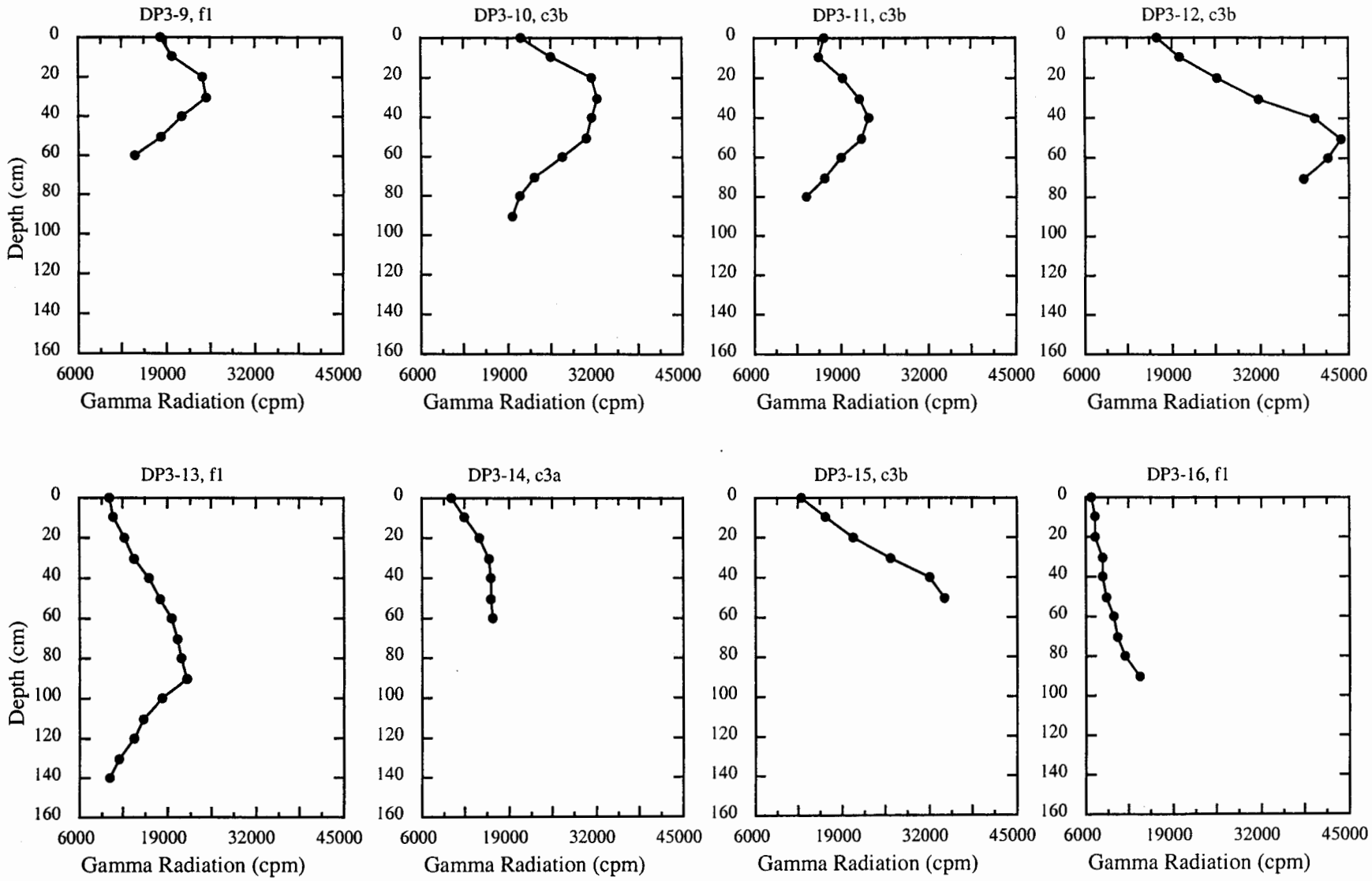


Figure B-3.2-4 (continued). Fixed-point gross gamma profiles for reach DP-3

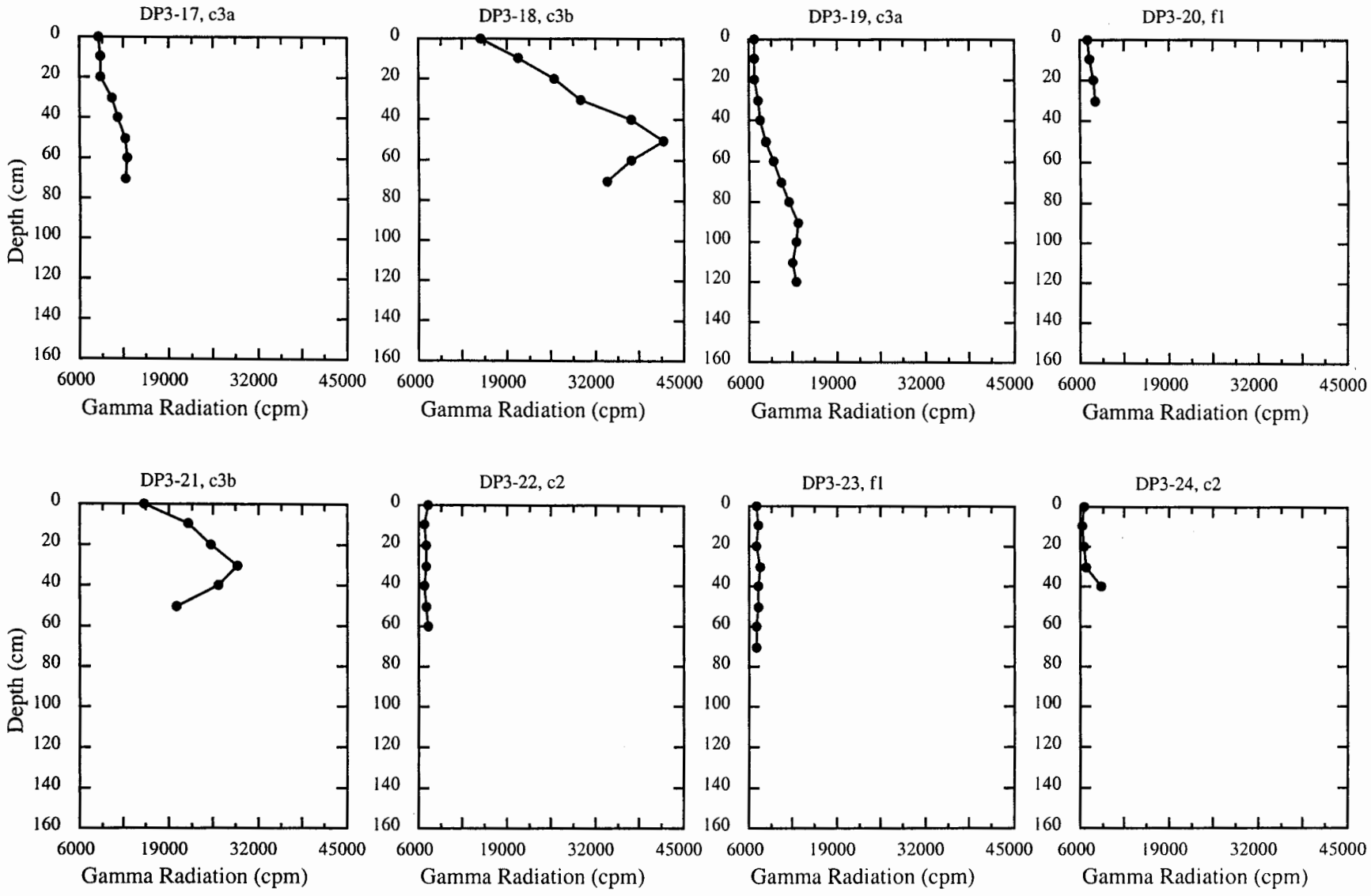


Figure B-3.2-4 (continued). Fixed-point gross gamma profiles for reach DP-3

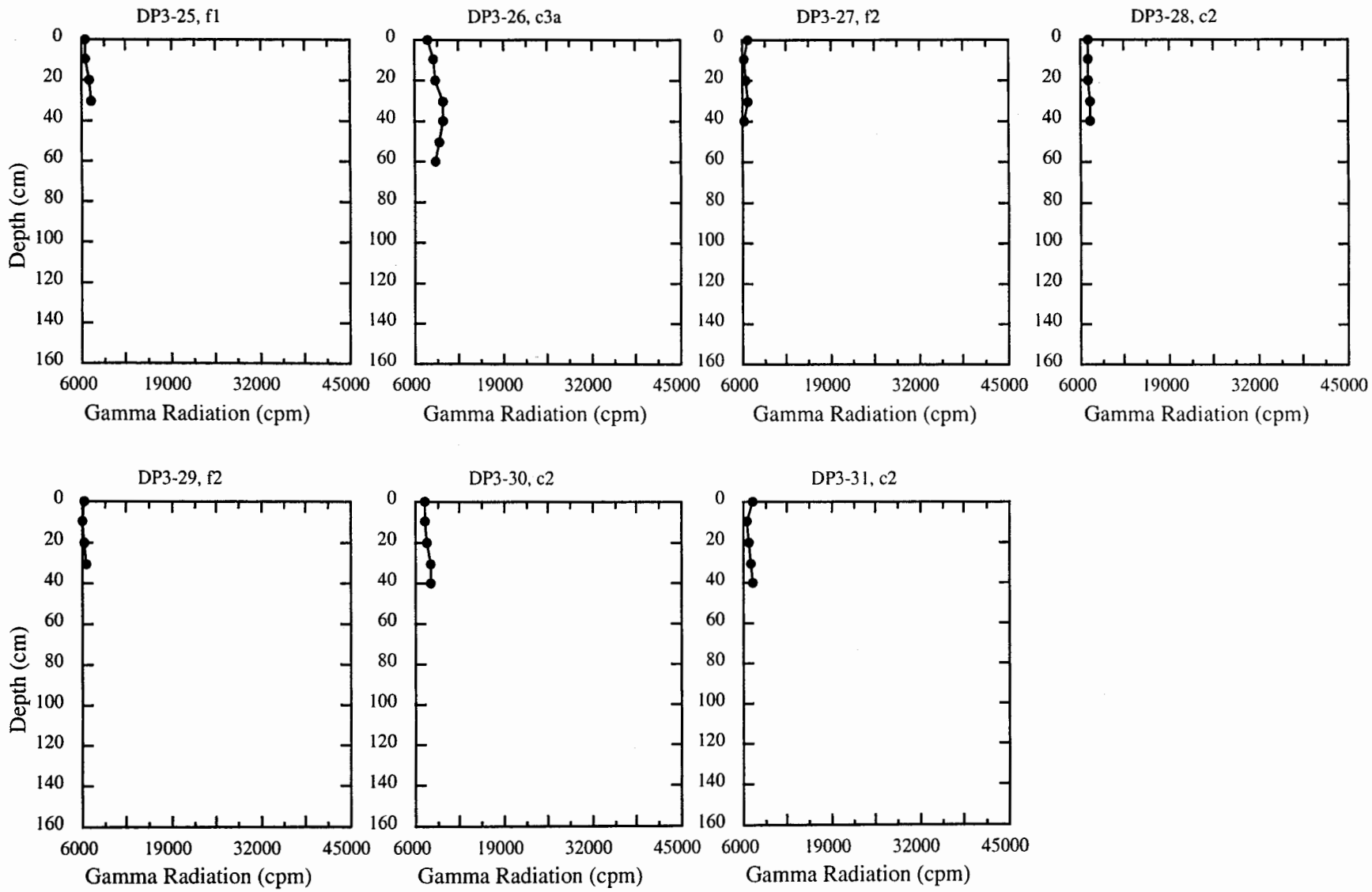


Figure B-3.2-4 (continued). Fixed-point gross gamma profiles for reach DP-3

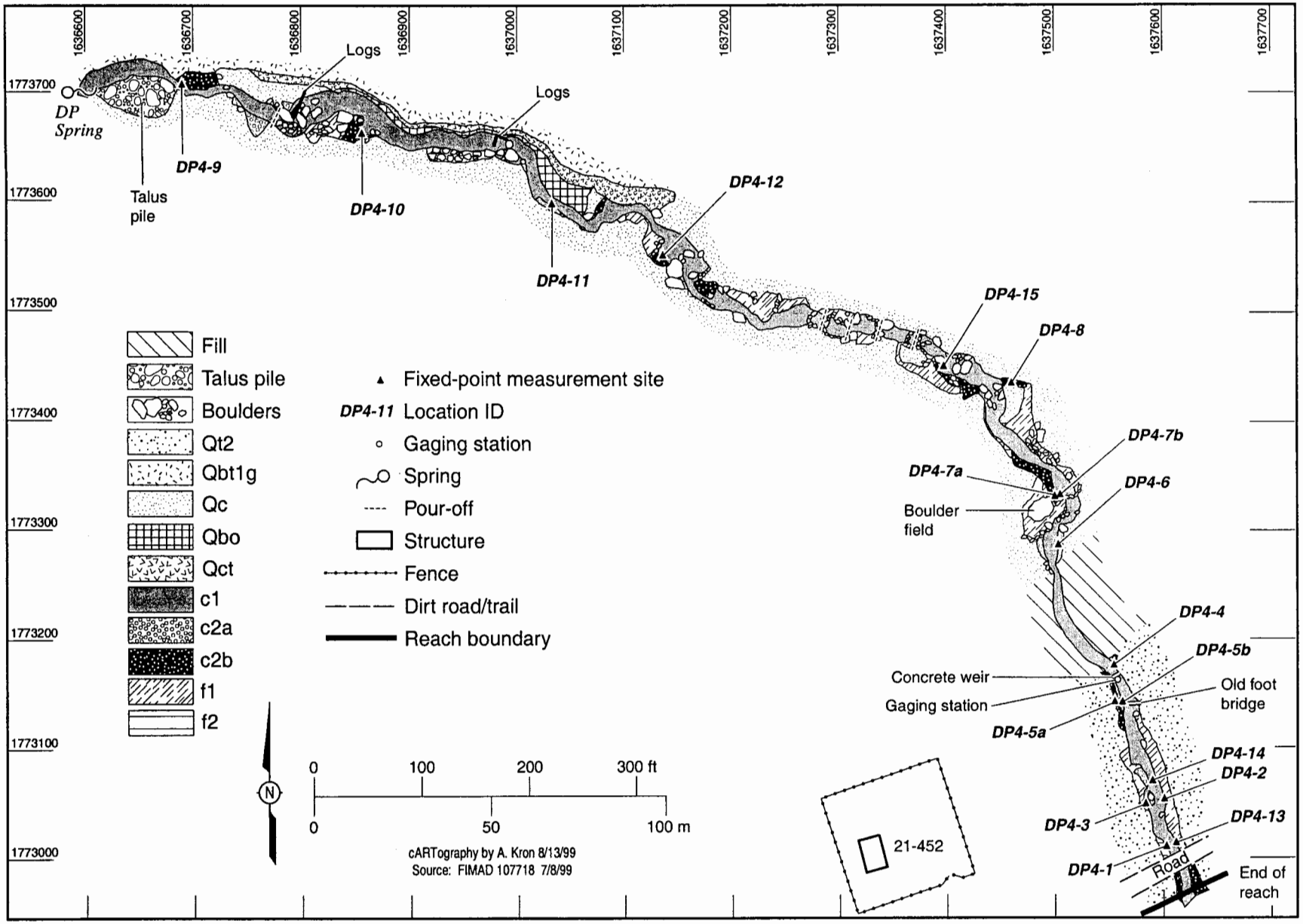


Figure B-3.2-5. Reach DP-4 geomorphology and fixed-point measurement sites

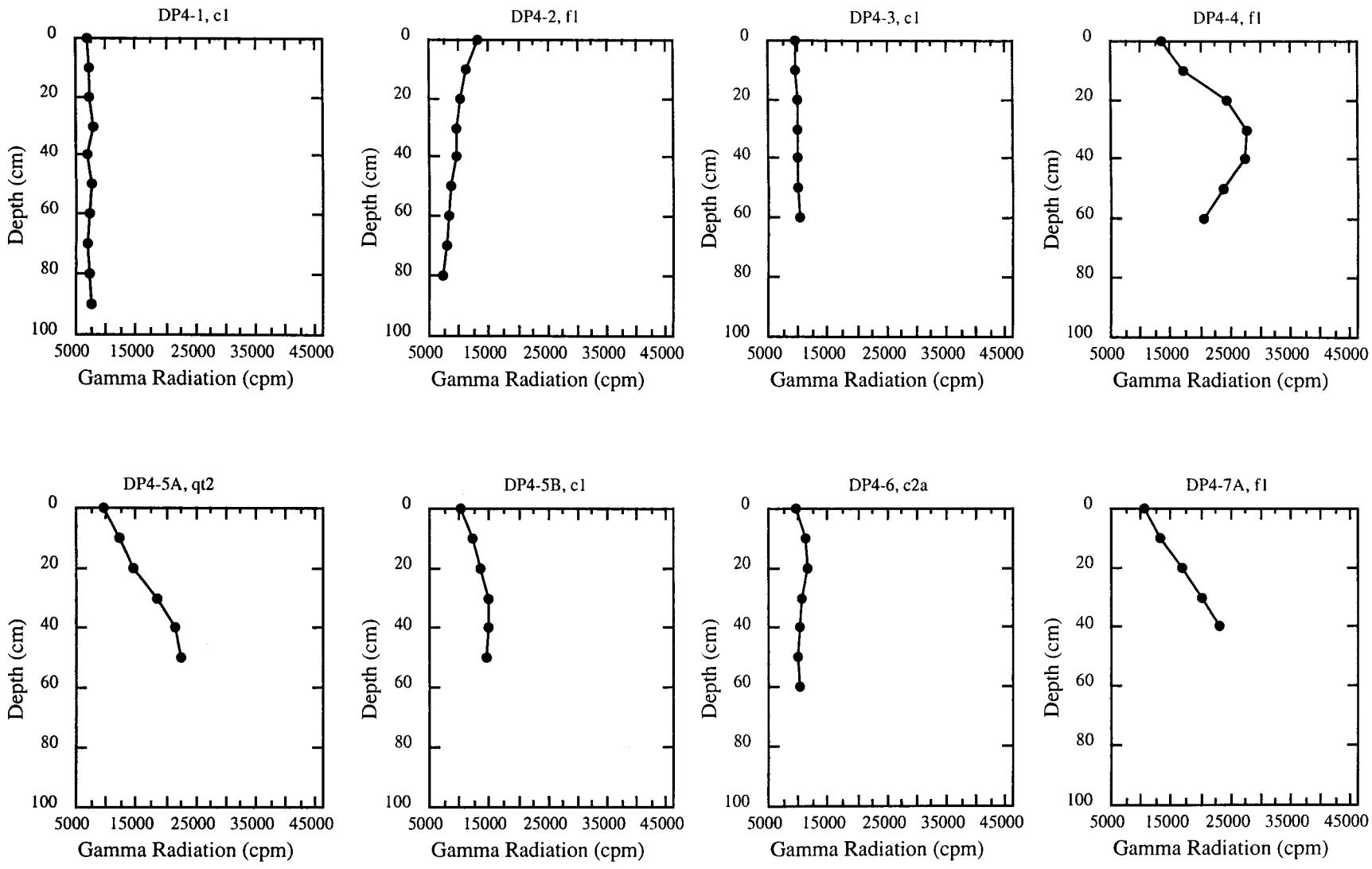


Figure B-3.2-6. Fixed-point gross gamma profiles for reach DP-4

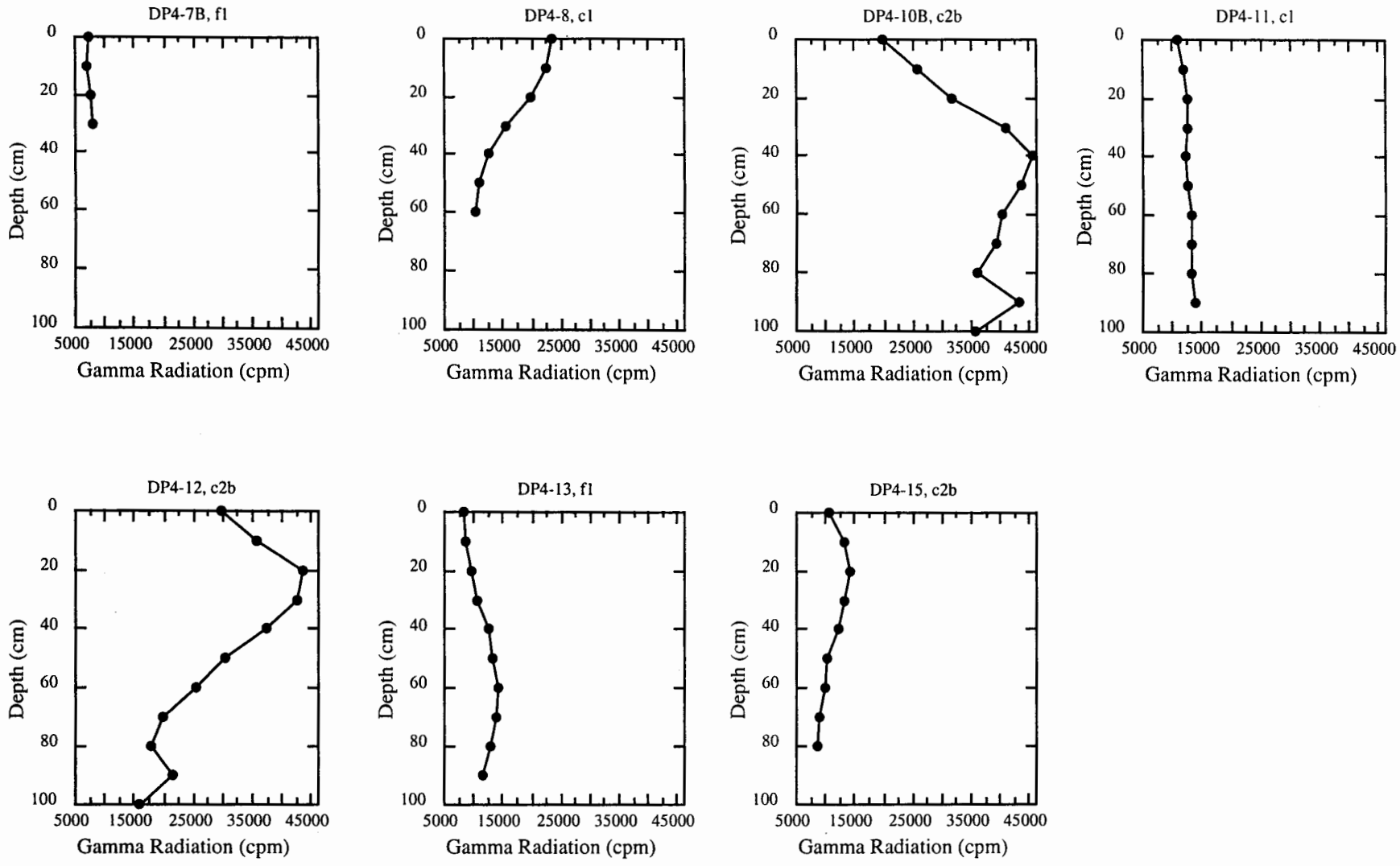


Figure B-3.2-6 (continued). Fixed-point gross gamma profiles for reach DP-4

Table B-1.0-1
Estimated Average Facies Thickness by Geomorphic Unit within Reach

Reach	Geomorphic Unit Facies	c2 coarse (m)	c2 fine (m)	c2a coarse (m)	c2a fine (m)	c2b coarse (m)	c2b fine (m)	c3 coarse (m)	c3 fine (m)	c3a coarse (m)	c3a fine (m)	c3b coarse (m)	c3b fine (m)	f1 fine (m)	f2 fine (m)
Reach DP-1W	Average	0.25[a]	0.20	—[b]	—	—	—	0.25[a]	0.58	—	—	—	—	0.45	—
	Standard deviation	[c]	—	—	—	—	—	[c]	0.04	—	—	—	—	0.14	—
	No. of measurements	[d]	1	—	—	—	—	[d]	2	—	—	—	—	2	—
Reach DP-1C	Average	—	—	—	—	—	—	0.33	0.27	—	—	—	—	0.52	—
	Standard deviation	—	—	—	—	—	—	0.13	0.11	—	—	—	—	0.25	—
	No. of measurements	—	—	—	—	—	—	9	9	—	—	—	—	7	—
Reach DP-1E	Average	0.09	0.33	—	—	—	—	0.21	0.62	—	—	—	—	0.42	—
	Standard deviation	0.09	0.04	—	—	—	—	0.17	0.21	—	—	—	—	0.21	—
	No. of measurements	2	2	—	—	—	—	10	11	—	—	—	—	8	—
Reach DP-2	Average	0.50[a]	0.37[e]	—	—	—	—	—	—	0.50[a]	0.53	0.50[a]	0.52	0.43	—
	Standard deviation	[c]	0.16	—	—	—	—	—	—	[c]	0.15	[c]	0.12	0.30	—
	No. of measurements	[d]	5	—	—	—	—	—	—	[d]	9	[d]	17.00	5	—
Reach DP-3	Average	0.25[a]	0.37	—	—	—	—	—	—	0.25[a]	0.45	0.25[a]	0.65	0.70	0.72
	Standard deviation	[c]	0.16	—	—	—	—	—	—	[c]	0.18	[c]	0.20	0.26	0.29
	No. of measurements	[d]	5	—	—	—	—	—	—	[d]	7	[d]	8	8	3
Reach DP-4	Average	—	—	0.50[a]	0.33	0.50[a]	0.22	—	—	—	—	—	—	0.22	0.40
	Standard deviation	—	—	[c]	0.13	[c]	0.16	—	—	—	—	—	—	0.13	—
	No. of measurements	—	—	[d]	4	[d]	6	—	—	—	—	—	—	5	1

[a] Estimate based on thickness of c1 alluvium estimated from unrecorded field observations.

[b] A dash in the table means geomorphic unit not present in reach.

[c] Standard deviation not calculated.

[d] Number of field observations not recorded.

[e] Estimate from reach DP-3.

Table B-2.0-1
Reach DP-1 Particle Size and Organic Matter

Sample ID	pH	Gravel (>2 mm) (wt %)	Very Coarse Sand (2–1 mm) (wt %)	Coarse Sand (1–0.5 mm) (wt %)	Medium Sand (0.5–0.25 mm) (wt %)	Fine Sand (0.25–0.125 mm) (wt %)	Very Fine Sand (0.125–0.0625 mm) (wt %)	Coarse Silt (62.5–15 μm) (wt %)	Fine Silt (15–2 μm) (wt %)	Clay (<2 μm) (wt %)	Organic Matter (wt %)	Median Particle Size Class	Median Particle Size (mm)
DP-1 Central													
0121-97-1431	—[a]	3.3	4.4	10.9	23.2	20.4	12	14.9	6.7	7	2.5	fs[b]	0.169
DP-1 West													
CA21-98-0051	7.5	26	10	11.9	12.3	10	9.7	22	11.5	12.3	4	vfs[c]	0.083
CA21-98-0052	7.6	15.3	30.7	40.6	21.2	3.7	0.8	0.6	0.5	1.7	1.2	cs[d]	0.719
CA21-98-0053	7.2	5.5	3.7	12.4	23.8	18.5	12.3	12.5	8.2	8.5	3.5	fs	0.171
CA21-98-0054	6.9	33.5	12.9	16.9	19.6	12.3	7.6	11	9.8	9.8	4.5	fs	0.242
CA21-98-0055	7.1	13.1	3.6	4.9	7.1	12.1	17.5	29.4	14.3	10.9	4.7	csi[e]	0.050
CA21-98-0056	7.5	35.9	45.7	35.2	14.4	2.1	0.4	0.2	0.4	1.4	1	cs	0.919
DP- 1 Central													
CA21-98-0057	7.2	5.3	1.5	2.5	2.7	3.9	10.4	50.2	14.6	14	4.3	csi	0.027
CA21-98-0058	7.6	34.9	10.4	12	19.4	16.2	12.1	12.7	7.5	9.7	3.2	fs	0.176
CA21-98-0059	7.7	62.2	34.1	26.6	11.6	4.9	2.9	4.7	6.1	9	2.3	cs	0.661
CA21-98-0060	6.8	24.1	17.1	12.7	10.6	5.8	6.9	15.7	10.7	20.6	3.6	vfs	0.085
CA21-98-0061	6.3	54.7	49	30.4	12.8	2.8	0.8	0.9	1.9	1.2	0.9	cs	0.977
CA21-98-0062	6.5	2.1	2.7	9.7	23.3	20.8	13.1	14.4	6.7	9.2	3.2	fs	0.155
DP-1 East													
CA21-98-0063	6.7	4	8.3	15.1	21.7	16.7	10.4	13.4	5.8	8.4	2.1	fs	0.204
CA21-98-0064	7	1.6	3.8	6	9.2	11.6	14.5	33.8	11.6	9.3	3.1	csi	0.051
CA21-98-0065	6.3	1	2.5	5.4	12	17.9	18.4	23.8	7.6	12.3	3.1	vfs	0.079
CA21-98-0066	6.9	36.4	36.1	36	13.3	2.8	1.1	0.7	2.1	8.3	1.4	cs	0.765
CA21-98-0067	7	1.7	2.5	3.2	4	6.9	16.5	42.1	10.7	13.4	4	csi	0.035
CA21-98-0068	7.2	14.4	37.2	33.9	17.1	5.6	1.5	1.7	0.8	2.4	0.6	cs	0.770
CA21-98-0069	6.8	0.6	1.9	4.7	12	18.4	20.2	24.1	7.2	11.4	3	vfs	0.080

[a] A dash in the table means "not analyzed."

[b] fs = fine sand.

[c] vfs = very fine sand.

[d] cs = coarse sand.

[e] csi = coarse silt.

Table B-2.0-2
Reach DP-2 Particle Size and Organic Matter

Sample ID	pH	Gravel (>2 mm) (wt %)	Very Coarse Sand (2–1 mm) (wt %)	Coarse Sand (1–0.5 mm) (wt %)	Medium Sand (0.5–0.25 mm) (wt %)	Fine Sand (0.25–0.125 mm) (wt %)	Very Fine Sand (0.125–0.0625 mm) (wt %)	Coarse Silt (62.5–15 μm) (wt %)	Fine Silt (15–2 μm) (wt %)	Clay (<2 μm) (wt %)	Organic Matter (wt %)	Median Particle Size Class	Median Particle Size (mm)
0121-97-1361	—[a]	1.8	4.5	10.2	21	18.9	14	18.7	5.9	6.5	1.9	fs[b]	0.148
0121-97-1362	—	2.1	2	1.7	5	12.4	20	36.4	12	10.1	3.1	vfs[c]	0.046
0121-97-1363	—	9	7.7	8.9	13.7	16.5	14.7	22.9	7.9	7.6	2.3	vfs	0.107
0121-97-1364	—	1.4	8.3	10.4	10.9	9.6	11.9	29.6	11.1	8	4	vfs	0.067
0121-97-1441	—	16.7	22	25.4	16.5	9.8	6.9	9.8	4.4	5.2	1.3	ms[d]	0.448
CA21-98-0070	—	0.7	4.1	14.8	28.8	18.6	9.6	10.6	3.4	10.1	2	fs	0.229
CA21-98-0072	—	10.7	5.7	9.3	11.8	13.1	15.6	24.9	7.8	11.7	2	vfs	0.080
CA21-98-0073	6.8	25	28.7	28.6	15.8	8.7	4.3	4.7	3.2	5.9	0.6	cs[e]	0.597
CA21-98-0074	7.1	2.9	4	7.5	20.1	23.8	17.1	15.6	4.7	7	1.8	fs	0.146
CA21-98-0075	—	6.4	4.2	7.8	16	17	14.9	21.9	8.2	9.9	2.4	vfs	0.099
CA21-98-0076	7.1	48.2	23.6	26	27	11.8	2.9	2.5	1.6	4.5	0.6	ms	0.495
CA21-98-0077	—	2.1	2.7	9.5	17	18.9	17.5	20.3	6.4	7.6	2.6	vfs	0.116
CA21-98-0078	—	7.2	2.7	11.0	13.1	14.3	15.6	24.9	7.9	10.5	3.2	vfs	0.051
CA21-98-0079	—	2.7	2.3	8.2	15.5	18.1	17.5	19.7	8	10.4	2.1	vfs	0.099
CA21-98-0080	—	31.5	37.5	26.1	16.6	6.9	2.7	2.9	2.4	4.8	1.3	cs	0.718
CA21-98-0081	—	6.2	1.5	3	6.1	12.2	16.2	36.5	12.4	12	5.2	csi[f]	0.041
CA21-98-0082	7.5	7.5	4.4	4.4	5.3	9.4	12.3	39.8	15.7	8.7	4.6	csi	0.038
CA21-98-0084	—	2.9	2	4	9.1	14.6	20.9	32.3	8.5	8.5	2.2	vfs	0.064
CA21-98-0085	—	3	0.5	1.9	6.4	16.8	26	33.3	6.2	8.9	2	vfs	0.065
CA21-98-0086	—	1.7	3.7	10	18.1	18.8	15.6	19.2	6.7	8	2.6	fs	0.128
CA21-98-0087	—	3	3.2	7.3	11.5	12.8	14.3	26.1	11.5	13.2	2.7	csi	0.060
CA21-98-0088	—	16	12.4	8.5	8	12.2	18.6	23.4	7	9.8	1.5	vfs	0.090
CA21-98-0089	—	35.7	35.8	24.4	10.3	5.8	4.2	8.6	4.3	6.6	0.8	cs	0.668
CA21-98-0090	—	22.5	16.4	15.2	9.2	7.3	10.2	21.9	9.7	10.2	2	vfs	0.110
CA21-98-0091	—	18.6	14.4	14.2	8.5	6.4	9.8	25.5	10.9	10.1	2.2	vfs	0.079
CA21-98-0092	—	3.1	3.8	7.6	14.4	18.3	16.1	23.4	5.4	10.8	2.8	vfs	0.097
CA21-98-0094	—	3.2	6.3	17	16.4	13	14.7	19	7.2	6.2	1.7	fs	0.144
CA21-98-0095	—	9.7	9.8	19.2	16.9	13	12.7	17.1	5.4	5.6	0.7	fs	0.201
CA21-98-0096	6.8	0.6	1.5	6.4	18.8	23.7	19.1	18.4	4.5	7.3	2.4	fs	0.126
CA21-98-0099	—	3.4	8.6	9.7	8.6	8.9	15.8	31.3	8.8	8.1	2.4	vfs	0.067
CA21-98-0100	—	3.7	25	36.5	15.1	4.9	3.5	7.4	3	4.6	0.6	cs	0.622

Table B-2.0-2 (continued)

Sample ID	pH	Gravel (>2 mm) (wt %)	Very Coarse Sand (2–1 mm) (wt %)	Coarse Sand (1–0.5 mm) (wt %)	Medium Sand (0.5–0.25 mm) (wt %)	Fine Sand (0.25–0.125 mm) (wt %)	Very Fine Sand (0.125–0.0625 mm) (wt %)	Coarse Silt (62.5–15 μm) (wt %)	Fine Silt (15–2 μm) (wt %)	Clay (<2 μm) (wt %)	Organic Matter (wt %)	Median Particle Size Class	Median Particle Size (mm)
CA21-98-0101	7.1	2.9	49.7	33.4	10.9	2.1	0.5	1.9	0.4	2	0.4	cs	0.994
CA21-98-0136	—	0	1	2.8	4.1	7.1	16	44.1	12.2	12.5	2.3	csi	0.034
CA21-98-0137	—	5.6	24.6	38.5	19.4	4.9	1.8	2	3.2	5.6	0.6	cs	0.633
CA21-98-0148	—	0.8	3.2	4.1	6.1	9.4	15.3	32.3	14.2	15.4	4.1	csi	0.037

[a] A dash in the table means "not analyzed."

[b] fs = fine sand.

[c] vfs = very fine sand.

[d] ms = medium sand.

[e] cs = coarse sand.

[f] csi = coarse silt.

Table B-2.0-3
Reach DP-3 Particle Size and Organic Matter

Sample ID	pH	Gravel (>2 mm) (wt %)	Very Coarse Sand (2–1 mm) (wt %)	Coarse Sand (1–0.5 mm) (wt %)	Medium Sand (0.5–0.25 mm) (wt %)	Fine Sand (0.25–0.125 mm) (wt %)	Very Fine Sand (0.125–0.0625 mm) (wt %)	Coarse Silt (62.5–15 μm) (wt %)	Fine Silt (15–2 μm) (wt %)	Clay (<2 μm) (wt %)	Organic Matter (wt %)	Median Particle Size Class	Median Particle Size (mm)
0121-97-1432	—[a]	21.8	19.2	14.9	15.2	11.5	8.9	16.3	7.2	6.3	1.9	fs[b]	0.240
CA21-98-0102	6.9	9.4	13.4	16.1	18.7	14.2	10.8	14.7	6.3	5.6	2.7	fs	0.229
CA21-98-0103	—	50.5	52.8	14.5	8.1	6	4.9	6.8	2	4.8	1.1	vcs[c]	1.037
CA21-98-0104	7.4	1.3	7.8	10.3	9.2	11	15.7	27.2	8.6	10.3	3.2	vfs[d]	0.075
CA21-98-0105	—	2.6	10.3	10.9	5.5	5.8	15.7	33.2	9	9.6	2.1	csi[e]	0.058
CA21-98-0106	—	1.7	0.9	1.7	3.2	9.2	22.5	41.8	14.8	5.6	2.6	csi	0.041
CA21-98-0107	—	11.6	16	25.1	19.4	10.8	7.7	9.1	6.5	5.4	1.5	ms[f]	0.364
CA21-98-0108	7	0.6	1.5	5.8	17.8	22.2	19.4	19.8	6.1	7.4	2.6	vfs	0.114
CA21-98-0109	—	2	4	11.1	16.4	14.4	13.6	21.1	9.3	9.9	3.1	vfs	0.101
CA21-98-0110	—	9.8	7.7	17.2	22.3	15.2	11	12.7	6	7.8	1.6	fs	0.220
CA21-98-0111	—	1.5	4.8	21.9	34.1	16.2	8.3	6.2	4	4.5	1.5	ms	0.311
CA21-98-0112	—	0.9	1.4	3.3	9.7	17.6	22.6	26.9	8.6	9.6	3	vfs	0.072
CA21-98-0113	—	2.5	4.9	8.2	13	16.5	18.2	22.2	7.8	9	3	vfs	0.094
CA21-98-0114	—	4.9	5.6	10.4	10.7	9.9	15	25.5	12	10.9	3.7	vfs	0.067
CA21-98-0115	—	4.7	3.9	8.5	14.5	15.1	15.2	24	10.1	8.5	3.4	vfs	0.087
CA21-98-0116	6.6	3.1	2.3	4.3	5.7	7.5	14.9	42.2	11.4	11.7	3.3	csi	0.037
CA21-98-0117	—	6.9	11.7	15.5	12.6	9.6	10.5	23.5	10.1	6.5	2.4	vfs	0.120
CA21-98-0118	—	43.1	61	24.4	5.5	1.4	1.5	2.7	0.8	2.7	0.8	vcs	1.133
CA21-98-0119	—	0.6	1.5	7	12.2	12.5	15.3	31	10.6	9.8	4.1	csi	0.058
CA21-98-0120	6.5	4.2	31.5	46	16.1	2.5	0.6	0.8	1.1	1.4	0.6	cs[g]	0.757
CA21-98-0154	7.5	13.5	32.4	35.4	11.9	2.9	2.2	4.1	4.1	7	0.7	cs	0.708

[a] A dash in the table means "not analyzed."

[b] fs = fine sand.

[c] vcs = very coarse sand.

[d] vfs = very fine sand.

[e] csi = coarse silt.

[f] ms = medium sand.

[g] cs = coarse sand.

Table B-2.0-4
Reach DP-4 Particle Size and Organic Matter

Sample ID	pH	Gravel (>2 mm) (wt %)	Very Coarse Sand (2–1 mm) (wt %)	Coarse Sand (1–0.5 mm) (wt %)	Medium Sand (0.5–0.25 mm) (wt %)	Fine Sand (0.25–0.125 mm) (wt %)	Very Fine Sand (0.125–0.0625 mm) (wt %)	Coarse Silt (62.5–15 μm) (wt %)	Fine Silt (15–2 μm) (wt %)	Clay (<2 μm) (wt %)	Organic Matter (wt %)	Median Particle Size Class	Median Particle Size (mm)
0121-97-1347	—[a]	3	3.6	5.3	11	19.3	23.2	26.1	5.8	5.4	2.3	vfs[b]	0.091
0121-97-1348	—	3.2	7	22.5	27.6	16.7	8.5	10	3.6	3.9	1.1	ms[c]	0.299
0121-97-1349	—	12.7	22.6	31.4	19.6	7.2	4.4	7.9	2.8	3.9	0.9	cs[d]	0.546
0121-97-1350	—	0.9	2.3	9.1	22.1	24.6	17.8	17	2.8	4.1	1.4	fs[e]	0.157
0121-97-1352	—	11.1	21.1	26.8	16.2	9.7	6.4	10.2	4.7	4.7	1.1	ms	0.457
0121-97-1353	—	6.2	21.1	3.5	9.2	16.6	19.7	32.1	9.1	7.3	2.9	vfs	0.127
0121-97-1354	—	0.7	2.5	13.2	31.4	22.9	12.9	11.1	2.8	3.2	0.9	fs	0.229
0121-97-1355	—	3.9	6.6	13.5	20.1	18.9	15.5	15.9	4.2	5.1	1.6	fs	0.175
CA21-98-0121	—	2.7	3.4	11.5	23.6	22.3	16.4	14.1	3.9	4.8	2.1	fs	0.175
CA21-98-0122	—	6.2	17.3	22.7	11.7	8.7	10.7	15.3	6.7	6.9	2	ms	0.276
CA21-98-0126	—	11.9	29.4	40	17.5	4.3	1.9	2	1.6	3.4	0.5	cs	0.700
CA21-98-0130	6.7	10.7	56.1	33.3	6.6	1.3	0.5	0.4	0.2	1.7	0.6	vcs[f]	1.078
CA21-98-0131	—	4.1	6.3	10.3	11.1	13.1	17	26.7	7.4	8.1	3.2	vfs	0.086
CA21-98-0133	—	30.5	44.4	23.6	6.8	2.6	2.3	5.6	6.2	8.4	1	cs	0.848
CA21-98-0149	—	1.1	0.7	4.4	18.6	34.4	20.3	10.4	3	8.2	2.6	fs	0.147
CA21-98-0150	—	1.4	1.1	3.2	11.4	24.1	22.3	23.7	5.8	7.3	2.9	vfs	0.091
CA21-98-0151	—	7.7	26.3	36.3	18.8	5.1	2.1	2.4	3.2	5.7	0.7	cs	0.636

[a] A dash in the table means "not analyzed."

[b] vfs = very fine sand.

[c] ms = medium sand.

[d] cs = coarse sand.

[e] fs = fine sand.

[f] vcs = very coarse sand.

Table B-2.0-5
Reach DP-1 Particle Size Summary

Geomorphic Unit	Sediment Facies	Summary Statistic	Gravel (>2 mm) (wt %)	Very Coarse Sand (2–1 mm) (wt %)	Coarse Sand (1–0.5 mm) (wt %)	Medium Sand (0.5–0.25 mm) (wt %)	Fine Sand (0.25–0.125 mm) (wt %)	Very Fine Sand (0.125–0.0625 mm) (wt %)	Coarse Silt (62.5–15 μm) (wt %)	Fine Silt (15–2 μm) (wt %)	Clay (<2 μm) (wt %)	Organic Matter (wt %)	Median Particle Size Class	Median Particle Size (mm)
DP-1 East														
c1	coarse	average	14.4	37.2	33.9	17.1	5.6	1.5	1.7	0.8	2.4	0.6	cs[a]	0.77
		number of samples	1	1	1	1	1	1	1	1	1	1	—[b]	—
c2	fine	average	4	8.3	15.1	21.7	16.7	10.4	13.4	5.8	8.4	2.1	fs[c]	0.204
		number of samples	1	1	1	1	1	1	1	1	1	1	—	—
c3	fine	average	1.63	2.93	7.00	15.73	18.90	16.87	20.93	7.17	10.23	2.87	vfs[d]	0.1
		standard deviation	1.46	1.31	3.40	6.47	1.32	4.31	5.23	0.45	2.84	0.32	—	—
		number of samples	3	3	3	3	3	3	3	3	3	3	—	—
	coarse	average	36.4	36.1	36	13.3	2.8	1.1	0.7	2.1	8.3	1.4	cs	0.765
		number of samples	1	1	1	1	1	1	1	1	1	1	—	—
f1	fine	average	1.65	3.15	4.60	6.60	9.25	15.50	37.95	11.15	11.35	3.55	csi[e]	0.041
		standard deviation	0.07	0.92	1.98	3.68	3.32	1.41	5.87	0.64	2.90	0.64	—	—
		number of samples	2	2	2	2	2	2	2	2	2	2	—	—
DP-1 Central														
c1	coarse	average	54.7	49	30.4	12.8	2.8	0.8	0.9	1.9	1.2	0.9	cs	0.977
		number of samples	1	1	1	1	1	1	1	1	1	1	—	—
c3	fine	average	18.5	6.55	10.85	20.85	18.5	12.6	13.55	7.1	9.45	3.2	fs	0.161
		standard deviation	23.19	5.44	1.63	2.05	3.25	0.71	1.20	0.57	0.35	0.00	—	—
		number of samples	2	2	2	2	2	2	2	2	2	2	—	—
	coarse	average	62.2	34.1	26.6	11.6	4.9	2.9	4.7	6.1	9	2.3	cs	0.661
		number of samples	1	1	1	1	1	1	1	1	1	1	—	—

Table B-2.0-5 (continued)

Geomorphic Unit	Sediment Facies	Summary Statistic	Gravel (>2 mm) (wt %)	Very Coarse Sand (2–1 mm) (wt %)	Coarse Sand (1–0.5 mm) (wt %)	Medium Sand (0.5–0.25 mm) (wt %)	Fine Sand (0.25–0.125 mm) (wt %)	Very Fine Sand (0.125–0.0625 mm) (wt %)	Coarse Silt (62.5–15 μm) (wt %)	Fine Silt (15–2 μm) (wt %)	Clay (<2 μm) (wt %)	Organic Matter (wt %)	Median Particle Size Class	Median Particle Size (mm)
DP-1 Central (continued)														
f1	fine	average	14.7	9.3	7.6	6.65	4.85	8.65	32.95	12.65	17.3	3.95	csi	0.036
		standard deviation	13.29	11.03	7.21	5.59	1.34	2.47	24.40	2.76	4.67	0.49	—	—
		number of samples	2	2	2	2	2	2	2	2	2	2	—	—
DP-1 West														
c1	coarse	average	25.6	38.2	37.9	17.8	2.9	0.6	0.4	0.45	1.55	1.1	cs	0.806
		standard deviation	14.57	10.61	3.82	4.81	1.13	0.28	0.28	0.07	0.21	0.14	—	—
		number of samples	2	2	2	2	2	2	2	2	2	2	—	—
c2	fine	average	33.5	12.9	16.9	19.6	12.3	7.6	11	9.8	9.8	4.5	fs	0.242
		number of samples	1	1	1	1	1	1	1	1	1	1	—	—
c3	fine	average	15.75	6.85	12.15	18.05	14.25	11.00	17.25	9.85	10.40	3.75	fs	0.133
		standard deviation	14.50	4.45	0.35	8.13	6.01	1.84	6.72	2.33	2.69	0.35	—	—
		number of samples	2	2	2	2	2	2	2	2	2	2	—	—
f1	fine	average	13.1	3.6	4.9	7.1	12.1	17.5	29.4	14.3	10.9	4.7	csi	0.05
		number of samples	1	1	1	1	1	1	1	1	1	1	—	—

[a] cs = coarse sand.

[b] A dash in the table means "not applicable."

[c] fs = fine sand.

[d] vfs = very fine sand.

[e] csi = coarse silt.

Table B-2.0-6
Reach DP-2 Particle Size Summary

Geomorphic Unit	Sediment Facies	Summary Statistic	Gravel (>2 mm) (wt %)	Very Coarse Sand (2–1 mm) (wt %)	Coarse Sand (1–0.5 mm) (wt %)	Medium Sand (0.5–0.25 mm) (wt %)	Fine Sand (0.25–0.125 mm) (wt %)	Very Fine Sand (0.125–0.0625 mm) (wt %)	Coarse Silt (62.5–15 μm) (wt %)	Fine Silt (15–2 μm) (wt %)	Clay (<2 μm) (wt %)	Organic Matter (wt %)	Median Particle Size Class	Median Particle Size (mm)
c1	coarse	average	2.9	49.7	33.4	10.9	2.1	0.5	1.9	0.4	2	0.4	cs[a]	0.994
		number of samples	1	1	1	1	1	1	1	1	1	1	—[b]	—
c2	fine	average	0.6	1.5	6.4	18.8	23.7	19.1	18.4	4.5	7.3	2.4	fs[c]	0.126
		number of samples	1	1	1	1	1	1	1	1	1	1	—	—
	coarse	average	16.7	22	25.4	16.5	9.8	6.9	9.8	4.4	5.2	1.3	ms[d]	0.448
		number of samples	1	1	1	1	1	1	1	1	1	1	—	—
c3a	fine	average	4.00	2.57	9.57	15.20	17.10	16.87	21.63	7.43	9.50	2.63	vfs[e]	0.099
		standard deviation	2.79	0.23	1.40	1.97	2.46	1.10	2.84	0.90	1.65	0.55	—	—
		number of samples	3	3	3	3	3	3	3	3	3	3	—	—
	coarse	average	31.5	37.5	26.1	16.6	6.9	2.7	2.9	2.4	4.8	1.3	cs	0.718
		number of samples	1	1	1	1	1	1	1	1	1	1	—	—
c3b	fine	average	5.25	5.42	10.07	15.45	15.62	14.92	22.07	7.18	9.15	2.05	vfs	0.107
		standard deviation	4.77	3.03	4.44	6.18	4.27	2.17	7.86	2.49	2.48	0.57	—	—
		number of samples	13	13	13	13	13	13	13	13	13	13	—	—
	coarse	average	28.63	28.18	29.38	18.13	7.80	3.30	4.45	3.08	5.65	0.65	cs	0.598
		standard deviation	18.04	5.54	6.32	7.00	3.12	1.19	3.00	1.11	0.87	0.10	—	—
		number of samples	4	4	4	4	4	4	4	4	4	4	—	—

Table B-2.0-6 (continued)

Geomorphic Unit	Sediment Facies	Summary Statistic	Gravel (>2 mm) (wt %)	Very Coarse Sand (2–1 mm) (wt %)	Coarse Sand (1–0.5 mm) (wt %)	Medium Sand (0.5–0.25 mm) (wt %)	Fine Sand (0.25–0.125 mm) (wt %)	Very Fine Sand (0.125–0.0625 mm) (wt %)	Coarse Silt (62.5–15 μm) (wt %)	Fine Silt (15–2 μm) (wt %)	Clay (<2 μm) (wt %)	Organic Matter (wt %)	Median Particle Size Class	Median Particle Size (mm)
f1	fine	average	7.27	6.76	7.41	7.64	10.02	14.71	31.73	11.48	10.12	3.31	csi[f]	0.053
		standard deviation	7.89	5.57	5.06	2.06	2.60	4.00	5.60	2.40	2.36	1.19	—	—
		number of samples	9	9	9	9	9	9	9	9	9	9	—	—
	coarse	average	3.35	12.75	1.90	10.75	10.85	14.75	20.35	4.60	6.75	1.3	fs	0.052
		standard deviation	0.49	17.32	36.50	6.15	8.41	15.91	18.31	2.26	3.04	0.99	—	—
		number of samples	2	2	2	2	2	2	2	2	2	2	—	—

[a] cs = coarse sand.

[b] A dash in the table means "not applicable."

[c] fs = fine sand.

[d] ms = medium sand.

[e] vfs = very fine sand.

[f] csi = coarse silt.

Table B-2.0-7
Reach DP-3 Particle Size Summary

Geomorphic Unit	Sediment Facies	Summary Statistic	Gravel (>2 mm) (wt %)	Very Coarse Sand (2–1 mm) (wt %)	Coarse Sand (1–0.5 mm) (wt %)	Medium Sand (0.5–0.25 mm) (wt %)	Fine Sand (0.25–0.125 mm) (wt %)	Very Fine Sand (0.125–0.0625 mm) (wt %)	Coarse Silt (62.5–15 μm) (wt %)	Fine Silt (15–2 μm) (wt %)	Clay (<2 μm) (wt %)	Organic Matter (wt %)	Median Particle Size Class	Median Particle Size (mm)
c1	coarse	average	4.2	31.5	46	16.1	2.5	0.6	0.8	1.1	1.4	0.6	cs[a]	0.757
		number of samples	1	1	1	1	1	1	1	1	1	1	—[b]	—
c3a	fine	average	9.4	13.4	16.1	18.7	14.2	10.8	14.7	6.3	5.6	2.7	fs[c]	0.229
		number of samples	1	1	1	1	1	1	1	1	1	1	—	—
	coarse	average	50.5	52.8	14.5	8.1	6	4.9	6.8	2	4.8	1.1	vcs[d]	1.037
		number of samples	1	1	1	1	1	1	1	1	1	1	—	—
c3b	fine	average	5.69	6.55	10.27	12.8	12.76	15.26	24.59	8.71	8.13	2.44	vfs[e]	0.088
		standard deviation	7.75	6.28	5.23	6.98	5.22	4.68	10.18	3	1.84	0.6	—	—
		number of samples	7	7	7	7	7	7	7	7	7	7	—	—
	coarse	average	12.55	24.2	30.25	15.65	6.85	4.995	6.6	5.3	6.2	1.1	cs	0.554
		standard deviation	1.34	11.6	7.28	5.3	5.59	3.89	3.54	1.7	1.13	0.57	—	—
		number of samples	2	2	2	2	2	2	2	2	2	2	—	—
f1	fine	average	3.5	4.94	10.3	14.33	13.2	14.96	24.36	9.14	8.67	2.9	vfs	0.089
		standard deviation	2.12	3.34	6.51	9.17	4.07	4.71	10.5	2.7	60.7	0.74	—	—
		number of samples	7	7	7	7	7	7	7	7	7	7	—	—
	coarse	average	43.1	61	24.4	5.5	1.4	1.5	2.7	0.8	2.7	0.8	vcs	1.133
		number of samples	1	1	1	1	1	1	1	1	1	1	—	—

Table B-2.0-7 (continued)

Geomorphic Unit	Sediment Facies	Summary Statistic	Gravel (>2 mm) (wt %)	Very Coarse Sand (2–1 mm) (wt %)	Coarse Sand (1–0.5 mm) (wt %)	Medium Sand (0.5–0.25 mm) (wt %)	Fine Sand (0.25–0.125 mm) (wt %)	Very Fine Sand (0.125–0.0625 mm) (wt %)	Coarse Silt (62.5–15 μm) (wt %)	Fine Silt (15–2 μm) (wt %)	Clay (<2 μm) (wt %)	Organic Matter (wt %)	Median Particle Size Class	Median Particle Size (mm)
f2	fine	average	0.6	1.5	7	12.2	12.5	15.3	31	10.6	9.8	4.1	csi[f]	0.058
		number of samples	1	1	1	1	1	1	1	1	1	1	—	—

[a] cs = coarse sand.
[b] A dash in the table means "not applicable."
[c] fs = fine sand.
[d] vcs = very coarse sand.
[e] vfs = very fine sand.
[f] csi = coarse silt.

Table B-2.0-8
Reach DP-4 Particle Size Summary

Geomorphic Unit	Sediment Facies	Summary Statistic	Gravel (>2 mm) (wt %)	Very Coarse Sand (2–1 mm) (wt %)	Coarse Sand (1–0.5 mm) (wt %)	Medium Sand (0.5–0.25 mm) (wt %)	Fine Sand (0.25–0.125 mm) (wt %)	Very Fine Sand (0.125–0.0625 mm) (wt %)	Coarse Silt (62.5–15 μm) (wt %)	Fine Silt (15–2 μm) (wt %)	Clay (<2 μm) (wt %)	Organic Matter (wt %)	Median Particle Size Class	Median Particle Size (mm)
c1	coarse	average	10.7	56.1	33.3	6.6	1.3	0.5	0.4	0.2	1.7	0.6	vcs[a]	1.078
		number of samples	1	1	1	1	1	1	1	1	1	1	—[b]	—
c2a	fine	average	0.9	2.3	9.1	22.1	24.6	17.8	17	2.8	4.1	1.4	fs[c]	0.157
		number of samples	1	1	1	1	1	1	1	1	1	1	—	—
c2b	fine	average	5.26	11.43	14.27	16.3	15.24	14.77	19.3	5.54	5.7	1.97	fs	0.174
		standard deviation	3.79	8.6	9.82	7.96	5.81	6.17	9.03	2.39	1.81	0.91	—	—
		number of samples	7	7	7	7	7	7	7	7	7	7	—	—
	coarse	average	12.88	25.64	29.84	17.38	7.68	4.24	6.04	3.86	5.22	0.88	cs[d]	0.568
		standard deviation	10.43	13.55	7.86	7.41	5.68	3.03	3.96	1.72	1.98	0.27	—	—
		number of samples	5	5	5	5	5	5	5	5	5	5	—	—
f1	fine	average	1.73	1.73	6.37	17.87	26.93	19.67	16.07	4.23	6.77	2.53	fs	0.135
		standard deviation	0.85	1.46	4.9	6.13	6.53	3	6.86	1.43	1.76	0.4	—	—
		number of samples	3	3	3	3	3	3	3	3	3	3	—	—

[a] vcs = very coarse sand.

[b] A dash in the table means "not applicable."

[c] fs = fine sand.

[d] cs = coarse sand.

Table B-3.2-1
Fixed-Point Gross Gamma Radiation Measurements in Reach DP-2

Location ID	DP2-1	DP2-2	DP2-3	DP2-4	DP2-5	DP2-6	DP2-7	DP2-8	DP2-9	DP2-10	DP2-11	DP2-12	DP2-13	DP2-14	DP2-17	DP2-18	DP2-19
	Geomorphic Unit																
Depth (cm)	c3b	Qt	c3a	c3a	c2a	f1	c3b	c3b	f1	c3b	c2	f1	f1	Qt	f1	c3b	c1
0	8062	6215	7091	7569	6961	6722	6679	6447	21522	27683	15701	15983	10682	7750	5912	9230	5389
10	8275	6427	6736	7837	7193	6139	6540	6169	21247	25686	16409	15273	9595	7107	5823	11555	
20	9121	6579	7160	8469	8112	6589	7401	6280	23567	30423	18710	15123	9652	7676	6401	16321	
30	10071	6642	7452	8469	8861	6887	7526	6664	24599	30634	19268	14328	9405	7324	6664	19562	
40	12263	6562	7689	8690	8862	6827	8283	7087	23021	27180	18772	12291	8789	7601	6807	26026	
50	14786	6959	7639	9173	8729	6838	9135	7206	20630	22936	17379	10473	9000	7669	6753	31422	
60	16855	6952	8532	9152	8701		11066	7172	16917	21546	15081	9002		7551	7111	33396	
70	21988	6772	8832	8487	8307		13521	7203	14706	20838		7675		8017	7178	26547	
80	31492		9835	8305	8039				12997			7656		7978	7300	22810	
90	46907		10179	8343	7677							7629		8081			
100	74037		10472									7821					
110	92578		11318														
120	108326																
130	94129																
140	76197																

Table B-3.2-2
Fixed-Point Gross Gamma Radiation Measurements in Reach DP-3

Part 1																
Location ID	DP3-1	DP3-2	DP3-3	DP3-4	DP3-5	DP3-6	DP3-7	DP3-8	DP3-9	DP3-10	DP3-11	DP3-12	DP3-13	DP3-14	DP3-15	DP3-16
	Geomorphic Unit															
Depth (cm)	c2	c3a	c3a	f1	c3a	f1	c3b	c3b	f1	c3b	c3b	c3b	f1	c3a	c3b	f1
0	8352	9118	10691	7241	8653	7997	14364	19718	18144	21096	16638	16864	10355	10575	12909	6955
10	8733	10194	12768	7260	9217	8100	22180	25968	19948	25387	15662	20290	10931	12484	16602	7401
20	9094	11219	13662	7918	10353	8267	29010	29471	24233	31506	19348	25787	12580	14684	20602	7590
30	9334	11929	13240	8608	11044	8647	35960	32340	24765	32381	21858	31884	13990	15971	26266	8527
40		12150		9178	11086	9097	39882	33173	21256	31463	23242	40191	16412	16427	32114	8681
50				9350	10922	9191	36493	32225	18217	30560	21999	43811	18065	16252	34234	9102
60				9948		9610	30506	31362	14291	26981	18973	42007	19607	16519		10159
70				10488		9852	21754	30573		22997	16621	38446	20421			10796
80						12095	17063	29118		20638	13663		20956			11773
90						12715	16294	21821		19500			21700			14022
100						14952	14501	16286		18296			18133			
110						16839	14490			15702			15422			
120						17664	14271			13806			14047			
130						18464	13150			12806			11853			
140						19009	12470			12571			10464			
150						18854				11588						

Table B-3.2-2 (continued)

Part 2																
Location ID	DP3-17	DP3-18	DP3-19	DP3-20	DP3-21	DP3-22	DP3-23	DP3-24	DP3-25	DP3-26	DP3-27	DP3-28	DP3-29	DP3-30	DP3-31	DP3-32
	Geomorphic Unit															
Depth (cm)	c3a	c3b	c3a	f1	c3b	c2	c2	f1	f1	c3a	f2	c2	f2	c2	c2	c1
0	8770	15171	6830	7096	15450	7430	7285	6610	6698	7961	6933	7181	6407	7499	7505	7734
10	9011	20609	6855	7561	21718	6911	7422	6386	6620	8727	6302	7229	6105	7440	6718	
20	9061	25960	6973	7910	25023	7061	7216	6481	7086	9077	6588	7303	6270	7803	6790	
30	10814	29833	7527	8254	28974	7123	7711	6928	7482	10206	6804	7441	6709	8192	7294	
40	11554	37313	7832		26220	7006	7461	9085		10322	6453	7574		8326	7494	
50	12749	41944	8585		20273	7096	7333			9710						
60	12858	37155	9572			7346	7202			9025						
70	12613	33805	10637				7146									
80			11787													
90			13300													
100			12917													
110			12381													
120			12839													
130																
140																
150																

Table B-3.2-3
Fixed-Point Gross Gamma Radiation Measurements in Reach DP-4

Location ID	DP4-1	DP4-2	DP4-3	DP4-4	DP4-5A	DP4-5B	DP4-6	DP4-7A	DP4-7B	DP4-8	DP4-9	DP4-10	DP4-11	DP4-12	DP4-13	DP4-14	DP4-15
	Geomorphic Unit																
Depth (cm)	f2	f1	f1	c2b	c2b	c2a	c2a	c2b	c2a	c2b	c2b	c2b	c2a	c2b	f1	c1	c2b
0	6980	13188	9704	13532	9520	10288	9760	10584	7229	23368	11244	19920	10780	29696	8270	8002	10777
10	7392	11176	9584	17344	12232	12200	11224	13284	7056	22428	11960	25716	11980	35740	8587		13131
20	7200	10420	10108	24316	14720	13560	11528	16964	7780	19972	12640	31748	12676	43640	9451		14141
30	7864	9568	9976	27756	18576	14872	10568	20248	8032	15592	12492	40916	12724	42484	10741		13390
40	7016	9656	10060	27444	21316	14948	10188	23272		12564	12672	15572	12380	37132	12445		12245
50	7476	8692	10000	23836	22440	14528	10044			10852	11988	43520	12532	30240	13386		10405
60	7264	8204	10228	20572			10164			10328	13032	40268	13088	25308	14192		10010
70	7136	7936									13700	39324	13100	19964	13753		8935
80	7396	7456									14292	35800	13276	17836	12958		8551
90	7500											43156	14008	21636	11690		
100												35552		15956			

Table B-4.0-1
Summary of Sediment Sampling Events in DP Canyon

Reach	Sampling Event	Sampling Date	Number of Samples Collected*	Primary Goals
DP-1	1	10/23/97	1	Full-suite analysis conducted at one sample site to assess the nature of contamination up canyon of PRS 21-011(k) and down-canyon of PRSs with hydrocarbon constituents as primary contaminants.
DP-1 (all subreaches)	2	11/17/98	17	Two full-suite samples analyzed in reach DP-1 west. Emphasis on determining nature and extent of organic (DROs, SVOCs, pesticides and PCBs) and inorganic contaminants. Goal was also to evaluate potential contributions from the townsite and PRSs located within DP-1.
DP-2	1	7/24/97	4	Full-suite analyses at most sites; determine contaminants present above background values and primary risk drivers; examine variations in contaminant concentrations within and between geomorphic units.
DP-2	2	10/23/97	6	Completion of full-suite analysis at phase 1 sites in reach DP-2 consisted of resampling for unanalyzed organics from 7/24/97 sampling event.
DP-2	3	11/18–20/98	32	Emphasis on analysis for americium-241, cesium-137, plutonium isotopes, and strontium-90; evaluate nature and extent and collocation of contaminants.
DP-3	1	10/23/97	1	Full-suite analysis conducted at one sample site to assess the nature of contamination down-canyon of PRS 21-011(k), evaluate whether contaminant signature was the same as reach DP-2.
DP-3	2	11/20/98	20	Emphasis on analysis for americium-241, cesium-137, plutonium isotopes, strontium-90 analyses; evaluate nature and extent and collocation of contaminants.
DP-4	1	8/21/97	9	Full-suite analysis conducted to assess the nature of contamination and primary risk drivers, and examine variations in contaminant concentrations within and between geomorphic units.
DP-4	2	11/23/98	19	Emphasis on analysis for americium-241, cesium-137, plutonium isotopes, and strontium-90 for nature and extent, and to evaluate collocation of contaminants.

* Number of samples does not include quality assurance duplicates.

Appendix C

Results of Quality Assurance/Quality Control Activities

C-1.0 QUALITY ASSURANCE/QUALITY CONTROL ACTIVITIES

This appendix consists of analytical results from DP Canyon investigations conducted during 1997 and 1998. The data are from sediment samples collected from DP Canyon as well as four quarters of groundwater data and two surface water sampling events. Samples were analyzed for gamma spectroscopy radionuclides, isotopic plutonium, isotopic uranium, tritium, stontium-90, inorganic chemicals (target analyte list [TAL] metals), semivolatile organic compounds (SVOCs), volatile organic compounds (VOCs), organochlorine pesticides, total petroleum hydrocarbons-diesel range organics (TPH-DROs), and polychlorinated biphenyls (PCBs). Analytical suites and methods are described in Sections C-2.0, C-3.0, and C-4.0.

Paragon Analytics, Inc., RECRA LabNet, Kemron Environmental Services, Environmental Science Engineering (ESE), ThermoNUtech, and QST Environmental, Inc., performed the analyses. Section C-5.0 of this appendix lists the laboratories that analyzed each sample delivery group. Quality assurance (QA), quality control (QC), and data validation procedures were implemented in accordance with the requirements of the QA plan requirements for sampling and analysis (LANL 1996, 54609), and the Los Alamos national Laboratory (LANL) Environmental Restoration (ER) Project analytical services statement of work (SOW) for contract laboratories (LANL 1995, 49738).

Results of the QA/QC activities were used to estimate the accuracy, bias, and precision of the analytical measurements. QC samples, including method blanks, blank spike samples, matrix spikes, matrix spike duplicates, and laboratory control samples, were used to assess accuracy and bias. Internal standards, external standards, surrogates, and tracers were also used to assess accuracy. Duplicate samples were used to determine precision. The type and frequency of QC analyses are described in the ER Project analytical services SOW (LANL 1995, 49738). Other QC factors such as sample preservation and holding times were also assessed. The requirements for sample preservation and holding times are given in the ER Project standard operating procedure (SOP) LANL-ER-SOP-1.02, Rev. 0, "Sample Container and Preservation."

Results for individual samples were qualified using the ER Project data validation process by assessing the QC parameters listed above. The ER Project data validation process adheres to the US Environmental Protection Agency (EPA) contract laboratory program national functional guidelines (NFG) for inorganic data review (EPA 1994, 48639) for data validation and incorporates LANL-specific reason codes for qualifying data. Data packages received from the analytical laboratory were reviewed with respect to the NFGs and LANL quality procedures for data validation. Data validation results, including sample IDs and their associated qualifiers, are discussed in Section C-5.0.

A focused data validation also was performed for the data packages, which are also referred to as request numbers (RN). The focused validation followed the same procedure discussed above and included a more detailed review of the raw data results generated by the analytical laboratory.

The data, including the qualified data, can be used for evaluation and interpretive purposes. The entire data set meets the standards set for use in this report, except those for selected gamma spectroscopy analytes discussed in Section C-3.1.

Collected Samples

Tables C-1.0-1, C-1.0-2, and C-1.0-3 list the sediment samples collected for analyses. The samples for the four quarters of groundwater sampling and the two surface water events are listed in Tables C-1.0-4, C-1.0-5, and C-1.0-6.

Table C-1.0-1
Summary of Sediment Samples for Inorganic Analysis

RN	TAL Metal
3468	4
3619	9
3853	4
4961	17
4977	3
4983	3
4997	5
5004	2
Total	47

Table C-1.0-2
Summary of Sediment Samples for Organic Analyses

RN	SVOC	TPH-DRO	Pesticide	VOC	PCB
3618	9	0	0	0	9
3852	6	0	0*	6	6
4960	19	19	4	0	6
4975	3	3	3	0	3
4981	3	4	3	0	3
4995	5	5	5	0	5
5002	10	10	10	0	10
Total	55	41	25	6	42

* Some pesticides were reported although only PCBs were requested.

Table C-1.0-3
Summary of Sediment Samples for Radionuclide Analysis

RN	Gamma Spectroscopy	Isotopic Plutonium	Isotopic Uranium	Tritium	Strontium-90
3469	4	4	4	4	4
3620	9	9	9	9	9
3854	4	4	4	2	4
4964	5	5	5	5	5
4980	8	8	0	0	8
4986	19	13	0	3	18
5000	19	9	2	0	10
5001	2	2	0	2	0
5007	13	13	0	1	13
Total	83	67	24	26	71

Table C-1.0-4
Summary of Surface and Groundwater Samples for Inorganic Analysis

RN	TAL Metal
3609	6
3616	4
3977	6
4253	4
4256	2
4641	2
4644	4
4937	4
Total inorganic water samples	32

Table C-1.0-5
Summary of Surface Water Samples for Organic Analysis

RN	SVOC	TPH-DRO	Pesticide	VOC	PCB
3608	6	6	0	3	6
3615	4	0	4	2	4
3800	0	0	0	2	0
3976	3	3	0	3	3
4252	2	0	2	2	2
4255	1	0	1	1	1
4640	0	0	0	1	0
4643	0	0	0	2	0
4827	1	0	1	0	1
4843	1	0	1	0	1
4926	3	2	4	2	4
Total	21	11	12	18	22

Table C-1.0-6
Summary of Surface and Groundwater Samples for Radionuclide Analysis

RN	Gamma Spectroscopy	Isotopic Plutonium	Isotopic Uranium	Tritium*	Strontium-90
3610	6	6	6	3	6
3978	6	6	6	3	6
4254	4	4	4	2	4
4257	2	2	2	1	2
4642	2	2	2	1	2
4645	4	4	4	2	4
Total	24	24	24	12	24

* Tritium analysis was performed only for the unfiltered samples.

The following sections summarize the analytical methods used for metals, radionuclides, and organic analytes. The contract required detection limit (CRDL) for each analyte listed is provided in Appendix D (Chapter 1). These limits are also detailed in the ER Project analytical services SOW (LANL 1995, 49738).

C-2.0 INORGANIC CHEMICAL ANALYSES

C-2.1 General

Forty-seven sediment samples and thirty-two water samples were analyzed by EPA SW-846 Method 6010A (inductively coupled plasma emission spectroscopy [ICPES]) for TAL metals, and Method 7471 (cold vapor atomic absorption [CVAA]) for mercury (see Table C-2.1-1) (EPA 1987, 57589). Paragon Analytics, Inc.; RECRA LabNet; Kemron Environmental Services; and QST Environmental, Inc., performed the analyses. Holding times were met for all inorganic chemical digestions and analyses.

Table C-2.1-1
Analytical Methods for Inorganic Chemical Analysis

Analytical Method*	Analytical Description	Analytical Suite
EPA SW-846 Method 6010B (3050A)	ICPES	Aluminum, antimony, arsenic, barium, beryllium, calcium, cadmium, cobalt, chromium, copper, iron, lead, magnesium, manganese, nickel, potassium, selenium, sodium, silver, thallium, vanadium, and zinc
EPA SW-846 Method 7471A (7471A)	CVAA	Mercury

* Sample preparation methods are in parentheses.

CRDLs defined by the ER Project analytical services SOW (LANL 1995, 49738) for inorganic chemicals are provided in Table D-1.0-1 in Appendix D of this document. The qualifiers for inorganic analytes are provided in Section C-5.2 of this document.

C-2.2 Inorganic Quality Assurance/Quality Control Samples

Laboratory control samples, method blanks, matrix spike samples, laboratory duplicate samples, interference check samples, and serial dilution samples were analyzed to assess accuracy and precision for inorganic chemical analyses. Each of these QA/QC sample types is defined in the ER Project analytical services SOW (LANL 1995, 49738) and described briefly below.

The laboratory control sample (LCS) served as a monitor of the overall performance of each step during the analysis, including sample digestion. Analytical results for the samples were qualified according to NFGs if the individual LCS recovery indicated an unacceptable bias in individual analyte measurements.

Preparation blanks were used to measure bias and potential cross contamination. Sample analytes that qualified as nondetected as a result of preparation blank contamination are summarized in Table C-5.0-2.

Accuracy for inorganic chemical analyses also was assessed using matrix spike samples. A matrix spike sample was designed to provide information about the effect of each sample matrix on the sample preparation procedures and analytical technique.

Analyzing laboratory duplicate samples assessed the precision of inorganic chemical analyses.

C-3.0 RADIOCHEMICAL ANALYSES

C-3.1 General

DP Canyon sediment samples were analyzed by the methods listed in Table C-3.1-1.

Table C-3.1-1
Analytical Methods for Radiochemical Analyses

Radionuclide	Analytical Technique
Gamma-emitting (includes americium-241, cesium-137, and cobalt-60)	Gamma spectroscopy
Isotopic plutonium	Radiochemical separation/alpha spectroscopy
Isotopic uranium	Radiochemical separation/alpha spectroscopy
Tritium	Liquid scintillation counting
Strontium	Radiochemical separation/air proportional beta analysis

The detection status for radiochemical analyses was determined by comparing the sample result with the minimum detectable activity (MDA) for all samples and analytes. The maximum allowable estimated quantitation limit (EQL) as defined in the ER Project analytical services SOW for radiochemicals are provided in Table D-1.0-2 in Appendix D of this report. Sample results were qualified as not detected when the result was less than the MDA. All RNs showed one or more samples qualified as not detected based on results that were less than the MDA. These samples and their associated analytes are summarized in Section C-5.3. Each radionuclide result was compared with its corresponding total propagated uncertainty (TPU) (1-sigma uncertainty). If the result was not greater than three times the TPU, the result was qualified as undetected (U).

Results for the gamma spectroscopy analyses were reviewed with respect to their uncertainty values and parent decay series. Based on LANL ER guidelines, only eight of the gamma spectroscopy analytes are routinely evaluated as part of the Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) data set. These analytes include amercium-241, cesium-134, cesium-137, cobalt-60, europium-152, ruthenium-106, sodium-22, and uranium-235.

Laboratory results indicated spectral interference for several gamma spectroscopy analytes. These values were rejected (R), as detailed in Table C-5.0-4.

C-3.2 Radiochemical Quality Assurance/Quality Control Samples

Precision and bias of radiochemical analyses performed at off-site fixed laboratories were assessed using matrix spike samples, laboratory control samples, method blanks, duplicates, and tracers.

The ER Project analytical services SOW (LANL 1995, 49738) specifies that spike-sample recoveries should be within ±25% of the certified value. All spike samples had acceptable recoveries.

LCSs were analyzed to assess accuracy for radionuclide analyses. The LCSs serve as monitors of the overall performance of each step during the analyses, including radiochemical separation preparation. The ER Project analytical services SOW (LANL 1995, 49738) specifies that LCS recoveries should be within ±25% of the certified value. Analytical results for individual LCSs were all within the ±25% recovery control limit, except those for strontium-90 in RN 3978 (Table C-5.0-4).

Method blanks are also used to assess bias. The ER Project analytical services SOW (LANL 1995, 49738) specifies that the method blank concentration should not exceed the required EQL. All method blanks met these criteria.

C-4.0 ORGANIC CHEMICAL ANALYSES

Samples were collected for SVOCs, TPH-DROs, organochlorine pesticides, and PCBs. The summaries for these analyses are presented below. All extraction and analysis procedures, QC procedures, and acceptance criteria were followed as required in the ER Project analytical services SOW (LANL 1995, 49738).

C-4.1 SVOC Analysis

Fifty-five sediment samples and twenty-one water samples were analyzed for SVOCs using EPA-SW-846 Method 3540 for extraction and Method 8270 B for analyses. The SVOC analyte list, including the corresponding required EQLs, are provided in Appendix D of this report. Methods are listed in Table C-4.1-1. All holding times for extraction and analyses were met for the SVOC analyses.

Table C-4.1-1
Analytical Methods for Organic Analyses

Analytical Method*	Analytical Description	TAL
EPA SW-846 Method 8270 (3540)	SVOCs	ER Project analytical services SOW (LANL 1995, 49738).
EPA SW-846 Method 8081 (3540)	Organochlorine pesticides	ER Project analytical services SOW (LANL 1995, 49738).
EPA SW-846 Method 8082 (3540)	PCBs	ER Project analytical services SOW (LANL 1995, 49738).
EPA SW-846 Guidance 8000	TPH-DROs	Boiling point fraction DROs

* Sample preparation methods are in parentheses.

C-4.2 Organochlorine Pesticides and PCB Chemical Analysis

Twenty-five sediment samples and twelve water samples were analyzed for pesticides. Forty-two sediment samples and twenty-two water samples were analyzed for PCBs. Sample extraction was performed using EPA SW-846 Method 3540. Sample analysis for pesticides was performed using EPA SW-846 Method 8081 and for PCBs using EPA Method 8082. All holding times for extraction and analyses were met for these analyses.

C-4.3 Total Petroleum Hydrocarbons-Diesel Range Organics

Forty-one sediment samples and eleven water samples were analyzed for TPH-DROs using EPA SW-846 Guidance 8000. All holding times for extraction and analyses were met for the TPH/DRO analyses.

C-4.4 Volatile Organic Compounds

Six sediment samples and eighteen water samples were analyzed for VOCs using EPA Method 8260. The VOC analyte list, including the corresponding required EQLs, is provided in Appendix D. All holding times were met for the VOC analyses.

C-5.0 DATA VALIDATION

The following tables present the data qualifiers applied to each analyte for a given sample. Data qualifiers are defined in Table C-5.0-1. Individual sample qualifiers for DP Canyon data are presented in Table C-5.0-2 (inorganic data quality), Table C-5.0-3 (organic data quality), and Table C-5.0-4 (radionuclide data quality). In RN 3852, some sediment samples analyzed for SVOCs were analyzed twice. The first analysis had internal standard recoveries that were outside acceptance criteria. Therefore, these samples were reanalyzed to demonstrate that the internal standard recoveries were a result of matrix effects. Some target analytes were detected at low concentrations in the first analysis but not in the reevaluation. Other analytes were detected in the reevaluation but not the initial analysis. All results from the initial and the reevaluation have been qualified in Table C-5.0-3. For the RFI data set, the maximum value between the initial analysis and the reevaluation is reported.

Table C-5.0-1
Data Qualifiers for Data Validation Procedure

Qualifier	Explanation
U	Analyte was analyzed for but not detected. Reported value is the sample-specific estimated quantitation limit or detection limit. For radionuclide analyses, the reported value is the best estimate of the analyte concentration, even when that estimate is less than the detection limit. For statistical reasons, the estimates sometimes may be negative values.
J	Reported value should be regarded as estimated.
J+	Reported value should be regarded as estimated and biased high.
J-	Reported value should be regarded as estimated and biased low.
UJ	Analyte was analyzed for but not detected. Reported value is an estimate of the sample-specific quantitation limit or detection limit.
UJ+	Analyte was analyzed for but not detected. Reported value is an estimate of the sample-specific quantitation limit or reporting limit with a high bias.
UJ-	Analyte was analyzed for but not detected. Reported value is an estimate of the sample-specific quantitation limit or reporting limit with a low bias.
R	Sample results were rejected because of serious deficiencies in the ability to analyze the sample and meet QC criteria; presence or absence cannot be verified.

Table C-5.0-2
Inorganic Data Quality Evaluation for DP Canyon Data

RN	Location ID	Sample ID	Analyte	Explanation
3609	21-1811	0121-97-1396 0121-97-1398 0121-97-1400 0121-97-1401	Aluminum, lead	Results should be regarded as estimated and biased low (J-) because matrix spike recoveries for these analytes were low.
3609	21-1811	0121-97-1397	Lead	Result should be regarded as estimated and biased low (J-) because the matrix spike recovery for this analyte was low.
3609	21-1811	0121-97-1397 0121-97-1399	Aluminum	Reporting limits should be regarded as estimated and biased low (UJ-) because the matrix spike recovery for this analyte was low.
3616	21-5471	0121-97-1381 0121-97-1382 0121-97-1383 0121-97-1384	Aluminum	Results should be regarded as estimated and biased high (J+) because the matrix spike recovery for this analyte was high.
3616	21-5471	0121-97-1381 0121-97-1382	Barium, chromium, cobalt, copper, magnesium, nickel, potassium, thallium, vanadium	Results should be regarded as estimated (J), because these analytes were reported below the method detection limit (MDL) but above the instrument detection limit (IDL).
3616	21-5472	0121-97-1383	Arsenic, barium, beryllium, chromium, cobalt, magnesium, nickel, potassium, thallium, vanadium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
3616	21-5472	0121-97-1384	Barium, beryllium, cobalt, magnesium, nickel, potassium, thallium, vanadium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
3619	21-5486 21-5488 21-5486 21-5487 21-5487 21-5489 21-5490 21-5491 21-5491	0121-97-1347 0121-97-1348 0121-97-1349 0121-97-1350 0121-97-1351 0121-97-1352 0121-97-1353 0121-97-1354 0121-97-1355	Antimony	Reporting limit should be regarded as estimated and biased low (UJ-) because the matrix spike recovery for this analyte was low.
3619	21-5486	0121-97-1347	Arsenic, beryllium, cobalt, magnesium, nickel, potassium, sodium, vanadium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
3619	21-5488	0121-97-1348	Arsenic, barium, beryllium, calcium, cobalt, magnesium, mercury, nickel, potassium, sodium, vanadium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
3619	21-5486 21-5487 21-5487 21-5489	0121-97-1349 0121-97-1350 0121-97-1351 0121-97-1352	Arsenic, barium, beryllium, calcium, cobalt, magnesium, nickel, potassium, sodium, vanadium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
3619	21-5490	0121-97-1353	Beryllium, cobalt, magnesium, mercury, nickel, potassium, sodium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
3619	21-5491	0121-97-1354	Arsenic, barium, beryllium, cobalt, magnesium, mercury, nickel, potassium, sodium, vanadium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.

Table C-5.0-2 (continued)

RN	Location ID	Sample ID	Analyte	Explanation
3619	21-5491	0121-97-1355	Arsenic, beryllium, cobalt, magnesium, mercury, nickel, potassium, sodium, vanadium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
3853	21-5496 21-5497	0121-97-1431 0121-97-1432	Cadmium, cobalt, magnesium, nickel, potassium, silver, sodium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
3853	21-5502	0121-97-1441	Beryllium, cobalt, copper, magnesium, nickel, potassium, sodium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
3853	21-5502	0121-97-1442	Beryllium, cobalt, magnesium, nickel, potassium, sodium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
3977	21-1811 21-1812 21-1811 21-1811 21-1812 21-1811	0121-97-1424 0121-97-1425 0121-97-1426 0121-97-1428 0121-97-1429 0121-97-1430	Magnesium	Results should be regarded as nondetected (U) because this analyte was detected at a higher concentration in the preparation blank than in the samples.
4253	21-1811 21-1811 21-1812 21-1812	CA21-98-0001 CA21-98-0002 CA21-98-0003 CA21-98-0004	Selenium	Reporting limit should be regarded as estimated and biased low (UJ-) because the matrix spike recovery for this analyte was low.
4253	21-1811	CA21-98-0001	Zinc	Result should be regarded as nondetected (U) because this analyte was detected in the preparation blank.
4256	21-1854	CA21-98-0005	Zinc	Result should be regarded as nondetected (U) because this analyte was detected in the preparation blank.
4641	21-01854	CA21-98-0011	Barium, boron, copper, magnesium, molybdenum, nickel, thallium, vanadium, zinc	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
4641	21-01854	CA21-98-0012	Aluminum, barium, boron, copper, magnesium, manganese, molybdenum, nickel, vanadium, zinc	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
4644	21-01811	CA21-98-0007	Aluminum, barium, boron, copper, lithium, magnesium, nickel, thallium, vanadium, zinc	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
4644	21-01811	CA21-98-0008	Aluminum, barium, boron, copper, iron, lithium, magnesium, molybdenum, nickel, thallium, vanadium, zinc	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
4644	21-01812	CA21-98-0009	Aluminum, arsenic, barium, boron, cobalt, copper, lithium, magnesium, thallium, vanadium, zinc	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
4644	21-01812	CA21-98-0010	Aluminum, arsenic, barium, boron, cobalt, copper, magnesium, nickel, thallium, vanadium, zinc	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
4927	21-10816	CA21-98-0013	Antimony, arsenic, barium, chromium, cobalt, copper, magnesium, mercury, nickel, potassium, selenium, thallium, vanadium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.

Table C-5.0-2 (continued)

RN	Location ID	Sample ID	Analyte	Explanation
4927	21-10816	CA21-98-0014	Aluminum, arsenic, barium, boron, calcium, chromium, copper, iron, magnesium, nickel, potassium, sodium, thallium, vanadium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
4927	21-10817	CA21-98-0015	Arsenic, barium, beryllium, cadmium, cobalt, magnesium, mercury, nickel, potassium, sodium, vanadium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
4927	21-10817	CA21-98-0016	Aluminum, barium, boron, chromium, copper, lithium, magnesium, manganese, nickel, potassium, sodium, vanadium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
4961	21-10929 21-10930 21-10931 21-10932 21-10933 21-10934 21-10935 21-10936 21-10936 21-10938 21-10939 21-10940 21-10941 21-10942 21-10942 21-10942 21-10944	CA21-98-0051 CA21-98-0052 CA21-98-0053 CA21-98-0054 CA21-98-0055 CA21-98-0056 CA21-98-0057 CA21-98-0058 CA21-98-0059 CA21-98-0061 CA21-98-0062 CA21-98-0063 CA21-98-0064 CA21-98-0065 CA21-98-0066 CA21-98-0069 CA21-98-0068	Antimony, lead	1. Reporting limits should be regarded as estimated and biased low (UJ-) because the matrix spike recovery was low. 2. Results should be regarded as estimated and biased high (J+) because the matrix spike recovery was high.
4961	21-10929	CA21-98-0051	Beryllium, cadmium, cobalt, mercury, nickel, potassium, sodium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
4961	21-10930	CA21-98-0052	Arsenic, barium, beryllium, cobalt, magnesium, nickel, potassium, sodium, vanadium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
4961	21-10931	CA21-98-0053	Arsenic, beryllium, cadmium, cobalt, magnesium, mercury, nickel, potassium, and sodium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
4961	21-10932	CA21-98-0054	Arsenic, beryllium, cadmium, cobalt, magnesium, mercury, nickel, potassium, selenium, sodium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
4961	21-10933	CA21-98-0055	Beryllium, cadmium, cobalt, mercury, nickel, selenium, sodium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
4961	21-10934	CA21-98-0056	Arsenic, barium, beryllium, cadmium, cobalt, magnesium, nickel, potassium, sodium, vanadium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
4961	21-10935	CA21-98-0057	Beryllium, cadmium, cobalt, magnesium, mercury, nickel, potassium, selenium, sodium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
4961	21-10936	CA21-98-0058	Beryllium, cadmium, cobalt, magnesium, nickel, potassium, sodium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.

Table C-5.0-2 (continued)

RN	Location ID	Sample ID	Analyte	Explanation
4961	21-10936	CA21-98-0059	Beryllium, cadmium, cobalt, magnesium, potassium, sodium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
4961	21-10938	CA21-98-0061	Arsenic, barium, beryllium, cadmium, cobalt, magnesium, nickel, potassium, sodium, vanadium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
4961	21-10939	CA21-98-0062	Arsenic, beryllium, cadmium, cobalt magnesium, mercury, nickel, potassium, silver, sodium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
4961	21-10940	CA21-98-0063	Arsenic, beryllium, cadmium, cobalt, magnesium, mercury, nickel, potassium, sodium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
4961	21-10941 21-10942	CA21-98-0064 CA21-98-0065	Beryllium, cadmium, cobalt, magnesium, mercury, nickel, potassium, sodium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
4961	21-10942 21-10944	CA21-98-0066 CA21-98-0068	Arsenic, barium, beryllium, cadmium, calcium, cobalt, copper, magnesium, mercury, nickel, potassium, sodium, vanadium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
4961	21-10942	CA21-98-0069	Beryllium, cadmium, cobalt, magnesium, mercury, nickel, potassium, selenium, sodium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
4977	21-05501 21-10950 21-10950	CA21-98-0073 CA21-98-0074 CA21-98-0076	Antimony	Reporting limits should be regarded as estimated and biased low (UJ-) because the matrix spike recovery for this analyte was low.
4977	21-05501	CA21-98-0073	Arsenic, barium, beryllium, cadmium, calcium, cobalt, magnesium, mercury, nickel, potassium, silver, sodium, vanadium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
4977	21-10950	CA21-98-0074	Arsenic, beryllium, cadmium, cobalt, magnesium, mercury, nickel, potassium, sodium, vanadium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
4977	21-10950	CA21-98-0076	Arsenic, barium, beryllium, calcium, cobalt, copper, magnesium, nickel, potassium, sodium, vanadium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
4983	21-05500	CA21-98-0082	Antimony, beryllium, cadmium, cobalt, magnesium, mercury, nickel, sodium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
4983	21-05502	CA21-98-0096	Antimony	Reporting limit should be regarded as estimated and biased low (UJ-) because the matrix spike recovery for this analyte was low.
4983	21-05502	CA21-98-0096	Arsenic, barium, beryllium, cobalt, copper, magnesium, mercury, nickel, potassium, sodium, vanadium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
4983	21-10960	CA21-98-0101	Antimony, arsenic, barium, beryllium, calcium, chromium, cobalt, copper, magnesium, nickel, potassium, sodium, vanadium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
4997	21-10961 21-10962 21-10963 21-10965 21-10967	CA21-98-0102 CA21-98-0104 CA21-98-0108 CA21-98-0116 CA21-98-0120	Antimony	Reporting limits should be regarded as estimated and biased low (UJ-) because the matrix spike recovery for this analyte was low.

Table C-5.0-2 (continued)

RN	Location ID	Sample ID	Analyte	Explanation
4997	21-10961	CA21-98-0102	Arsenic, beryllium, cadmium, cobalt, copper, magnesium, nickel, potassium, sodium, vanadium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
4997	21-10962	CA21-98-0104	Arsenic, beryllium, cadmium, cobalt, magnesium, mercury, nickel, sodium, vanadium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
4997	21-10963	CA21-98-0108	Arsenic, beryllium, cobalt, copper, magnesium, nickel, potassium, selenium, sodium, vanadium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
4997	21-10965	CA21-98-0116	Beryllium, cobalt, copper, magnesium, nickel, sodium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
4997	21-10967	CA21-98-0120	Arsenic, barium, beryllium, calcium, chromium, cobalt, copper, magnesium, nickel, potassium, sodium, vanadium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
5004	21-10969 21-05497	CA21-98-0130 CA21-98-0154	Antimony	Reporting limits should be regarded as estimated and biased low (UJ-) because the matrix spike recovery for this analyte was low.
5004	21-10969	CA21-98-0130	Barium, beryllium, calcium, chromium, cobalt, copper, magnesium, nickel, potassium, sodium, vanadium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.
5004	21-05497	CA21-98-0154	Barium, beryllium, calcium, chromium, cobalt, copper, magnesium, nickel, potassium, silver, sodium, vanadium	Results should be regarded as estimated (J), because these analytes were reported below the MDL but above the IDL.

Table C-5.0-3
Organic Data Quality Evaluation for DP Canyon Data

RN	Location ID	Sample ID	Analytical Suite	Analyte	Explanation
3608	21-1811	0121-97-1396	VOCs	Acetone	The result should be regarded as nondetected (U) because result was less than 10 times the concentration in the blank. This indicates the detected result was indistinguishable from blank contamination.
3615	21-5471	0121-97-1381	SVOCs	Benzo(b)fluoranthene, bis(2-ethylhexyl)phthalate, di-n-octylphthalate, fluoranthene, pyrene	Results should be regarded as estimated (J) because internal standard recovery associated with these compounds was low.
3615	21-5471	0121-97-1381 0121-97-1382	Pesticides/ PCBs	All nondetected analytes	Reporting limits should be regarded as estimated and biased low (UJ-) because the associated surrogate recovery was low.
3615	21-5471	0121-97-1381 0121-97-1382 0121-97-1383 0121-97-1384	SVOCs	All nondetected analytes	Reporting limits should be regarded as estimated (UJ) because internal standard recoveries associated with these compounds were low.
3615	21-5471	0121-97-1382	SVOCs	Benzo(b)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, di-n-octylphthalate, fluoranthene, phenanthrene, pyrene	Results should be regarded as estimated (J) because internal standard recoveries associated with these compounds were low.
3615	21-5471	0121-97-1382 0121-97-1384	VOCs	2-Butanone	Result should be regarded as estimated (J) because result was less than the EQL, but above the method detection limit (MDL).
3615	21-5471	0121-97-1382 0121-97-1384	VOCs	Acetone	Results should be regarded as nondetected (U) because results were less than 10 times the concentration of the analyte detected in the blank. This indicates the detected result was indistinguishable from blank contamination.
3615	21-5471	0121-97-1382 0121-97-1384	VOCs	Methylene chloride	Results should be regarded as nondetected (U) because results were less than the EQL, and the results were less than 10 times the concentration of the analyte detected in the blank. This indicates the detected result was indistinguishable from blank contamination.
3615	21-5472	0121-97-1383	SVOCs	Benzo(b)fluoranthene, bis(2-ethylhexyl)phthalate, di-n-octylphthalate, pyrene	Results for these analytes should be regarded as estimated (J) because internal standard recoveries associated with these compounds were low.

Table C-5.0-3 (continued)

RN	Location ID	Sample ID	Analytical Suite	Analyte	Explanation
3618	21-5486 21-5488 21-5486 21-5487 21-5487 21-5489 21-5490 21-5491 21-5491	0121-97-1347 0121-97-1348 0121-97-1349 0121-97-1350 0121-97-1351 0121-97-1352 0121-97-1353 0121-97-1354 0121-97-1355	SVOCs	All target analytes	Sample extracts could not be concentrated to a final volume of 1 mL. Extracts were concentrated to a final volume of 10 mL. Reporting limits are therefore elevated 10 times.
3800	21-1854	0121-97-1422	VOCs	Bromomethane	Result for this analyte should be regarded as estimated (J) because the result was less than EQL, but above MDL.
3852	21-5496	0121-97-1431	SVOCs	Benzo(a)pyrene, bis(2-ethylhexyl)phthalate, benz(a)anthracene, chrysene, pyrene,	Results f should be regarded as estimated (J) because internal standard recovery associated with these compounds was low.
3852	21-5496	0121-97-1431	SVOCs	Benzo(a)pyrene, benzo(g,h,i)perylene, benzo(b)fluoranthene, butylbenzylphthalate, benzo(k)fluoranthene, 3,3'-dichlorobenzidine, di-n-octylphthalate, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene	Reporting limits should be regarded as estimated (UJ) because internal standards associated with these compounds were low.
3852	21-5497	0121-97-1432	SVOCs	Benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, di-n-octylphthalate, dibenz(a,h)anthracene, 3,3'-dichlorobenzidine, indeno(1,2,3-cd)pyrene	Reporting limits should be regarded as estimated (UJ) because internal standards associated with these compounds were low.
3852	21-5497	0121-97-1432	SVOCs	Bis(2-ethylhexyl)phthalate, butylbenzylphthalate, pyrene	Results should be regarded as estimated (J) because internal standard recovery associated with these compounds was low.
3852	21-5497 21-5499 21-5500 21-5501	0121-97-1432 0121-97-1434 0121-97-1435 0121-97-1440	VOCs	Methylene chloride	Results should be regarded as nondetected (U) because results were less than the EQL, and results were less than 10 times the concentration of the analyte detected in the blank. This indicates the detected result was indistinguishable from blank contamination.
3852	21-5498	0121-97-1433	SVOCs	Benzo(g,h,i)perylene, Butylbenzylphthalate, di-n-octylphthalate, dibenz(a,h)anthracene, 3,3'-dichlorobenzidine, indeno(1,2,3-cd)pyrene	Reporting limits for these analytes should be regarded as estimated (UJ) because the internal standards associated with these compounds were low.

Table C-5.0-3 (continued)

RN	Location ID	Sample ID	Analytical Suite	Analyte	Explanation
3852	21-5498	0121-97-1433	SVOCs	Benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, butylbenzylphthalate, chrysene, indeno(1,2,3-cd)pyrene, pyrene	Results should be regarded as estimated (J) because internal standard recovery associated with these compounds was low.
3852	21-5500	0121-97-1435	SVOCs	Benzo(b)fluoranthene, benzo(g,h,i)perylene benzo(k)fluoranthene, butylbenzylphthalate, 3,3'-dichlorobenzidine, di-n-octylphthalate, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene	Reporting limits should be regarded as estimated (UJ) because internal standards associated with these compounds were low.
3852	21-5500	0121-97-1435	SVOCs	Benz(a)anthracene, benzo(a)pyrene, benzo(g,h,i)perylene, bis(2-ethylhexyl)phthalate, chrysene, 3,3'-dichlorobenzidine, pyrene	Results should be regarded as estimated (J) because internal standard recovery associated with these compounds was low.
3852	21-5500	0121-97-1435	SVOCs	Acetone	The result should be regarded as estimated (J), because result was less than EQL but above MDL.
3852	21-5501	0121-97-1440	SVOCs	Benzo(g,h,i)perylene, dibenz(a,h)anthracene, 3,3'-dichlorobenzidine, di-n-octylphthalate	Reporting limits should be regarded as estimated (UJ) because internal standards associated with these compounds were low.
3852	21-5501	0121-97-1440	SVOCs	Benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, butylbenzylphthalate, chrysene, indeno(1,2,3-cd)pyrene, pyrene	Results should be regarded as estimated (J) because internal standard recovery associated with these compounds was low.
3852	21-5501	0121-97-1440	VOCs	All nondetected target analytes	Reporting limits should be regarded as estimated and biased low (UJ-) because surrogate recoveries associated with these analytes were low.
3852	21-5501	0121-97-1440	VOCs	Toluene	Result should be regarded as estimated and biased low (J-) because surrogate recovery associated with this analyte was low.
3976	21-1812 21-1811	0121-97-1425 0121-97-1426	SVOCs	All nondetected analytes	Reporting limits should be regarded as estimated and biased low (UJ-) because the associated surrogate recovery was low.
4252	21-1811	CA21-98-0001 CA21-98-0003	Pesticides/ PCBs	All nondetected analytes	Reporting limits should be regarded as estimated and biased low (UJ-) because associated surrogate recovery was low.
4640	21-01854	CA21-98-0011	SVOCs	All target analytes	The 14-day extraction holding time was missed; location was resampled and samples were reanalyzed.

Table C-5.0-3 (continued)

RN	Location ID	Sample ID	Analytical Suite	Analyte	Explanation
4640	21-01854	CA21-98-0011	Pesticides/ PCBs	All target analytes	The 14-day extraction holding time was missed; location was resampled and samples were reanalyzed.
4643	21-01811 21-01812	CA21-98-0007 CA21-98-0009	SVOCs	All target analytes	The 14-day extraction holding times were missed; locations were resampled and samples were reanalyzed.
4643	21-01811 21-01812	CA21-98-0007 CA21-98-0009	Pesticides/ PCBs	All target analytes	The 14-day extraction holding times were missed; locations were resampled and samples were reanalyzed.
4827	21-01854	CA21-98-0043	Pesticides/ PCBs	All nondetected analytes	Reporting limits should be regarded as estimated and biased low (UJ-) because associated surrogate recovery was low.
4926	21-10816	CA21-98-0013	SVOCs	Bis(2-ethylhexyl)phthalate, di-n-butylphthalate	Results for these analytes should be regarded as estimated (J) because results were less than EQL but above the MDL.
4926	21-10816	CA21-98-0013	VOCs	2-Butanone, 4-methyl-2-pentanone	Results should be regarded as nondetected (U) because results were less than EQL, and less than 10 times the concentration of the analyte in the blank. This indicates the detected result was indistinguishable from blank contamination.
4926	21-10816	CA21-98-0013 CA21-98-0014 CA21-98-0015 CA21-98-0016	Pesticides/ PCBs	All nondetected analytes	Reporting limits should be regarded as estimated and biased low (UJ-) because associated surrogate recovery was low.
4926	21-10816	CA21-98-0014	SVOCs	Benzoic acid	The result should be regarded as estimated (J) because result was less than EQL but above the MDL.
4926	21-10817	CA21-98-0015	SVOCs	Bis(2-ethylhexyl)phthalate	The result should be regarded as estimated (J) because result was less than EQL but above the MDL.

Table C-5.0-3 (continued)

RN	Location ID	Sample ID	Analytical Suite	Analyte	Explanation
4960	21-10929 21-10930 21-10931 21-10932 21-10933 21-10934 21-10935 21-10936 21-10936 21-10937 21-10938 21-10939 21-10940 21-10941 21-10942 21-10942 21-10942 21-10943 21-10944	CA21-98-0051 CA21-98-0052 CA21-98-0053 CA21-98-0054 CA21-98-0055 CA21-98-0056 CA21-98-0057 CA21-98-0058 CA21-98-0059 CA21-98-0060 CA21-98-0061 CA21-98-0062 CA21-98-0063 CA21-98-0064 CA21-98-0065 CA21-98-0066 CA21-98-0069 CA21-98-0067 CA21-98-0068	SVOCs	All nondetected target analytes.	Reporting limits should be regarded as estimated (UJ) because internal standard recoveries associated with these compounds were low.
4960	21-10929 21-10934	CA21-98-0051 CA21-98-0056	SVOCs	Benz(a)anthracene, benzo(b)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, fluoranthene, phenanthrene, pyrene	Results should be regarded as estimated (J) because internal standard recoveries associated with these compounds were low.
4960	21-10929 21-10930 21-10931 21-10932 21-10933 21-10934 21-10936 21-10936 21-10938 21-10939 21-10940 21-10941 21-10942 21-10942 21-10942	CA21-98-0051 CA21-98-0052 CA21-98-0053 CA21-98-0054 CA21-98-0055 CA21-98-0056 CA21-98-0058 CA21-98-0059 CA21-98-0061 CA21-98-0062 CA21-98-0063 CA21-98-0064 CA21-98-0065 CA21-98-0066 CA21-98-0069	SVOCs	All target analytes	The sample extracts could not be concentrated to final volume of 1 mL. Extracts were concentrated to a final volume of 10 mL. Reporting limits therefore are elevated 10 times.
4960	21-10929 21-10930 21-10931 21-10932 21-10933 21-10934 21-10936 21-10936 21-10938 21-10939 21-10940 21-10942 21-10942 21-10942	CA21-98-0051 CA21-98-0052 CA21-98-0053 CA21-98-0054 CA21-98-0055 CA21-98-0056 CA21-98-0058 CA21-98-0059 CA21-98-0061 CA21-98-0062 CA21-98-0063 CA21-98-0065 CA21-98-0066 CA21-98-0069	TPH-DROs	DRO compounds	Samples were diluted due to matrix interference; reporting limits therefore are elevated.
4960	21-10930	CA21-98-0052	SVOCs	Benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene	Results should be regarded as estimated (J) because internal standard recoveries associated with these compounds were low.

Table C-5.0-3 (continued)

RN	Location ID	Sample ID	Analytical Suite	Analyte	Explanation
4960	21-10931	CA21-98-0053	Pesticides	α-Chlordane	The result should be regarded as estimated (J) because result was less than EQL but above MDL.
4960	21-10931 21-10932 21-10942	CA21-98-0053 CA21-98-0054 CA21-98-0069	Pesticides/ PCBs	All target analytes and congeners	Samples were diluted due to matrix interference; reporting limits therefore are elevated.
4960	21-10931	CA21-98-0053	SVOCs	Anthracene, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, fluoranthene, naphthalene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene	Results should be regarded as estimated (J) because internal standard recoveries associated with these compounds were low.
4960	21-10932	CA21-98-0054	SVOCs	Anthracene, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, butylbenzylphthalate, carbazole, chrysene, dibenz(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene	Results should be regarded as estimated (J) because internal standard recoveries associated with these compounds were low.
4960	21-10933	CA21-98-0055	SVOCs	Benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, phenanthrene, pyrene	Results for these analytes should be regarded as estimated (J) because internal standard recoveries associated with these compounds were low.
4960	21-10935	CA21-98-0057	SVOCs	Benz(a)anthracene, bis(2-ethylhexyl)phthalate, chrysene, fluoranthene, 2-methylnaphthalene, phenanthrene, pyrene	Results for these analytes should be regarded as estimated (J) because the internal standard recoveries associated with these compounds were low.
4960	21-10936	CA21-98-0058	SVOCs	Acenaphthene, anthracene, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, butylbenzylphthalate, chrysene, fluoranthene, naphthalene, phenanthrene, pyrene	Results for these analytes should be regarded as estimated (J) because internal standard recoveries associated with these compounds were low.
4960	21-10936	CA21-98-0059	SVOCs	Phenanthrene, pyrene	Results should be regarded as estimated (J) because internal standard recoveries associated with these compounds were low.
4960	21-10936 21-10942 21-10942	CA21-98-0059 CA21-98-0065 CA21-98-0069	TPH (DROs)	DRO compounds	TPH result should be regarded as estimated and biased high (J+) because surrogate recovery was high.
4960	21-10937	CA21-98-0060	SVOCs	Bis(2-ethylhexyl)phthalate	Result should be regarded as estimated (J) because internal standard recovery associated with this compound was low.

Table C-5.0-3 (continued)

RN	Location ID	Sample ID	Analytical Suite	Analyte	Explanation
4960	21-10938	CA21-98-0061	SVOCs	Bis(2-ethylhexyl)phthalate, benzo(b)fluoranthene, benz(a)anthracene, carbazole, chrysene, fluoranthene, phenanthrene, pyrene	Results should be regarded as estimated (J) because internal standard recoveries associated with these compounds were low.
4960	21-10939	CA21-98-0062	SVOCs	Benz(a)anthracene, bis(2-ethylhexyl)phthalate, chrysene, fluoranthene, phenanthrene, pyrene	Results should be regarded as estimated (J) because internal standard recoveries associated with these compounds were low.
4960	21-10940 21-10941	CA21-98-0063 CA21-98-0064	PCBs	Aroclor-1260	Results should be regarded as estimated (J) because results were less than EQL but above MDL.
4960	21-10940	CA21-98-0063	SVOCs	Benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, fluoranthene, phenanthrene, pyrene	Results should be regarded as estimated (J) because internal standard recoveries associated with these compounds were low.
4960	21-10941	CA21-98-0064	SVOCs	Benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, phenanthrene, pyrene	Results should be regarded as estimated (J) because internal standard recoveries associated with these compounds were low.
4960	21-10942	CA21-98-0065	SVOCs	Bis(2-ethylhexyl)phthalate, fluoranthene, phenanthrene, pyrene	Results should be regarded as estimated (J) because the internal standard recoveries associated with these compounds were low.
4960	21-10942	CA21-98-0066	SVOCs	Bis(2-ethylhexyl)phthalate, pyrene	Results should be regarded as estimated (J) because internal standard recoveries associated with these compounds were low.
4960	21-10943	CA21-98-0067	SVOCs	Butylbenzylphthalate, 2-methylnaphthalene, phenanthrene, pyrene	Results should be regarded as estimated (J) because internal standard recoveries associated with these compounds were low.
4960	21-10944	CA21-98-0068	SVOCs	Anthracene, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, carbazole, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene pyrene	Results should be regarded as estimated (J) because internal standard recoveries associated with these compounds were low.
4960	21-10942	CA21-98-0069	Pesticides	α-Chlordane, γ-chlordane	Results should be regarded as estimated (J) because results were less than EQL but above MDL.
4960	21-10942	CA21-98-0069	SVOCs	Bis(2-ethylhexyl)phthalate, butylbenzylphthalate, phenanthrene, pyrene	Results should be regarded as estimated (J) because internal standard recoveries associated with these compounds were low.
4975	21-05501	CA21-98-0073	Pesticides	4,4'-DDT	The result should be regarded as estimated (J) because the result was less than EQL but above MDL.
4975	21-05501	CA21-98-0073	SVOCs	Anthracene, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, fluoranthene, fluorene, naphthalene, phenanthrene, pyrene	Results should be regarded as estimated (J) because results were less than EQL but above MDL.

Table C-5.0-3 (continued)

RN	Location ID	Sample ID	Analytical Suite	Analyte	Explanation
4975	21-05501 21-10950 21-10950	CA21-98-0073 CA21-98-0074 CA21-98-0076	SVOCs	All target analytes	Samples diluted due to matrix interference; the reporting limits are therefore elevated.
4975	21-10950 21-10950	CA21-98-0074 CA21-98-0076	Pesticides/ PCBs	All target analytes	Samples diluted due to matrix interference; reporting limits therefore are elevated.
4975	21-10950	CA21-98-0074	SVOCs	Benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, di-n-octylphthalate, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene	Results should be regarded as estimated (J) because results were less than EQL but above MDL.
4975	21-10950	CA21-98-0076	SVOCs	Benz(a)anthracene, benzo(b)fluoranthene, chrysene, fluoranthene, phenanthrene, pyrene	Results should be regarded as estimated (J) because results were less than EQL but above MDL.
4981	21-05500	CA21-98-0082	Pesticides/ PCBs	All target analytes	Sample diluted due to matrix interference; reporting limits therefore are elevated.
4981	21-05500	CA21-98-0082	SVOCs	Benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene	Results should be regarded as estimated (J) because internal standard recoveries associated with these compounds were low.
4981	21-05500 21-05502 21-10960	CA21-98-0082 CA21-98-0096 CA21-98-0101	SVOCs	All target analytes	Samples diluted due to matrix interference; reporting limits therefore are elevated.
4981	21-05502	CA21-98-0096	Pesticides	4,4'-DDT	Result should be regarded as estimated (J) because the result was less than EQL, but above MDL.
4981	21-05502	CA21-98-0096	SVOCs	Benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, carbazole, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene	Results should be regarded as estimated (J) because internal standard recoveries associated with these compounds were low.
4981	21-05502	CA21-98-0096	TPH (DRO)	DRO compounds	Sample diluted due to matrix interference; reporting limit therefore is elevated.
4981	21-10960	CA21-98-0101	SVOCs	Bis(2-ethylhexyl)phthalate	Result should be regarded as estimated (J) because internal standard recovery associated with this compound was low.
4995	21-10961 21-10963	CA21-98-0102 CA21-98-0108	Pesticides	4,4'-DDT	Results should be regarded as estimated and biased low (J-) because associated surrogate recovery was low.

Table C-5.0-3 (continued)

RN	Location ID	Sample ID	Analytical Suite	Analyte	Explanation
4995	21-10961 21-10963	CA21-98-0102 CA21-98-0108	Pesticides/ PCBs	All nondetected target analytes	Reporting limits should be regarded as estimated and biased low (UJ-) because associated surrogate recovery was low.
4995	21-10961 21-10961 21-10967	CA21-98-0102 CA21-98-0108 CA21-98-0120	Pesticides/ PCBs	All target analytes	These samples were diluted due to matrix interference; the reporting limits are therefore elevated.
4995	21-10961	CA21-98-0102	SVOCs	Benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene	Results should be regarded as estimated (J) because results were less than EQL but above MDL.
4995	21-10962	CA21-98-0104	PCBs	Aroclor-1260	The result for this congener should be regarded as estimated (J) because the result was less than the quantitation limit (EQL), but above the MDL.
4995	21-10962	CA21-98-0104	SVOCs	Benzo(b)fluoranthene, fluoranthene, pyrene	Results should be regarded as estimated (J) because results were less than EQL but above MDL.
4995	21-10963	CA21-98-0108	SVOCs	Benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, di-n-butylphthalate, fluoranthene, phenanthrene, pyrene	Results should be regarded as estimated (J) because results were less than EQL but above MDL.
4995	21-10965 21-10967	CA21-98-0116 CA21-98-0120	SVOCs	All nondetected target analytes.	Reporting limits should be regarded as estimated and biased low (UJ-) because associated surrogate recovery was low.
4995	21-10965	CA21-98-0116	SVOCs	Benzoic acid	Result should be regarded as estimated (J) because internal standard recovery associated with this compound was low.
4995	21-10967	CA21-98-0120	SVOCs	Benz(a)anthracene, benzo(b)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, fluoranthene, phenanthrene, pyrene	Results should be regarded as estimated (J) because internal standard recovery associated with these compounds was low.
5002	21-05486 21-05489	CA21-98-0123 CA21-98-0129	Pesticides	γ-Chlordane, 4,4'-DDT	Results should be regarded as estimated (J) because results were less than EQL but above MDL.
5002	21-05486 21-05487 21-05489 21-05491	CA21-98-0123 CA21-98-0125 CA21-98-0129 CA21-98-0134	Pesticides/ PCBs	All target analytes	Sample diluted due to matrix interference; reporting limits are therefore elevated.
5002	21-05486 21-05486 21-05487 21-05488 21-05489 21-10969 21-05490 21-05491 21-05491	CA21-98-0123 CA21-98-0124 CA21-98-0125 CA21-98-0127 CA21-98-0129 CA21-98-0130 CA21-98-0132 CA21-98-0134 CA21-98-0135	SVOCs	All nondetected target analytes	Reporting limits should be regarded as estimated (UJ) because internal standard recoveries associated with these compounds were low.

Table C-5.0-3 (continued)

RN	Location ID	Sample ID	Analytical Suite	Analyte	Explanation
5002	21-05486	CA21-98-0123	SVOCs	Butylbenzylphthalate	Result should be regarded as estimated (J) because internal standard recovery associated with this compound was low.
5002	21-05486 21-05487	CA21-98-0124 CA21-98-0125	Pesticides	4,4'-DDE	Results should be regarded as estimated (J) because results were less than EQL but above MDL.
5002	21-05487	CA21-98-0125	SVOCs	Anthracene, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, bis(2-ethylhexyl)phthalate, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene	Results should be regarded as estimated and biased high (J+) because surrogates associated with these analytes were high.
5002	21-05488	CA21-98-0127	SVOCs	Pyrene	Result should be regarded as estimated (J) because internal standard recovery associated with this compound was low.
5002	21-05489	CA21-98-0129	SVOCs	Benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene	Results should be regarded as estimated and biased high (J+) because surrogates associated with these analytes were high.
5002	21-10969	CA21-98-0130	SVOCs	Benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, fluoranthene, pyrene	Results should be regarded as estimated and biased high (J+) because surrogates associated with these analytes were high.
5002	21-05490	CA21-98-0132	Pesticides	α-Chlordane, γ-chlordane, 4,4'-DDT	Results should be regarded as estimated (J) because internal standard recoveries associated with these compounds were low.
5002	21-05490	CA21-98-0132	Pesticides/ PCBs	All nondetected target analytes	Reporting limits analytes should be regarded as estimated and biased low (UJ-) because associated surrogate recovery was low.
5002	21-05490	CA21-98-0132	SVOCs	Benzo(b)fluoranthene, fluoranthene, phenanthrene, pyrene	Results should be regarded as estimated and biased high (J+) because surrogates associated with these analytes were high.
5002	21-05491	CA21-98-0134	Pesticides	γ-Chlordane	Result should be regarded as estimated (J) because result was less than EQL but above MDL.
5002	21-05491	CA21-98-0135	SVOCs	Dimethyl phthalate	Result should be regarded as estimated (J) because internal standard recovery associated with this compound was low.

Table C-5.0-4
DP Canyon Radionuclide Data Quality Evaluation

RN	Location ID	Sample ID	Analyte Suite	Analyte	Explanation
3469	21-5501	0121-97-1361	Gamma spectroscopy	Cobalt-60, europium-152, sodium-22	Results should be regarded as nondetected (U) because results were less than 3 times the 1-sigma uncertainty.
3469	21-5500 21-5498	0121-97-1362 0121-97-1364	Gamma spectroscopy	Cobalt-60, europium-152, ruthenium-106	Results should be regarded as nondetected (U) because results were less than 3 times the 1-sigma uncertainty.
3469	21-5499	0121-97-1363	Gamma spectroscopy	Cobalt-60, europium-152, ruthenium-106, sodium-22	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
3610	21-1811	0121-97-1396 0121-97-1397 0121-97-1398 0121-97-1399 0121-97-1400 0121-97-1401	Gamma spectroscopy	Americium-241, cesium-134, cesium-137, cobalt-60, europium-152, ruthenium-106, sodium-22, uranium-235	Results should be regarded as nondetected (U) because results were less than 3 times the 1-sigma uncertainty.
3610	21-1811	0121-97-1396 0121-97-1397 0121-97-1399 0121-97-1401	Isotopic plutonium	Plutonium-238, plutonium-239	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
3610	21-1811	0121-97-1396 0121-97-1398 0121-97-1399 0121-97-1400 0121-97-1401	Isotopic uranium	Uranium-235 + uranium-236	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
3610	21-1811	0121-97-1396 0121-97-1398 0121-97-1400	Tritium	Tritium	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
3610	21-1811	0121-97-1397	Isotopic uranium	Uranium-235 + uranium-236, uranium-238	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
3610	21-1812	0121-97-1398 0121-97-1400	Isotopic plutonium	Plutonium-238	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
3620	21-5486 21-5487 21-5487 21-5490 21-5491 21-5491	0121-97-1347 0121-97-1350 0121-97-1351 0121-97-1353 0121-97-1354 0121-97-1355	Gamma spectroscopy	Cesium-134, cobalt-60, europium-152, ruthenium-106, sodium-22, uranium-235	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
3620	21-5488 21-5486 21-5489	0121-97-1348 0121-97-1349 0121-97-1352	Gamma spectroscopy	Americium-241, cesium-134, cobalt-60, europium-152, ruthenium-106, sodium-22, uranium-235	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
3620	21-5487 21-5491 21-5491	0121-97-1350 0121-97-1354 0121-97-1355	Tritium	Tritium	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
3854	21-5496	0121-97-1431	Strontium-90	Strontium-90	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
3854	21-5496 21-5497	0121-97-1431 0121-97-1432	Tritium	Tritium	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.

Table C-5.0-4 (continued)

RN	Location ID	Sample ID	Analyte Suite	Analyte	Explanation
3854	21-5496	0121-97-1431	Gamma spectroscopy	Americium-241, cobalt-60, europium-152, sodium-22, ruthenium-106	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
3854	21-5497 21-5502 21-5502	0121-97-1432 0121-97-1441 0121-97-1442	Gamma spectroscopy	Cobalt-60, europium-152, ruthenium-106, sodium-22	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
3978	21-1811	0121-97-1424	Isotopic plutonium	Plutonium-238, Plutonium-239	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
3978	21-1811	0121-97-1424 0121-97-1425 0121-97-1426	Tritium	Tritium	Results should be regarded as nondetected (U) because results were less than the MDA.
3978	21-1811	0121-97-1424 0121-97-1425 0121-97-1426 0121-97-1428 0121-97-1429 0121-97-1430	Stontium-90	Strontium-90	Results should be regarded as estimated and biased low (J-) because laboratory control sample recovery was low.
3978	21-1811	0121-97-1424 0121-97-1425 0121-97-1428 0121-97-1429 0121-97-1430	Gamma spectroscopy	Americium-241, cesium-134, cesium-137, cobalt-60, europium-152, ruthenium-106, sodium-22, uranium-235	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
3978	21-1811	0121-97-1424 0121-97-1426	Isotopic uranium	Uranium-235 + uranium-236, uranium-238	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
3978	21-1812	0121-97-1425	Isotopic uranium	Uranium-235 + uranium-236, uranium-238	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
3978	21-1812	0121-97-1425 0121-97-1428 0121-97-1429 0121-97-1430	Isotopic plutonium	Plutonium-238, Plutonium-239	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
3978	21-1811	0121-97-1426	Gamma spectroscopy	Americium-241	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
3978	21-1811	0121-97-1426	Gamma spectroscopy	Cesium-134, cesium-137, cobalt-60, europium-152, ruthenium-106, sodium-22, uranium-235	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
3978	21-1811	0121-97-1426	Isotopic plutonium	Plutonium-238	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
3978	21-1811	0121-97-1428 0121-97-1429	Isotopic uranium	Uranium-238	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
3978	21-1811	0121-97-1428 0121-97-1429 0121-97-1430	Isotopic uranium	Uranium 235	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
4254	21-1811	CA21-98-0001	Tritium	Tritium	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.

Table C-5.0-4 (continued)

RN	Location ID	Sample ID	Analyte Suite	Analyte	Explanation
4254	21-1811	CA21-98-0001	Isotopic plutonium	Plutonium-238	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
4254	21-1811	CA21-98-0001	Isotopic uranium	Uranium-235, uranium-238	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
4254	21-1811	CA21-98-0001 CA21-98-0002 CA21-98-0003 CA21-98-0004	Gamma spectroscopy	Americium-241, cesium-134, cesium-137, cobalt-60, europium-152, ruthenium-106, sodium-22, uranium-235	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
4254	21-1811	CA21-98-0002	Isotopic uranium	Uranium-235, uranium-238	Results for these analytes should be regarded as nondetected (U) because results were less than three times the 1-sigma uncertainty.
4254	21-1811	CA21-98-0002 CA21-98-0003 CA21-98-0004	Isotopic Plutonium	Plutonium-238, plutonium-239	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
4254	21-1812	CA21-98-0003 CA21-98-0004	Isotopic uranium	Uranium-235	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
4257	21-1854	CA21-98-0005	Gamma spectroscopy	Americium-241, cesium-134, cesium-137, cobalt-60, europium-152, ruthenium-106, sodium-22, uranium-235	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
4257	21-1854	CA21-98-0005	Tritium	Tritium	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
4257	21-1854	CA21-98-0005	Isotopic plutonium	Plutonium-238	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
4257	21-1854	CA21-98-0005	Isotopic plutonium	Plutonium-239	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
4257	21-1854	CA21-98-0005 CA21-98-0006	Isotopic uranium	Uranium-235, uranium-238	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
4257	21-1854	CA21-98-0006	Gamma spectroscopy	Americium-241 cesium-134 cobalt-60 europium-152 sodium-22 uranium-235	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
4257	21-1854	CA21-98-0006	Gamma spectroscopy	Cesium-137, ruthenium-106	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
4257	21-1854	CA21-98-0006	Isotopic plutonium	Plutonium-238, plutonium-239	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
4642	21-01854	CA21-98-0011	Tritium	Tritium	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
4642	21-01854	CA21-98-0011 CA21-98-0012	Gamma spectroscopy	Americium-241, cesium-134, cesium-137, cobalt-60, europium-152, ruthenium-106, sodium-22, uranium-235	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.

Table C-5.0-4 (continued)

RN	Location ID	Sample ID	Analyte Suite	Analyte	Explanation
4642	21-01854	CA21-98-0011 CA21-98-0012	Isotopic plutonium	Plutonium-238, plutonium-239	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
4642	21-01854	CA21-98-0011 CA21-98-0012	Isotopic uranium	Uranium-235	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
4645	21-01811	CA21-98-0007 CA21-98-0008 CA21-98-0009 CA21-98-0010	Gamma spectroscopy	Americium-241, cesium-134 cesium-137, cobalt-60, europium-152, ruthenium-106, sodium-22, uranium-235	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
4645	21-01811	CA21-98-0007 CA21-98-0008 CA21-98-0009 CA21-98-0010	Isotopic plutonium	Plutonium-238, plutonium-239	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
4645	21-01811	CA21-98-0007 CA21-98-0009	Tritium	Tritium	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
4645	21-01811	CA21-98-0008 CA21-98-0009	Isotopic uranium	Uranium-235	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
4645	21-01812	CA21-98-0010	Isotopic uranium	Uranium-235, uranium-238	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
4964	21-10931	CA21-98-0053	Gamma spectroscopy	Americium-241	The result for this analyte should be regarded as unusable (R) due to spectral interference.
4964	21-10931	CA21-98-0053	Gamma spectroscopy	Cesium-134, cobalt-60, ruthenium-106	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
4964	21-10931	CA21-98-0053	Gamma spectroscopy	Europium-152, sodium-22, uranium-235	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
4964	21-10931 21-10933 21-10935 21-10942 21-10942	CA21-98-0053 CA21-98-0055 CA21-98-0057 CA21-98-0065 CA21-98-0069	Isotopic plutonium	Plutonium-238	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
4964	21-10931 21-10933 21-10935 21-10942 21-10942	CA21-98-0053 CA21-98-0055 CA21-98-0057 CA21-98-0065 CA21-98-0069	Strontium-90	Strontium-90	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
4964	21-10931 21-10935	CA21-98-0053 CA21-98-0057	Tritium	Tritium	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
4964	21-10933	CA21-98-0055	Gamma spectroscopy	Americium-241, cesium-134, cobalt-60, europium-152, ruthenium-106, sodium-22, uranium-235	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
4964	21-10935	CA21-98-0057	Gamma spectroscopy	Americium-241, cesium-134, cobalt-60, europium-152, ruthenium-106, sodium-22	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.

Table C-5.0-4 (continued)

RN	Location ID	Sample ID	Analyte Suite	Analyte	Explanation
4964	21-10935	CA21-98-0057	Gamma spectroscopy	Cesium-137, uranium-235	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
4964	21-10942	CA21-98-0065	Gamma spectroscopy	Uranium-235	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
4964	21-10942	CA21-98-0065	Gamma spectroscopy	Americium-241, cesium-134, cobalt-60, europium-152, ruthenium-106, sodium-22	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
4964	21-10942	CA21-98-0069	Gamma spectroscopy	Uranium-235	The result for this analyte should be regarded as unusable (R) due to spectral interference.
4964	21-10942	CA21-98-0069	Gamma spectroscopy	Americium-241, cesium-134, cesium-137, cobalt-60	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
4964	21-10942	CA21-98-0069	Gamma spectroscopy	Europium-152, ruthenium-106, sodium-22	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
4980	21-05501 21-10950 21-10950 21-10951	CA21-98-0070 CA21-98-0074 CA21-98-0075 CA21-98-0077 CA21-98-0078	Strontium-90	Strontium-90	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
4980	21-10950	CA21-98-0075	Gamma spectroscopy	Americium-241	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
4980	21-10950	CA21-98-0076	Gamma spectroscopy	Americium-241, cesium-134, cobalt-60, europium-152, ruthenium-106, sodium-22	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
4980	21-10950	CA21-98-0076	Gamma spectroscopy	Uranium-235	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
4980	21-10951	CA21-98-0078	Gamma spectroscopy	Cesium-134, cobalt-60, ruthenium-106	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
4980	21-10951	CA21-98-0078	Gamma spectroscopy	Europium-152, sodium-22, uranium-235	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
4986	21-10951	CA21-98-0080	Gamma spectroscopy	Cesium-134, europium-152, ruthenium-106, sodium-22, uranium-235	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
4986	21-10951	CA21-98-0080	Gamma spectroscopy	Cobalt-60	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
4986	21-10955 21-10955 21-05499 21-10959 21-10959	CA21-98-0090 CA21-98-0091 CA21-98-0095 CA21-98-0099 CA21-98-0100	Gamma spectroscopy	Americium-241	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
4986	21-10959	CA21-98-0100	Strontium-90	Strontium-90	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.

Table C-5.0-4 (continued)

RN	Location ID	Sample ID	Analyte Suite	Analyte	Explanation
4986	21-10960	CA21-98-0101	Gamma spectroscopy	Americium-241	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
4986	21-10960	CA21-98-0101	Isotopic plutonium	Plutonium-238	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
4986	21-10960	CA21-98-0101	Strontium-90	Strontium-90	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
4986	21-10960	CA21-98-0101	Tritium	Tritium	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
5000	21-10962 21-10962 21-10966 21-10956	CA21-98-0106 CA21-98-0107 CA21-98-0119 CA21-98-0137	Gamma spectroscopy	Americium-241	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
5000	21-10962 21-10965 21-10967	CA21-98-0107 CA21-98-0116 CA21-98-0120	Isotopic plutonium	Plutonium-238	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
5000	21-10965	CA21-98-0116	Gamma spectroscopy	Cesium-137	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
5000	21-10965 21-10965 21-10967	CA21-98-0116 CA21-98-0118 CA21-98-0120	Gamma spectroscopy	Americium-241	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
5000	21-10967	CA21-98-0120	Strontium-90	Strontium-90	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
5000	21-10956	CA21-98-0137	Isotopic uranium	Uranium-235	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
5001	21-10964	CA21-98-0112	Gamma spectroscopy	Uranium-235	The result for this analyte should be regarded as unusable (R) due to spectral interference.
5001	21-10964	CA21-98-0112	Gamma spectroscopy	Cesium-134, cobalt-60, europium-152, ruthenium-106, sodium-22	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
5001	21-10965	CA21-98-0117	Gamma spectroscopy	Americium-241	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
5001	21-10965	CA21-98-0117	Gamma spectroscopy	Cesium-134, cesium-137, cobalt-60, europium-152, ruthenium-106, sodium-22, uranium-235	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
5007	21-10969	CA21-98-0130	Isotopic plutonium	Plutonium-238	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.
5007	21-10969 21-05490 21-10973	CA21-98-0130 CA21-98-0133 CA21-98-0151	Gamma spectroscopy	Americium-241	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.

Table C-5.0-4 (continued)

RN	Location ID	Sample ID	Analyte Suite	Analyte	Explanation
5007	21-10973	CA21-98-0151	Isotopic plutonium	Plutonium-238	Results should be regarded as nondetected (U) because results were less than 3 times 1-sigma uncertainty.
5007	21-05497	CA21-98-0154	Tritium	Tritium	Results for these analytes should be regarded as nondetected (U) because results were less than MDA.

C-5.1 Organic Data Review

RN 3608

Kemron Environmental Services analyzed 6 groundwater samples (3 filtered and 3 unfiltered). The samples were analyzed for SVOCs by EPA SW-846 Method 8270, PCBs (no pesticides were analyzed) by EPA Method 8081, TPH-DRO by EPA Guidance 8000, and VOCs by EPA Method 8260 (only unfiltered samples were analyzed for volatile organic compounds).

Analyses

SVOC—Samples were extracted and analyzed within required holding times. Initial and continuing calibrations, internal standards, surrogate recoveries, and method blank met all acceptance criteria.

PCB—Samples were extracted and analyzed within required holding times. The initial and continuing calibrations surrogate recoveries and method blank all met acceptance criteria.

TPH-DRO—Method blank was free of DROs.

VOC—Samples were analyzed within the required holding times. Initial and continuing calibrations, internal standards, and surrogate recoveries, met all acceptance criteria. Acetone was detected in the method blank, and acetone was therefore qualified as nondetected (U) in one sample (Table C-5.0-3).

RN 3615

Paragon Analytics, Inc., analyzed 4 surface water samples (2 filtered and 2 unfiltered) for SVOCs by EPA SW-846 Method 8270, pesticides and PCBs by EPA Method 8081, and VOCs by EPA Method 8260 (only unfiltered samples were analyzed for VOCs).

Analyses

SVOC—Samples were extracted and analyzed within required holding times. Initial and continuing calibration criteria were met. No target analytes were detected in the method blank. Recoveries and relative percent differences for the blank spike and blank spike duplicate met acceptance criteria. All surrogate recoveries met acceptance criteria. Samples were qualified because of low internal standard recoveries as summarized in Table C-5.0-3.

Pesticide/PCB—Samples were extracted and analyzed within the required holding times. No target analytes were detected in the method blank. There was not enough sample to analyze a matrix spike or

matrix spike duplicate. Recoveries and relative percent differences for the blank spike and blank spike duplicate met acceptance criteria. For the initial calibration, the recoveries for Endosulfan and Endrin ketone were out of the specified range (high) on both columns. Methoxychlor was out high on the confirmation column. Since these compounds were not detected, qualification for these compounds was not necessary. All breakdown criteria for Endrin, 4,4'-DDT and the combined breakdown were met. Two samples were qualified (Table C-5.0-3) because of low surrogate recoveries.

VOC—Samples were analyzed within the required holding time. Acetone and methylene chloride were detected in the method blank. When acetone and methylene chloride were detected, the samples were qualified as nondetected. All internal standard and surrogate recoveries met acceptance criteria. Recoveries and relative percent differences for the blank spike and blank spike duplicate met acceptance criteria.

RN 3618

Paragon Analytics, Inc., analyzed 9 soil samples for SVOCs by EPA SW-846 Method 8270 and PCBs (no pesticides were analyzed) by EPA Method 8081.

SVOC—Samples were extracted and analyzed within required holding times. The method blank was below the reporting limits for all target analytes. The nine samples were extracted to a final volume of 10 mL, instead of the usual 1 mL. Detection limits therefore are elevated 10 times. A matrix spike sample was extracted but not analyzed because the extracts were concentrated only to a volume of 10 mL. A blank spike and blank spike duplicate therefore were analyzed. All blank spike and blank spike duplicate recoveries and relative percent differences were within acceptance criteria. Surrogate recoveries could not be evaluated because the surrogates were diluted out due to the final extraction volume of 10 mL.

PCB—Samples were extracted and analyzed within required holding times. The method blank was below the reporting limits for all congeners. Detention time windows met acceptance criteria. The blank spike and blank spike duplicate recoveries and relative percent differences met acceptance criteria. All initial calibrations criteria were met. Some continuing calibration criteria were outside the criteria range, high. Results for these congeners therefore were reported from the gas chromatograph (GC) column, which met continuing calibration criteria.

RN 3800

Paragon Analytics Inc., analyzed 2 samples (1 field blank and 1 confirmation sample) from DP Spring for VOCs by EPA Method 8260. Samples were analyzed within the required holding time. When some initial calibration criteria were not met using average response factor calibration, a quadratic fit was employed. All continuing calibration criteria were met. Methylene chloride was detected in the method blank, but not in the samples. All internal standards and surrogate recoveries met acceptance criteria. Recoveries and relative percent differences for the blank spike and blank spike duplicate met acceptance criteria.

RN 3852

ESE analyzed 6 sediment samples for SVOCs by EPA SW-846 Method 8270, VOCs by EPA Method 8260, and PCBs by EPA Method 8081 (pesticides were not requested, but some were reported when they were detected in the PCB analyses).

Analyses

SVOC—Method blank results were below the detection limit for all target analytes. Extraction- and analysis-required holding times were met. Initial and continuing calibration criteria were met. Samples were qualified because of internal standards that were outside acceptance criteria (see Table C-5.0-3).

VOC—Initial and continuing calibrations and the laboratory control sample met acceptance criteria. The method blank was free of target analytes except those for methylene chloride; detected methylene chloride in the samples therefore was attributed to laboratory contamination. One sample was qualified because of a low surrogate recovery (see Table C-5.0-3).

PCB—Method blank results were below detection limits for the PCB congeners. Initial and continuing calibration criteria, laboratory control sample results, and breakdown criteria were met. The pesticides alpha chlordane, gamma chlordane, and 4-4'-DDT were detected and reported as part of the PCB analyses.

RN 3976

Kemron Environmental Services analyzed three unfiltered groundwater samples for SVOCs by EPA SW-846 Method 8270, PCBs (no pesticides were analyzed) by EPA Method 8081, TPH-DRO by EPA Guidance 8000, and VOCs by EPA Method 8260 (only unfiltered samples were analyzed for VOCs).

Analyses

SVOC—Samples were extracted and analyzed within required holding times. Target analytes were not detected in the method blank. The acceptance criteria for the initial and continuing calibrations were met. All internal standards met acceptance criteria. Two samples were qualified because of surrogate failures (see Table C-5.0-3).

PCB—All holding times, method blank, initial and continuing calibration, retention time windows, and surrogate recoveries met acceptance criteria.

TPH-DRO—All holding times, method blank, initial and continuing calibration, retention time windows, and surrogate recoveries met acceptance criteria.

VOC—Sample was analyzed within the required 14 day holding time because the 7-day sample holding time was extended by preservation with hydrochloric acid. The method blank was free of target analytes except acetone, 2-butanone, and methylene chloride. Initial and continuing calibrations, internal standards, and surrogate recoveries all met acceptance criteria.

RN 4252

Kemron Environmental Services analyzed two unfiltered groundwater samples for Semivolatile organic compounds by EPA SW-846 Method 8270, pesticides and PCBs by EPA Method 8081, and VOCs by EPA Method 8260 (only unfiltered samples were analyzed for VOCs).

SVOC—Samples were extracted and analyzed within required holding times. The method blank was free of target analytes. Initial and continuing calibrations, internal standards, surrogate recoveries, laboratory control sample recoveries, and matrix spike recoveries met acceptance criteria.

Pesticide/PCB—Samples were extracted and analyzed within required holding times. No pesticide target analytes were reported in the method blank. Blank results were not reported for Aroclors. Initial and continuing calibrations met acceptance criteria. Retention time window criteria were met. The Endrin breakdown and 4,4'-DDT breakdown met acceptance criteria. The combined Endrin/4,4'-DDT breakdown was greater than the required 30%. Because the combined breakdown was only 31%, the samples were not qualified. Two samples were qualified (Table C-5.0-3) because of low surrogate recoveries.

VOC—Sample was analyzed within the required 14 day holding time because the 7-day sample holding time was extended by preservation with hydrochloric acid. Initial and continuing calibrations, internal standards, surrogate recoveries, and method blank met acceptance criteria.

RN 4255

Kemron Environmental Services analyzed 1 unfiltered sample from DP Spring for SVOCs by EPA SW-846 Method 8270, pesticides and PCBs by EPA Method 8081, and VOCs by EPA Method 8260.

Analyses

SVOC—Sample was extracted and analyzed within holding times. Initial and continuing calibrations, internal standards, surrogate recoveries, and method blank all met acceptance criteria.

Pesticide/PCB—Samples were extracted and analyzed within required holding times. No target analytes were reported in the method blank. Initial and continuing calibrations met acceptance criteria. Retention time window criteria were met.

VOC—Sample was analyzed within the required 14 day holding time because the 7-day sample holding time was extended by preservation with hydrochloric acid. The method blank was free of target analytes. Initial and continuing calibrations met performance criteria. All internal standard and surrogate recoveries met acceptance criteria.

RN 4640

Kemron Environmental Services analyzed 1 unfiltered sample from DP Spring for VOCs by EPA Method 8260. The sample was analyzed within the required 14 day holding time because the 7-day sample holding time was extended by preservation with hydrochloric acid. Initial calibration criteria met acceptance criteria. The continuing calibration met performance criteria but was not analyzed the same day as the samples as, required by method. The method blank was free of target analytes. Internal standards and surrogate recoveries were within acceptance criteria. Recoveries for the matrix spike and matrix spike duplicate were within acceptance criteria except those for iodomethane.

RN 4643

Kemron Environmental Services analyzed 2 unfiltered groundwater samples for VOCs by EPA Method 8260. The sample was analyzed within the required 14 day holding time because the 7-day sample holding time was extended by preservation with hydrochloric acid. Initial and continuing calibration criteria were met. All internal standards and surrogate recoveries met acceptance criteria.

RN 4827

Kemron Environmental Services analyzed 1 unfiltered sample for SVOCs by EPA SW-846 Method 8270, Pesticides by EPA Method 8081, and PCBs by EPA Method 8082. This sample (CA21-98-0043) replaced sample CA21-98-0011, because the laboratory missed the holding time for the original sample on SVOCs and pesticides.

Analyses

SVOC—All initial calibration and continuing calibration criteria were met. The sample was extracted and analyzed within holding times. No target analytes were detected in the method blank. All laboratory control sample recoveries were met except those for 2-chloronaphthalene. All internal standards and surrogate recoveries met acceptance criteria.

Pesticide/PCB—Extraction and analysis holding time was met. All initial and continuing calibration criteria were met. No target analytes were detected in the method blank. The sample was qualified (Table C-5.0-3) because of low surrogate recovery. All breakdown and retention time window criteria were met.

RN 4843

Kemron Environmental Services analyzed 1 unfiltered sample for SVOCs by EPA SW-846 Method 8270, pesticides by EPA Method 8081, and PCBs by EPA Method 8082. This sample (CA21-98-0042) replaced sample CA21-98-0009, because the laboratory missed the holding time for the original sample on SVOCs and Pesticides.

SVOC—All initial calibration and continuing calibration criteria were met. The sample was extracted and analyzed within holding times. No target analytes were detected in the method blank. All internal standards and surrogate recoveries met acceptance criteria.

Pesticide/PCB—Extraction and analysis holding time was met. All initial and continuing calibration criteria were met. No target analytes were detected in the method blank. All breakdown and retention time window criteria were met.

RN 4926

Paragon Analytics, Inc., analyzed 4 surface water samples (2 filtered and 2 unfiltered) for SVOCs by EPA SW-846 Method 8270, pesticides and PCBs by EPA Method 8081, TPH-DRO by EPA Guidance 8000 (unfiltered samples), and VOCs by EPA Method 8260 (only unfiltered samples were analyzed for VOCs).

Analyses

SVOC—Samples were extracted and analyzed within the required holding times. Initial and continuing calibration criteria were met. No target analytes were detected in the method blank. Recoveries and relative percent differences for the blank spike and blank spike duplicate met acceptance criteria. All internal standard and surrogate recoveries met acceptance criteria.

Pesticide/PCB—Samples were extracted and analyzed within required holding times. No target analytes were detected in the method blank. Recoveries and relative percent differences for the blank spike and blank spike duplicate met acceptance criteria. All breakdown criteria for Endrin, 4,4'-DDT and the combined breakdown were met. Samples were qualified because of low surrogate recoveries (see Table C-5.0-3).

VOC—Samples were analyzed within the required holding time. All internal standard and surrogate recoveries met acceptance criteria. Recoveries and relative percent differences for the blank spike and blank spike duplicate met acceptance criteria. The analytes 2-butanone and 4-methyl-2-pentanone were detected in the method blank and therefore were qualified as nondetected (U) in one sample (see Table C-5.0-3).

TPH-DRO—All holding times, method blank, initial and continuing calibration, retention time windows, and surrogate recoveries met acceptance criteria.

RN 4960

Nineteen soil samples were analyzed at Paragon Analytics, Inc., for SVOCs by EPA SW-846 Method 8270 and TPH-DROs by EPA Guidance 8000. Four of the 19 samples were analyzed for pesticides by EPA Method 8081. PCBs were analyzed by EPA Method 8082. Six of the samples were analyzed for PCBs only.

Analyses

SVOC—All initial calibration and continuing calibration criteria were met. Samples were extracted and analyzed within holding times. No target analytes were detected in the blanks. All laboratory control sample recoveries were met except those for phenol. Phenol recovery was high. Since phenol was not detected in any of the samples, qualification was not necessary. Matrix spike and matrix spike duplicate samples were not reported, because this sample could only be concentrated to a final volume of 10 mL, instead of the typical volume of 1 mL. This effectively diluted out the matrix spike compounds. As reported in Table C-5.0-3, some samples' internal standard recoveries were outside acceptance criteria. Analytes associated with these internal standards have been qualified as estimated (J) in Table C-5.0-3. Fifteen of the nineteen samples could not be concentrated to a final volume of 1 mL (see Table C-5.0-3). Detection limits reported by the laboratory were therefore elevated.

TPH-DRO—All initial and continuing calibration criteria were within acceptance criteria. All samples were extracted and analyzed within holding times. No DRO compounds were detected in the method blank. Laboratory control spike and laboratory control spike duplicate recoveries and relative percent differences were within acceptance criteria. In the three samples listed in Table C-5.0-3, TPH results should be considered estimated and biased high (J+) because the surrogate recoveries were high. Fourteen of the nineteen samples were diluted due to matrix interference (see Table C-5.0-3), and the detection limits reported by the laboratory were therefore elevated.

Pesticide/PCB—All samples were extracted and analyzed within holding times. No target analytes were detected in the method blank. All laboratory control spike and laboratory control spike duplicate recoveries and relative percent differences were within acceptance criteria. Three samples were analyzed at dilutions with elevated detection limits due to matrix interference. Some calibration compounds were outside acceptance criteria. These calibration compounds were not out of the specified QC range on both GC columns. Results therefore were reported from the GC column, which was within acceptance criteria. The percent breakdown criteria for Endrin, 4,4'-DDT, and the combined breakdown met acceptance criteria.

RN 4975

Three soil samples were analyzed at Paragon Analytics, Inc., for SVOCs by EPA SW-846 Method 8270, TPH-DROs by EPA Guidance 8000, pesticides by EPA Method 8081, and PCBs by EPA Method 8082.

Analyses

SVOC—All initial calibration and continuing calibration criteria were met. Samples were extracted and analyzed within holding times. No target analytes were detected in the blanks. All laboratory control sample recoveries were met. A matrix/matrix spike duplicate sample was not designated for this sample delivery group. All three samples were diluted due to matrix interference.

TPH-DRO—All initial and continuing calibration criteria were within acceptance criteria. All samples were extracted and analyzed within holding times. No DRO compounds were detected in the method blank. Laboratory control spike and laboratory control spike duplicate recoveries and relative percent differences were within acceptance criteria.

Pesticide/PCB—All samples were extracted and analyzed within holding times. No target analytes were detected in the method blank. All laboratory control spike and laboratory control spike duplicate recoveries and relative percent differences were within acceptance criteria. Two samples were analyzed at dilutions with elevated detection limits due to matrix interference. Some calibration compounds were outside performance criteria (high) on both GC columns. Because the sensitivity of the instrument increased, no qualifications were necessary. Percent breakdown criteria for Endrin, 4,4'-DDT, and the combined breakdown met acceptance criteria.

RN 4981

Three soil samples were analyzed at Paragon Analytics, Inc., for SVOCs by EPA SW-846 Method 8270, TPH-DROs by EPA Guidance 8000, pesticides by EPA Method 8081, and PCBs by EPA Method 8082. A fourth sample was analyzed only for TPH.

SVOC—All initial calibration and continuing calibration criteria were met. Samples were extracted and analyzed within holding times. No target analytes were detected in the blanks. All laboratory control sample recoveries were met. A matrix/matrix spike duplicate sample was not designated for this sample delivery group. All three samples were diluted due to matrix interference. Samples were qualified (Table C-5.0-3) because of low internal standard recoveries.

TPH-DRO—All initial and continuing calibration criteria were within acceptance criteria. All samples were extracted and analyzed within holding times. No DRO compounds were detected in the method blank. Laboratory control spike and laboratory control spike duplicate recoveries and relative percent differences were within acceptance criteria One sample was analyzed at a dilution with an elevated detection limit.

Pesticide/PCB—All samples were extracted and analyzed within holding times. No target analytes were detected in the method blank. All laboratory control spike and laboratory control spike duplicate recoveries and relative percent differences were within acceptance criteria. One sample was analyzed at a dilution with elevated detection limits due to matrix interference. Some calibration compounds were outside performance criteria high on both GC columns. Because the sensitivity of the instrument increased, no qualifications were necessary. Percent breakdown criteria for Endrin, 4,4'-DDT, and the combined breakdown met acceptance criteria.

RN 4995

Five soil samples were analyzed at Paragon Analytics, Inc., for SVOCs by EPA SW-846 Method 8270, TPH-DROs by EPA Guidance 8000, pesticides by EPA Method 8081, and PCBs by EPA Method 8082.

Analyses

SVOC—All initial calibration and continuing calibration criteria were met. Samples were extracted and analyzed within holding times. No target analytes were detected in the blanks. All laboratory control sample recoveries were met. A matrix/matrix spike duplicate sample was not designated for this sample delivery group. Two samples were qualified because of internal standards and surrogates that were outside acceptance criteria.

TPH-DRO—All initial and continuing calibration criteria were within acceptance criteria. All samples were extracted and analyzed within holding times. No DRO compounds were detected in the method blank. Laboratory control spike and laboratory control spike duplicate recoveries and relative percent differences were within acceptance criteria.

Pesticide/PCB—All samples were extracted and analyzed within holding times. No target analytes were detected in the method blank. All laboratory control spike and laboratory control spike duplicate recoveries and relative percent differences were within acceptance criteria. Three samples were analyzed at dilutions with elevated detection limits due to matrix interference. Two samples were qualified because of surrogate recoveries that were outside acceptance criteria. Some calibration compounds were outside acceptance criteria. These calibration compounds were not out on both GC columns. Results were therefore reported from the GC column, which was within acceptance criteria. The percent breakdown criteria for Endrin, 4,4'-DDT, and the combined breakdown met acceptance criteria.

RN 5002

Ten sediment samples were analyzed at Paragon Analytics, Inc., for SVOCs by EPA SW-846 Method 8270, TPH-DROs by EPA Guidance 8000, pesticides by EPA Method 8081, and PCBs by EPA Method 8082.

Analyses

SVOC—All initial calibration and continuing calibration criteria were met. Samples were extracted and analyzed within holding times. No target analytes were detected in the blanks. All laboratory control sample recoveries were met. A matrix/matrix spike duplicate sample was not designated for this sample delivery group. Four samples were qualified because of high surrogate recovery. Nine samples were qualified because of internal standard recoveries that were outside acceptance criteria.

TPH-DRO—All initial and continuing calibration criteria were within acceptance criteria. All samples were extracted and analyzed within holding times. No DRO compounds were detected in the method blank. Laboratory control spike and laboratory control spike duplicate recoveries and relative percent differences were within acceptance criteria. All surrogate recoveries were within acceptance criteria.

Pesticide/PCB—All samples were extracted and analyzed within holding times. No target analytes were detected in the method blank. All laboratory control spike and laboratory control spike duplicate recoveries and relative percent differences were within acceptance criteria. Some calibration compounds were outside acceptance criteria. These calibration compounds were not out on both GC columns. Results were therefore reported from the GC column, which was within acceptance criteria. Percent breakdown criteria for Endrin, 4,4'-DDT, and the combined breakdown met acceptance criteria. Four samples were analyzed at dilutions due to matrix interference. One sample was qualified because of internal standard and surrogate recoveries outside of acceptance criteria.

C-5.2 Inorganic Data Review

RN 3468

RECRA LabNet analyzed four sediment samples for the TAL metals. The samples were digested and analyzed within required holding times. Results for the method blanks were all below the reporting limits. Results for the initial and continuing calibrations and the interference check sample met acceptance criteria. The matrix spike and laboratory control sample recoveries met acceptance criteria.

RN 3609

Kemron Environmental Services analyzed 6 groundwater samples (3 filtered and 3 unfiltered) for TAL metals. The samples were extracted and analyzed within the required holding times. The initial and continuing calibration, method blank, interference check sample, and laboratory control sample all met acceptance criteria. The matrix spike sample met criteria, except aluminum and lead. Aluminum and lead matrix spike recoveries were low. The samples are qualified in Table C-5.0-2.

RN 3616

Paragon Analytics, Inc., analyzed 4 storm water samples (2 filtered and 2 unfiltered) for TAL metals. The samples were extracted and analyzed within required holding times. All preparation blank results were below practical quantitation limits. The initial and continuing calibration criteria were met. Recoveries for the laboratory control sample and interference check sample met acceptance criteria. Recoveries for the matrix spike sample all met acceptance criteria except aluminum. The aluminum matrix spike recovery was high; sample results are qualified in Table C-5.0-2.

RN 3619

Paragon Analytics, Inc., analyzed 9 sediment samples for TAL metals. The samples were digested and analyzed within required holding times. The method blank was below CRDLs for all requested analytes. The initial and continuing calibration criteria were met. Recoveries for the laboratory control sample and interference check sample were all within acceptance criteria. Recoveries for the matrix spike sample all met acceptance criteria except antimony. The matrix spike recovery for antimony was low; results are qualified in Table C-5.0-2.

RN 3853

QST Environmental, Inc., analyzed 4 sediment samples for TAL metals. The samples were extracted and analyzed within required holding times. All initial and continuing calibration criteria were met. The method blank and the initial and continuing calibration blanks were below the reporting limits for all requested analytes. The interference check sample met all acceptance criteria. Matrix spike recoveries were all within acceptance criteria.

RN 3977

Kemron Environmental Services analyzed 6 groundwater samples (3 filtered and 3 unfiltered) for TAL metals. The samples were extracted and analyzed within required holding times. All initial and continuing calibration criteria were met. Beryllium, chromium, copper, magnesium, mercury, and thallium were detected in the preparation blank. Of these analytes, only magnesium was detected in the samples.

Magnesium qualified as nondetected because of preparation blank contamination. All criteria for the interference check sample, spike sample, duplicate sample, and laboratory control sample were met.

RN 4253

Kemron Environmental Services analyzed 4 groundwater samples (2 filtered and two unfiltered) for TAL metals. Extraction and analysis holding times were met. Initial and continuing calibration criteria were met. Chromium, copper, iron, magnesium, selenium, silver, sodium, and zinc were detected in the preparation blank. Zinc in one sample was qualified as nondetected because of preparation blank contamination. A matrix spike analysis was not performed on the following analytes: aluminum, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, manganese, nickel, silver, vanadium, and zinc. The matrix spike recovery for selenium was low; selenium results were qualified as shown in Table C-5.0-2. Recoveries for the laboratory control sample and interference check sample met acceptance criteria.

RN 4256

Kemron Environmental Services analyzed 2 spring water samples (1 filtered and 1 unfiltered) for TAL metals. The samples were extracted and analyzed within holding times. The preparation blank was contaminated with chromium, copper, magnesium, selenium, silver, sodium, and zinc. Therefore, zinc in one sample was qualified as nondetected (Table C-5.0-2). Initial and continuing calibration criteria were met. All recoveries for the spike sample, interference check sample, and laboratory control sample were within performance criteria.

RN 4641

Paragon Analytics, Inc., analyzed 2 spring water samples (1 filtered and 1 unfiltered) for TAL metals. Extraction and analysis holding times were met. No target analytes were detected in the preparation blank. All acceptance criteria for the initial calibration, continuing calibration, laboratory control sample, matrix spike, and interference check sample were met.

RN 4644

Paragon Analytics, Inc., analyzed 4 groundwater samples (2 filtered and 2 unfiltered) for TAL metals. Extraction and analysis holding times were met. No target analytes were detected in the preparation blank. All acceptance criteria for the initial calibration, continuing calibration, laboratory control sample, matrix spike, and interference check sample were met.

RN 4927

Paragon Analytics, Inc., analyzed 4 storm water samples (2 filtered and two unfiltered) for TAL metals. Samples were extracted and analyzed within the required holding times. All preparation blank results were below the practical quantitation limit. All initial and continuing calibrations were within acceptance criteria. All recoveries for the spike sample and laboratory control sample met acceptance criteria.

RN 4961

Paragon Analytics, Inc., analyzed 17 samples for TAL metals. A method blank and laboratory control sample were digested and analyzed with the samples in this digestion batch. Method blank results for these 17 samples were below the practical quantitation limit for all requested analytes. The laboratory

control sample recoveries for all analytes were within acceptance limits. Initial and continuing calibration blanks were below the practical quantitation limits for the requested analytes. All initial and continuing calibration results were within acceptance criteria. Interference check sample results were within acceptance criteria.

A matrix spike sample was analyzed and all acceptance criteria were met except those for antimony and lead. Reporting limits for antimony should be regarded as estimated and biased low (UJ-) because the matrix spike recovery was low. Results for lead should be regarded as estimated and biased high (J+) because the matrix spike recovery was high.

Analytes that were detected below the method detection limit but above the instrument detection limit were qualified as estimated (J).

RN 4977

Paragon Analytics, Inc., analyzed 3 soil samples for TAL metals. All acceptance criteria for the blanks, initial and continuing calibration, laboratory control sample, and interference check sample were met.

A matrix spike sample was analyzed and all acceptance criteria were met except those for antimony. Reporting limits for antimony should be regarded as estimated and biased low (UJ-) because the matrix spike recovery for this analyte was low.

RN 4983

Paragon Analytics, Inc., analyzed 3 sediment samples for TAL metals. All acceptance criteria for the blanks, initial and continuing calibration, laboratory control sample, and interference check sample were met.

A matrix spike sample was analyzed and all acceptance criteria were met except those for antimony. Reporting limits for antimony should be regarded as estimated and biased low (UJ-) because the matrix spike recovery for this analyte was low.

RN 4997

Paragon Analytics, Inc., analyzed 5 sediment samples for TAL metals. All acceptance criteria for blanks, initial and continuing calibration, laboratory control sample, and interference check sample were met.

A matrix spike sample was analyzed and all acceptance criteria were met except those for antimony. Reporting limits for antimony should be regarded as estimated and biased low (UJ-) because the matrix spike recovery for this analyte was low.

RN 5004

Paragon Analytics, Inc., analyzed 2 sediment samples for TAL metals. All acceptance criteria for the blanks, initial and continuing calibration, laboratory control sample, and interference check sample were met.

A matrix spike sample was analyzed and all acceptance criteria were met except those for antimony. Reporting limits for antimony should be regarded as estimated and biased low (UJ-) because the matrix spike recovery for this analyte was low.

C-5.3 Radionuclide Data Review

RN 3469

QST Environmental, Inc., analyzed four sediment samples for

- gamma emitting radionuclides by gamma spectroscopy (QST SOP R008),
- tritium by liquid scintillation (QST SOP R020),
- isotopic uranium by alpha spectroscopy (QST SOP R032),
- isotopic plutonium by alpha spectroscopy (QST SOP R032), and
- strontium-90 by gas proportional beta analysis (QST SOP R031).

Analytes qualified as nondetected (U) because the results were less than MDA; analytes qualified as nondetected (U) because the results were less than 3 times the 1-sigma uncertainty are shown in Table C-5.0-4.

For gamma spectroscopy, the results for the method blank results were all nondetected laboratory control sample met acceptance criteria. For the isotopic uranium analyses, the method blank results were nondetected, and the laboratory control sample met acceptance criteria. Uranium-232 tracer recoveries for all samples met acceptance criteria. For the isotopic plutonium analyses, the method blank results were all nondetected. Results for the laboratory control sample met acceptance criteria, and the tracer recoveries met acceptance criteria for all samples. For the tritium analyses, tritium was not detected in the method blank; the laboratory control sample and matrix spike recoveries met acceptance criteria. For the strontium-90 analyses, stontium-90 was not detected in the method blank, and the recoveries for the laboratory control sample and matrix spike sample met acceptance criteria.

RN 3610

Paragon Analytics, Inc., analyzed 6 groundwater samples (3 filtered and 3 unfiltered). Samples were analyzed for

- gamma emitting radionuclides by gamma spectroscopy (PAI SOP 713R4),
- tritium by liquid scintillation (PAI SOP 704R4),
- isotopic uranium by alpha spectroscopy (PAI SOP 714R4),
- isotopic plutonium by alpha spectroscopy (PAI SOP 714R4), and
- strontium-90 by gas proportional beta analysis (PAI SOP724R5).

Analytes qualified as nondetected (U) because results were less than MDA; analytes qualified as nondetected (U) because results were less than 3 times the 1-sigma uncertainty are summarized in Table C-5.0-4.

For the gamma spectroscopy analyses, the method blank and laboratory control sample met acceptance criteria. For the isotopic uranium analyses, the method blank results were all nondetects. Uranium-232 tracer recoveries for all the samples met acceptance criteria. Uranium results for the laboratory control sample met acceptance criteria. For the isotopic plutonium analyses, the method blanks results were all

nondetects. Plutonium-242 tracer recoveries for all samples met acceptance criteria. Plutonium results for the laboratory control sample met acceptance criteria. For tritium the laboratory control sample percent recovery met acceptance criteria, and the matrix spike recovery also met acceptance criteria. For the strontium-90 analyses, the laboratory control sample percent recovery met acceptance criteria.

RN 3620

Paragon Analytics, Inc., analyzed 9 sediment samples for

- gamma emitting radionuclides by gamma spectroscopy (PAI SOP 713R4),
- tritium by liquid scintillation (PAI SOP 704R4),
- isotopic uranium by alpha spectroscopy (PAI SOP 714R4),
- isotopic plutonium by alpha spectroscopy (PAI SOP 714R4), and
- strontium-90 by gas proportional beta analysis (PAI SOP724R5).

Analytes qualified as nondetected (U) because results were less than the MDA; analytes qualified as nondetected (U) because results were less than 3 times the 1-sigma uncertainty are summarized in Table C-5.0-4.

For the gamma spectroscopy analyses, the method blank and laboratory control sample met acceptance criteria. For the isotopic uranium analyses, method blank results were all nondetects. Uranium-232 tracer recoveries for all samples met acceptance criteria. Uranium results for the laboratory control sample met acceptance criteria. For the isotopic plutonium analyses, method blanks results were all nondetects. Plutonium-242 tracer recoveries for all samples met acceptance criteria. Plutonium results for the laboratory control sample met acceptance criteria. For tritium, the laboratory control sample percent recovery met acceptance criteria at 92%, and the matrix spike recovery also met acceptance criteria at 103%. For the strontium-90 analyses, the blank spike percent recovery met acceptance criteria at 97%, and the matrix spike recovery also met criteria at 99%.

RN 3854

QST Environmental, Inc., analyzed four sediment samples for

- gamma emitting radionuclides by gamma spectroscopy (QST SOP R0008).
- tritium by liquid scintillation (QST SOP R020). Two samples were analyzed for tritium.
- isotopic uranium by alpha spectroscopy (QST SOP R032).
- isotopic plutonium by alpha spectroscopy (QST SOP R032).
- strontium-90 by gas proportional beta analysis (QST SOP R031).

Analytes qualified as nondetected (U) because results were less than MDA; analytes qualified as nondetected (U) because results were less than 3 times the 1-sigma uncertainty are summarized in Table C-5.0-4.

For gamma spectroscopy, results for the laboratory control sample, matrix spike sample, and method blank were all within acceptance criteria. For isotopic uranium and plutonium analyses, results for the

laboratory control samples, matrix spike samples, and method blanks were within acceptance criteria. Tracer recoveries for all samples were also acceptable. For strontium-90 analyses, the laboratory control sample and method blank were within acceptance criteria. For the tritium analyses, there was insufficient sample (insufficient sample moisture) to perform a matrix spike sample analysis. Tritium was not detected in the method blank.

RN 3978

ThermoNUtech analyzed 6 groundwater samples (3 filtered and 3 unfiltered) for

- gamma emitting radionuclides by gamma spectroscopy (EPA Method 901.1M),
- tritium by liquid scintillation (3 unfiltered samples) (EPA Method 906.0M),
- isotopic uranium by alpha spectroscopy (Method EML U-02M),
- isotopic plutonium by alpha spectroscopy (Method EML Pu-02M), and
- strontium-90 by gas proportional beta analysis (Method EiCHrom SRW01).

For gamma spectroscopy the results for the laboratory control sample and method blank were all within acceptance criteria. For isotopic uranium and plutonium analyses, the results for the laboratory control samples and method blank were within acceptance criteria. Tracer recoveries for all samples were also acceptable. For the strontium-90 analyses, the laboratory control sample recovery was low. Strontium-90 results are qualified in Table C-5.0-4. For the tritium analyses, the laboratory control sample met acceptance criteria.

RN 4254

Paragon Analytics, Inc., analyzed 4 groundwater samples (2 filtered and 2 unfiltered). Samples were analyzed for

- gamma emitting radionuclides by gamma spectroscopy (PAI SOP 713R4),
- tritium by liquid scintillation (PAI SOP 704R4) (unfiltered sample only),
- isotopic uranium by alpha spectroscopy (PAI SOP 714R4),
- isotopic plutonium by alpha spectroscopy (PAI SOP 714R4), and
- strontium-90 by gas proportional beta analysis (PAI SOP 724R5).

Analytes qualified as nondetected (U) because the results were less than the MDA; analytes qualified as nondetected (U) because the results were less than 3 times the 1-sigma uncertainty are summarized in Table C-5.0-4.

For the gamma spectroscopy analyses, the method blank and laboratory control sample met acceptance criteria. For the isotopic uranium analyses, method blank results were all nondetects. Uranium-232 tracer recoveries for all samples met acceptance criteria. Uranium results for the laboratory control sample met acceptance criteria. For the isotopic plutonium analyses, method blanks results were all nondetects. Plutonium-242 tracer recoveries for all samples met acceptance criteria. Plutonium result for the laboratory control sample met acceptance criteria. For tritium the laboratory control sample percent

recovery met acceptance criteria at 97%, and the matrix spike recovery also met acceptance criteria at 105%. For the strontium-90 analyses the laboratory control sample percent recovery met acceptance criteria at 91%, and the matrix spike recovery also met criteria at 97%.

RN 4257

Paragon Analytics, Inc., analyzed 2 spring water samples (1 filtered and 1 unfiltered) for

- gamma emitting radionuclides by gamma spectroscopy (PAI SOP 713R4),
- tritium by liquid scintillation (PAI SOP 704R4) (unfiltered sample only),
- isotopic uranium by alpha spectroscopy (PAI SOP 714R4),
- isotopic plutonium by alpha spectroscopy (PAI SOP 714R4), and
- strontium-90 by gas proportional beta analysis (PAI SOP 724R5).

Analytes qualified as nondetected (U) because the results were less than MDA; analytes qualified as nondetected (U) because the results were less than 3 times the 1-sigma uncertainty are summarized in Table C-5.0-4.

For the gamma spectroscopy analyses, the method blank and laboratory control sample met acceptance criteria. For the isotopic uranium analyses, method blank results were all nondetects. Uranium-232 tracer recoveries for all samples met acceptance criteria. Uranium results for the laboratory control sample met acceptance criteria For the isotopic plutonium analyses, method blanks results were all nondetects. Plutonium-242 tracer recoveries for all samples met acceptance criteria. Plutonium results for the laboratory control sample met acceptance criteria. For tritium, the laboratory control sample percent recovery met acceptance criteria at 96%, and the matrix spike recovery also met acceptance criteria at 105%. For the strontium-90 analyses, the laboratory control sample percent recovery met acceptance criteria at 91%, and the matrix spike recovery also met criteria at 103%.

RN 4642

Paragon Analytics, Inc., analyzed 2 samples from DP Spring (1 filtered and 1 unfiltered) for

- gamma emitting radionuclides by gamma spectroscopy (PAI SOP 713R4),
- tritium by liquid scintillation (PAI SOP 704R4) (unfiltered sample only),
- isotopic uranium by alpha spectroscopy (PAI SOP 714R4),
- isotopic plutonium by alpha spectroscopy (PAI SOP 714R4), and
- strontium-90 by gas proportional beta analysis (PAI SOP 724R5).

Analytes qualified as nondetected (U) because the results were less than MDA; analytes qualified as nondetected (U) because the results were less than 3 times the 1-sigma uncertainty are summarized in Table C-5.0-4.

For the gamma spectroscopy analyses, the method blank and laboratory control sample met acceptance criteria. For the isotopic uranium analyses, the method blank results were all nondetects. Uranium-232 tracer recoveries for all the samples met acceptance criteria. Uranium results for the laboratory control

sample met acceptance criteria. For the isotopic plutonium analyses, method blanks results were all nondetects. Plutonium-242 tracer recoveries for all samples met acceptance criteria. Plutonium results for the laboratory control sample met acceptance criteria. For tritium, the laboratory control sample percent recovery met acceptance criteria. For the strontium-90 analyses, the laboratory control sample percent recovery met acceptance criteria.

RN 4645

Paragon Analytics, Inc., analyzed four groundwater samples (2 filtered and 2 unfiltered) for

- gamma emitting radionuclides by gamma spectroscopy (PAI SOP 713R4),
- tritium by liquid scintillation (PAI SOP 704R4) (unfiltered sample only),
- isotopic uranium by alpha spectroscopy (PAI SOP 714R4),
- isotopic plutonium by alpha spectroscopy (PAI SOP 714R4), and
- strontium-90 by gas proportional beta analysis (PAI SOP 724R5).

Analytes qualified as nondetected (U) because results were less than MDA; analytes qualified as nondetected (U) because the results were less than 3 times the 1-sigma uncertainty are summarized in Table C-5.0-4.

For the gamma spectroscopy analyses, the method blank and laboratory control sample met acceptance criteria. For the isotopic uranium analyses, the method blank results were all nondetects. Uranium-232 tracer recoveries for all the samples met acceptance criteria. Uranium results for the laboratory control sample met acceptance criteria. For the isotopic plutonium analyses, method blanks results were all nondetects. Plutonium-242 tracer recoveries for all samples met acceptance criteria. Plutonium results for the laboratory control sample met acceptance criteria. For tritium, the laboratory control sample percent recovery met acceptance criteria at 97%. For the strontium-90 analyses, the laboratory control sample percent recovery met acceptance criteria at 99%.

RN 4964

Five sediment samples were analyzed by Paragon Analytics Inc., for

- gamma emitting radionuclides by gamma spectroscopy (PAI SOP 713R4),
- tritium by liquid scintillation (PAI SOP 7040R4),
- isotopic plutonium by alpha spectroscopy (PAI SOP 714R4),
- strontium-90 by gas proportional beta analysis (PAI SOP 724R5),
- isotopic uranium by alpha spectroscopy (PAI SOP 714R4).

Analytes qualified as nondetected (U) because the results were less than MDA; analytes qualified as nondetected (U) because the results were less than 3 times the 1-sigma uncertainty are summarized in Table C-5.0-4. Gamma spectroscopy results, which were qualified as unusable (R) due to spectral interference, are also summarized in Table-C-5.0-4.

For gamma spectroscopy analyses the results for the method blank were all below the detection limit. Results for the laboratory control sample were all within acceptance criteria. Tritium was not detected in the method blank. Recovery for tritium in the laboratory control sample was within acceptance criteria at 92%. For the isotopic plutonium analyses, the plutonium-242 tracer recoveries were within acceptance criteria for all samples. Plutonium isotopes were not detected in the blank The laboratory control sample was within acceptance criteria. For the strontium-90 analyses, no strontium was detected in the method blank. Strontium-90 recovery for the laboratory control sample was within acceptance criteria at 103%. The matrix spike recovery was also within acceptance criteria at 91%. For the isotopic uranium analyses, uranium-232 tracer recoveries were within acceptance criteria for all samples. No uranium isotopes were detected in the method blank. For the laboratory control sample, uranium recoveries were within acceptance criteria.

RN 4980

Eight sediment samples were analyzed by Paragon Analytics, Inc., for

- gamma emitting radionuclides by gamma spectroscopy (PAI SOP 713R4),
- isotopic plutonium by alpha spectroscopy (PAI SOP 714R4), and
- strontium-90 by gas proportional beta analysis (PAI SOP 724R5).

Analytes qualified as nondetected (U) because the results were less than MDA; analytes qualified as nondetected (U) because the results were less than 3 times the 1-sigma uncertainty are summarized in Table C-5.0-4.

For gamma spectroscopy analyses results for the method blank were all below the detection limit. Results for the laboratory control sample were all within acceptance criteria. For the isotopic plutonium analyses, plutonium-242 tracer recoveries were within acceptance criteria for all samples. Plutonium isotopes were not detected in the blank. The laboratory control sample was within acceptance criteria. For the strontium-90 analyses, no strontium was detected in the method blank. Strontium-90 recovery for the laboratory control sample was within acceptance criteria at 108%. The matrix spike recovery was also within acceptance criteria at 100%.

RN 4986

Twenty-one sediment samples were analyzed by Paragon Analytics, Inc., for

- strontium-90 by gas proportional beta analysis (PAI SOP 724R5) (18 samples),
- tritium by liquid scintillation (Paragon SOP 7040R4) (4 samples),
- gamma emitting radionuclides by gamma spectroscopy (PAI SOP 713R4) (19 samples), and
- isotopic plutonium by alpha spectroscopy (PAI SOP 714R4) (13 samples),

Analytes qualified as nondetected (U) because the results were less than MDA; analytes qualified as nondetected (U) because the results were less than 3 times the 1-sigma uncertainty are summarized in Table C-5.0-4.

For the strontium-90 analyses, no strontium was detected in the method blank. Strontium-90 recovery for the laboratory control sample was within acceptance criteria at 98%. The matrix spike recovery was also

within acceptance criteria at 100%. Tritium was not detected in the method blank. Recovery for tritium in the laboratory control sample was within acceptance criteria at 92%. For gamma spectroscopy analyses, the results for the method blank were all below the detection limit. Results for the laboratory control sample were all within acceptance criteria. For the isotopic plutonium analyses, the plutonium-242 tracer recoveries were within acceptance criteria for all samples. Plutonium isotopes were not detected in the blank.

RN 5000

Nineteen sediment samples were analyzed by Paragon Analytics, Inc., for

- gamma emitting radionuclides by gamma spectroscopy (PAI SOP 713R4). For gamma spectroscopy the analyte suite was limited to cesium-137 and americium-241.
- isotopic plutonium by alpha spectroscopy (PAI SOP 714R4). Nine samples were analyzed for isotopic plutonium.
- isotopic uranium by alpha spectroscopy (PAI SOP 714R4). Two samples were analyzed for isotopic uranium.
- strontium-90 by gas proportional beta analysis (PAI SOP 724R5). Ten samples were analyzed for strontium-90.

Analytes qualified as nondetected (U) because the results were less than MDA; analytes qualified as nondetected (U) because the results were less than 3 times the 1-sigma uncertainty are summarized in Table C-5.0-4.

For gamma spectroscopy analyses, results for the method blank were all below the detection limit. Results for the laboratory control sample were all within acceptance criteria. Only cesium-137 and americium-241 were reported. For the isotopic plutonium analyses, plutonium-242 tracer recoveries were within acceptance criteria for all samples. Plutonium isotopes were not detected in the blank. The laboratory control sample was within acceptance criteria. For the isotopic uranium analyses, the uranium-232 tracer recoveries were within acceptance criteria for all samples. No uranium isotopes were detected in the method blank. For the laboratory control sample, uranium recoveries were within acceptance criteria. For the strontium-90 analyses, no strontium was detected in the method blank. Strontium-90 recovery for the laboratory control sample was within acceptance criteria at 106%. The matrix spike recovery was also within acceptance criteria at 99%.

RN 5001

Seven sediment samples were analyzed by Paragon Analytics, Inc., for

- tritium by liquid scintillation (PAI SOP 7040R4). Two samples were analyzed for tritium.
- gamma emitting radionuclides by gamma spectroscopy (PAI SOP 713R4). Two samples were analyzed by gamma spectroscopy.
- isotopic plutonium by alpha spectroscopy (PAI SOP 714R4). Two samples were analyzed for isotopic plutonium.

Analytes qualified as nondetected (U) because the results were less than MDA; analytes qualified as nondetected (U) because the results were less than 3 times the 1-sigma uncertainty are summarized in

Table C-5.0-4. Gamma spectroscopy results, which were qualified as unusable (R) due to spectral interference, are also summarized in Table-C-5.0-4.

Tritium was not detected in the method blank. Recovery for tritium in the laboratory control sample was within acceptance criteria at 92%. For gamma spectroscopy analyses, results for the method blank were all below the detection limit. Results for the laboratory control sample were all within acceptance criteria. For the isotopic plutonium analyses, the plutonium-242 tracer recoveries were within acceptance criteria for all samples. Plutonium isotopes were not detected in the blank. The laboratory control sample was within acceptance criteria.

RN 5007

Thirteen sediment samples were analyzed by Paragon Analytics, Inc., for

- tritium by liquid scintillation (PAI SOP 7040R4). One sample was analyzed for tritium.
- gamma emitting radionuclides by gamma spectroscopy (PAI SOP 713R4). For gamma spectroscopy the analyte suite was limited to cesium-137 and americium-241.
- isotopic plutonium by alpha spectroscopy (PAI SOP 714R4).
- strontium-90 by gas proportional beta analysis (PAI SOP 724R5).

Analytes qualified as nondetected (U) because the results were less than MDA; analytes qualified as nondetected (U) because the results were less than three times the 1-sigma uncertainty are summarized in Table C-5.0-4.

Tritium was not detected in the method blank. Recovery for tritium in the laboratory control sample was within acceptance criteria at 92%. For gamma spectroscopy analyses the results for the method blank were all below detection limit. Results for the laboratory control sample were all within acceptance criteria. For the isotopic plutonium analyses, plutonium-242 tracer recoveries were within acceptance criteria for all samples. Plutonium isotopes were not detected in the blank. The laboratory control sample was within acceptance criteria. For the strontium-90 analyses, no strontium was detected in the method blank. Strontium-90 recovery for the laboratory control sample was within acceptance criteria at 107%. The matrix spike recovery was also within acceptance criteria at 107%.

Appendix D

Analytical Suites and Results

D-1.0 TARGET ANALYTES AND DETECTION LIMITS

This section summarizes the target analytes and detection limits for all analyses conducted during this investigation. Tables D-1.0-1 through D-1.0-7 summarize the analytical suites with contract required detection limits (CRDLs) in accordance with the Environmental Restoration Project analytical services statement of work (SOW) for contract laboratories (LANL 1995, 49738) and the Quality Assurance Project Plan (LANL 1996, 54609). In many cases, the laboratory reporting limits for the target analytes were significantly lower than the CRDLs. The sample-specific reporting limit for each analyte is available in the tables in Section D-2.0 of this appendix. Los Alamos National Laboratory's (LANL, the Laboratory) Facility for Information Management, Analysis, and Display (FIMAD) database also contains the sample specific reporting limits for each analyte.

D-1.1 Inorganic Analyses

Table D-1.0-1 shows detection limits, which are contract required quantitation limits (CRQLs). Some of the CRQLs listed in Table 1.0-1 are not adequate to meet Laboratory background levels. For these analytes, the contract laboratories were contacted, and whenever possible, reporting limits and analytical techniques (use of axial view inductively coupled plasma emission spectroscopy [ICPES] instead of radial view ICPES) were changed to meet the Laboratory background values.

D-1.2 Radionuclide Analyses

The CRDLs for radionuclides are summarized in Table D-1.0-2. The Laboratory methods for these analytes are contained in "Health and Environmental Chemistry: Analytical Techniques, Data Management, and Quality Assurance" (LANL 1993, 31793).

D-1.3 Organic Analyses

Table D-1.0-3 summarizes the semivolatile organic compound (SVOC) target analytes and the associated CRDLs. Samples were analyzed using either US Environmental Protection Agency (EPA) SW-846 Method 8270 or Contract Laboratory Program Method OLM02.0. These methods utilize solvent extraction. The sample extracts are analyzed using gas chromatography mass spectroscopy.

Table D-1.0-4 summarizes the volatile organic compound (VOC) target analytes and the associated CRDLs. Samples were analyzed using either EPA SW-846 Method 8260 or Contract Laboratory Program Method OLM02.0. These methods utilize purge and trap to extract and concentrate the samples. Analysis is accomplished using gas chromatography mass spectroscopy.

Table D-1.0-5 summarizes the pesticide/polychlorinated biphenyl (PCB) analytes and the associated CRDLs. Samples were analyzed using either EPA SW-846 Method 8081/8082 or Contract Laboratory Program Method OLM01.8. These methods utilize solvent extraction. The sample extracts are analyzed using gas chromatography.

Water and soil samples were also analyzed for total petroleum hydrocarbons-diesel range organics (TPH-DRO). Samples were analyzed for TPH-DRO using EPA Guidance 8000, Method 8015. Table D-1.0-6 summarizes the CRDLs for TPH-DRO.

D-1.4 Water Quality Analytes

General water quality parameters were also analyzed for the samples in this investigation. Table D-1.0-7 summarizes the analytes and their CRDLs.

Table D-1.0-1
LANL Contract Required Detection Limits for Inorganic Analytes

Analyte	EPA Sample Preparation Method	Analytical Technique	Water CRQLs[a] (µg/L)	Soil CRQLs (mg/kg)
Aluminum	3050A	ICPES[b]	200	40
Antimony	3050A	ICPES	60	12
Arsenic	7060/3050A	ICPES	10	2
Barium	3050A	ICPES	200	40
Beryllium	3050A	ICPES	5	1
Boron	3050A	ICPES	100	—[c]
Cadmium	3050A	ICPES	5	1
Calcium	3050A	ICPES	5000	1000
Chromium	3050A	ICPES	10	2
Cobalt	3050A	ICPES	50	10
Copper	3050A	ICPES	25	5
Cyanide	9012	Colorimetric	10	0.05
Iron	3050A	ICPES	100	20
Lead	7421/3050A	ICPES	3	0.6
Lithium	3050A	ICPES	10	—
Magnesium	3050A	ICPES	5000	1000
Manganese	3050A	ICPES	15	3
Mercury	7471	CVAA[d]	0.2	0.1
Molybdenum	3050A	ICPES	10	—
Nickel	3050A	ICPES	40	8
Potassium	3050A	ICPES	5000	1000
Selenium	7740/3050A	ICPES	5	1
Silver	3050A	ICPES	10	2
Sodium	3050A	ICPES	5000	1000
Strontium	3050A	ICPES	10	—
Thallium	7841/3050A	ICPES	10	2
Uranium	3050A	ICPES	200	—
Vanadium	3050A	ICPES	50	10
Zinc	3050A	ICPES	20	4

[a] CRDL = contract required quantitation limit.

[b] ICPES = inductively coupled plasma emission spectroscopy.

[c] A dash in the table means "not applicable."

[d] CVAA = cold vapor atomic absorption.

Table D-1.0-2
LANL Contract Required Detection Limits for Radionuclides

Analyte	Analytical Technique	Water CRDLs[a] (pCi/L)	Soil CRDLs (pCi/g)
Americium-241	Alpha spectroscopy	0.1	0.1
Americium-241	Gamma spectroscopy	Not available[b]	1.0
Cesium-137	Gamma spectroscopy	15	0.1
Cobalt-60	Gamma spectroscopy	150	0.5
Gross alpha/beta	Gas-proportional counting	3.0	10.0
Gross gamma	NaI (Tl) detector[c]	100	2.0
Plutonium-238	Alpha spectroscopy	0.1	0.1
Plutonium-239,240	Alpha spectroscopy	0.1	0.1
Strontium-90	Gas-proportional counting	5.0	2.0
Thorium-228	Alpha spectroscopy	0.1	0.1
Thorium-230	Alpha spectroscopy	0.1	0.1
Thorium-232	Alpha spectroscopy	0.1	0.1
Tritium	Liquid scintillation	250	250
Uranium-234	Alpha spectroscopy	0.1	0.1
Uranium-235	Alpha spectroscopy	0.1	0.1
Uranium-238	Alpha spectroscopy	0.1	0.1

[a] CRDL = contract required detection limit.

[b] The LANL SOW CRDLs are not specified for the other gamma-emitting radionuclides commonly analyzed; they are determined on a case-specific basis.

[c] NaI (Tl) = thallium drifted/sodium iodide detector.

Table D-1.0-3
LANL Contract Required Detection Limits for Semivolatile Organic Compounds

Analyte	Water CRDLs (µg/L)	Soil CRDLs (µg/kg)
Acenaphthene	10	330
Acenaphthylene	10	330
Aniline	20	660
Anthracene	10	330
Azobenzene	20	660
Benz(a)anthracene	10	330
Benzoic acid	50	3300
Benzo(b)fluoranthene	10	330
Benzo(k)fluoranthene	10	330
Benzo(g,h,i)perylene	10	330
Benzo(a)pyrene	10	330
Benzyl alcohol	20	660
Bis(2-chloroethoxy)methane	10	330
Bis(2-chloroethyl)ether	10	330
4-Bromophenyl phenylether	10	330
Butylbenzylphthalate	10	330
Carbazole	10	330
4-Chloroaniline	20	660
4-Chloro-3-methylphenol	20	660
2-Chloronaphthalene	10	330
2-Chlorophenol	10	330
4-Chlorophenyl phenylether	10	330
Chrysene	10	330
Dibenz(a,h)anthracene	10	330
Dibenzofuran	10	330
1,2-Dichlorobenzene	10	330
1,3-Dichlorobenzene	10	330
1,4-Dichlorobenzene	10	330
3,3'-Dichlorobenzidine	20	660
2,4-Dichlorophenol	10	330
Diethylphthalate	10	330
Dimethyl phthalate	10	330
2,4-Dimethylphenol	10	330
2,4-Dinitrophenol	50	1700
Di-n-butylphthalate	10	330
4,6-Dinitro-2-methylphenol	50	1700
2,4-Dinitrotoluene	10	330
2,6-Dinitrotoluene	10	330

Table D-1.0-3 (continued)

Analyte	Water CRDLs (µg/L)	Soil CRDLs (µg/kg)
Di-n-octyl phthalate	10	330
Bis(2-ethylhexyl)phthalate	10	330
Fluoranthene	10	330
Fluorene	10	330
Hexachlorobenzene	10	330
Hexachlorobutadiene	10	330
Hexachlorocyclopentadiene	10	330
Hexachloroethane	10	330
Indeno(1,2,3-cd)pyrene	10	330
Isophorone	10	330
2-Methylnaphthalene	10	330
2-Methylphenol	10	330
4-Methylphenol	10	330
Naphthalene	10	330
2-Nitroaniline	50	1600
3-Nitroaniline	50	1600
4-Nitroaniline	20	660
Nitrobenzene	10	330
2-Nitrophenol	10	330
4-Nitrophenol	50	1600
N-Nitrosodimethylamine	10	330
N-Nitrosodiphenylamine	10	330
N-Nitroso-di-n-propylamine	10	330
2,2'-oxybis(1-Chloropropane)	10	330
Pentachlorophenol	50	1600
Phenanthrene	10	330
Phenol	10	330
Pyrene	10	330
1,2,4-Trichlorobenzene	10	330
2,4,5-Trichlorophenol	60	1600
2,4,6-Trichlorophenol	10	330

Table D-1.0-4
LANL Contract Required Detection Limits for Volatile Organic Compounds

Analyte	Water CRDLs (µg/L)	Soil CRDLs (µg/kg)
Acetone	20	20
Benzene	5	5
Bromobenzene	5	5
Bromochloromethane	5	5
Bromodichloromethane	5	5
Bromoform	5	5
Bromomethane	10	10
2-Butanone	20	20
n-Butylbenzene	5	5
sec-Butylbenzene	5	5
tert-Butylbenzene	5	5
Carbon disulfide	5	5
Carbon tetrachloride	5	5
Chlorobenzene	5	5
Chlorodibromomethane	5	5
Chloroethane	10	10
Chloroform	5	5
Chloromethane	10	10
2-Chlorotoluene	5	5
4-Chlorotoluene	5	5
1,2-Dibromethane	5	5
1,2-Dibromo-3-chloropropane	10	10
Dibromomethane	5	5
1,2-Dichlorobenzene	5	5
1,3-Dichlorobenzene	5	5
1,4-Dichlorobenzene	5	5
Dichlorodifluoromethane	10	10
1,1-Dichloroethane	5	5
1,1-Dichloroethane	5	5
1,2-Dichloroethane	5	5
1,2-Dichloroethene	10	10
1,2-Dichloropropane	5	5
1,3-Dichloropropane	5	5
2,2-Dichloropropane	5	5
cis-1,3-Dichloropropene	5	5
trans-1,3-Dichloropropene	5	5
1,1-Dichloropropene	5	5
Ethylbenzene	5	5

Table D-1.0-4 (continued)

Analyte	Water CRDLs (µg/L)	Soil CRDLs (µg/kg)
2-Hexanone	20	20
Iodomethane	5	5
Isopropylbenzene	5	5
p-Isopropyltoluene	5	5
Methyl chloride	5	5
4-Methyl-2-pentanone	20	20
n-Propylbenzene	5	5
Styrene	5	5
1,1,1,2-Tetrachloroethane	5	5
1,1,2,2-Tetrachloroethane	5	5
Tetrachloroethene	5	5
Toluene	5	5
1,1,1-Trichloroethane	5	5
1,1,2-Trichloroethane	5	5
Trichloroethene	5	5
Trichlorofluoromethane	5	5
1,2,3-Trichloropropane	5	5
Trichlorotrifluoroethane	5	5
1,2,4-Trimethylbenzene	5	5
1,3,5-Trimethylbenzene	5	5
Vinyl chloride	10	10
Xylene (mixed)	5	5

Table D-1.0-5
LANL Contract Required Detection Limits for Pesticides and PCBs

Analyte	Water CRDLs (µg/L)	Soil CRDLs (µg/kg)
Aldrin	0.05	1.7
α-BHC	0.05	1.7
β-BHC	0.05	1.7
δ-BHC	0.05	1.7
γ-BHC (lindane)	0.05	1.7
α-Chlordane	0.05	1.7
γ-Chlordane	0.05	1.7
4,4'-DDD	0.10	3.3
4,4'-DDE	0.10	3.3
4,4'-DDT	0.10	3.3
Dieldrin	0.10	3.3
Endosulfan I	0.05	1.7
Endosulfan II	0.10	3.3
Endosulfan sulfate	0.10	3.3
Endrin	0.10	3.3
Endrin ketone	0.10	3.3
Endrin aldehyde	0.10	3.3
Heptachlor	0.05	1.7
Heptachlor Epoxide	0.05	1.7
Methoxychlor	0.10	17
Toxaphene	0.10	170
Aroclor-1016	1.0	33
Aroclor-1221	2.0	66
Aroclor-1232	1.0	33
Aroclor-1242	1.0	33
Aroclor-1248	1.0	33
Aroclor-1254	1.0	33
Aroclor-1260	1.0	33

Table D-1.0-6
LANL Contract Required Detection Limits for TPH-DRO

Analyte	Water CRDLs (µg/L)	Soil CRDLs (µg/kg)
TPH-DRO	10	1000

Table D-1.0-7
LANL Contract Required Detection Limits for Water Quality Parameters

Analyte	Method	Water CRDLs (µg/L)
Bicarbonate	Standard Methods 2320B	10,000
Bromide	EPA Method 300.0 or 325	200
Chloride	EPA Method 300.0	100
Fluoride	EPA Method 300.0 or 340	100
Iodide	EPA Method 300.0	100
Ammonium as N	EPA Method 350.1	100
Nitrate/Nitrite as N	EPA Method 300.0 or 353.2	100
Nitrate as N	EPA Method 300.0 or 353.2	100
Nitrite as N	EPA Method 300.0 or 353.2	100
Orthophosphate	EPA Method 300.0	100
Phosphorous	EPA Method 365.2	100
Sulfate	EPA Method 300.0	500
Boron	EPA Method 6010	200
Lithium	EPA Method 6010	1000
Strontium	EPA Method 6010	10
Total organic carbon	EPA Method 415	1000

D-2.0 ANALYTE SUITES AND REQUEST NUMBERS

Table D-2.0-1 presents the analytical suites and request numbers for each sediment sample collected in DP Canyon. The request number identifies a batch of samples sent to a specific off-site analytical laboratory for a specific suite of analyses, and the request numbers can be used to track the original data packages from the off-site analytical laboratories. Table D-2.0-1 also presents some field information (e.g., location ID, sample collection depth, and geomorphic unit). Table D-2.0-2 presents the analytical suites and request numbers for each water sample collected in DP Canyon. Table D-2.0-2 also presents some field information (like location ID and sample collection date). Table D-2.0-3 presents the analytical laboratory that analyzed each request number.

Table D-2.0-1
DP Canyon Sediment Samples, Analyte Suites, and Request Numbers

Sample ID	Reach or Subreach	Location ID	Depth (cm)	Geomorphic Unit	Sediment Facies	Date Collected	Related Sample ID	Gamma Spectroscopy	Tritium	Isotopic Pu	Isotopic U	Strontium-90	Metals	pH	Particle Size	PCBs	Pesticides and PCBs	SVOCs	TPH	VOCs	Sample Notes
0121-97-1347	DP-4	21-05486	14–27	c2b	fine	8/21/97	—[a]	3620R	3620R	3620R	3620R	3620R	3619R	—	4628R	3618R	—	3618R	—	—	
0121-97-1348	DP-4	21-05488	0–24	c2b	coarse	8/21/97	—	3620R	3620R	3620R	3620R	3620R	3619R	—	4628R	3618R	—	3618R	—	—	
0121-97-1349	DP-4	21-05486	35–54	c2b	fine	8/21/97	—	3620R	3620R	3620R	3620R	3620R	3619R	—	4628R	3618R	—	3618R	—	—	
0121-97-1350	DP-4	21-05487	0–40	c2a	fine	8/21/97	—	3620R	3620R	3620R	3620R	3620R	3619R	—	4628R	3618R	—	3618R	—	—	
0121-97-1351	DP-4	21-05487	0–40	c2a	fine	8/21/97	0121-97-1350	3620R	3620R	3620R	3620R	3620R	3619R	—	—	3618R	—	3618R	—	—	FD[b]
0121-97-1352	DP-4	21-05489	40–70	c2b	coarse	8/21/97	—	3620R	3620R	3620R	3620R	3620R	3619R	—	4628R	3618R	—	3618R	—	—	
0121-97-1353	DP-4	21-05490	28–53	c2b	fine	8/21/97	—	3620R	3620R	3620R	3620R	3620R	3619R	—	4628R	3618R	—	3618R	—	—	
0121-97-1354	DP-4	21-05491	30–46	c2b	fine	8/21/97	—	3620R	3620R	3620R	3620R	3620R	3619R	—	4628R	3618R	—	3618R	—	—	
0121-97-1355	DP-4	21-05491	0–30	c2b	fine	8/21/97	—	3620R	3620R	3620R	3620R	3620R	3619R	—	4628R	3618R	—	3618R	—	—	
0121-97-1361	DP-2	21-05501	20–51	c3b	fine	7/24/97	—	3469R	3469R	3469R	3469R	3469R	3468R	—	4628R	—	—	—	—	—	
0121-97-1362	DP-2	21-05500	20–41	f1	fine	7/24/97	—	3469R	3469R	3469R	3469R	3469R	3468R	—	4628R	—	—	—	—	—	
0121-97-1363	DP-2	21-05499	20–41	c3b	fine	7/24/97	—	3469R	3469R	3469R	3469R	3469R	3468R	—	4628R	—	—	—	—	—	
0121-97-1364	DP-2	21-05498	0–30	f1	fine	7/24/97	—	3469R	3469R	3469R	3469R	3469R	3468R	—	4628R	—	—	—	—	—	
0121-97-1431	DP-1 E	21-05496	13–21	c3	fine	10/23/97	—	3854R	3854R	3854R	3854R	3854R	3853R	—	4628R	3852R	—	3852R	—	3852R	
0121-97-1432	DP-3	21-05497	53–65	c3b	fine	10/23/97	—	3854R	3854R	3854R	3854R	3854R	3853R	—	4628R	3852R	—	3852R	—	3852R	
0121-97-1433	DP-2	21-05498	0–30	f1	fine	10/23/97	0121-97-1364	—	—	—	—	—	—	—	—	3852R	—	3852R	—	3852R	Resample
0121-97-1434	DP-2	21-05499	20–40	c3b	fine	10/23/97	0121-97-1363	—	—	—	—	—	—	—	—	3852R	—	3852R	—	3852R	Resample
0121-97-1435	DP-2	21-05500	20–40	f1	fine	10/23/97	0121-97-1362	—	—	—	—	—	—	—	—	3852R	—	3852R	—	3852R	Resample
0121-97-1440	DP-2	21-05501	20–50	c3b	fine	10/23/97	0121-97-1361	—	—	—	—	—	—	—	—	3852R	—	3852R	—	3852R	Resample
0121-97-1441	DP-2	21-05502	20–32	c2	coarse	10/23/97	—	3854R	—	3854R	3854R	3854R	3853R	—	4628R	—	—	—	—	—	
0121-97-1442	DP-2	21-05502	20–32	c2	coarse	10/23/97	0121-97-1441	3854R	—	3854R	3854R	3854R	3853R	—	—	—	—	—	—	—	FD
CA21-98-0051	DP-1 W	21-10929	0–34	c3	fine	11/17/98	—	—	—	—	—	—	4961R	4963R	4962R	—	—	4960R	4960R	—	
CA21-98-0052	DP-1 W	21-10930	0–5	c1	channel	11/17/98	—	—	—	—	—	—	4961R	4963R	4962R	—	—	4960R	4960R	—	
CA21-98-0053	DP-1 W	21-10931	0–19	c3	fine	11/17/98	—	4964R	4964R	4964R	4964R	4964R	4961R	4963R	4962R	—	4960R	4960R	4960R	—	
CA21-98-0054	DP-1 W	21-10932	0–19	c2	fine	11/17/98	—	—	—	—	—	—	4961R	4963R	4962R	—	4960R	4960R	4960R	—	
CA21-98-0055	DP-1 W	21-10933	0–19	f1	fine	11/17/98	—	4964R	4964R	4964R	4964R	4964R	4961R	4963R	4962R	—	4960R	4960R	4960R	—	
CA21-98-0056	DP-1 W	21-10934	0–5	c1	channel	11/17/98	—	—	—	—	—	—	4961R	4963R	4962R	—	—	4960R	4960R	—	
CA21-98-0057	DP-1 C	21-10935	0–12	f1	fine	11/17/98	—	4964R	4964R	4964R	4964R	4964R	4961R	4963R	4962R	4960R	—	4960R	4960R	—	
CA21-98-0058	DP-1 C	21-10936	20–28	c3	fine	11/17/98	—	—	—	—	—	—	4961R	4963R	4962R	4960R	—	4960R	4960R	—	
CA21-98-0059	DP-1 C	21-10936	28–55	c3	coarse	11/17/98	—	—	—	—	—	—	4961R	4963R	4962R	—	—	4960R	4960R	—	
CA21-98-0060	DP-1 C	21-10937	48–57	f1	fine	11/17/98	—	—	—	—	—	—	—	4963R	4962R	4960R	—	4960R	4960R	—	
CA21-98-0061	DP-1 C	21-10938	0–5	c1	channel	11/17/98	—	—	—	—	—	—	4961R	4963R	4962R	—	—	4960R	4960R	—	
CA21-98-0062	DP-1 C	21-10939	0–23	c3	fine	11/17/98	—	—	—	—	—	—	4961R	4963R	4962R	—	—	4960R	4960R	—	
CA21-98-0063	DP-1 E	21-10940	23–36	c2	fine	11/17/98	—	—	—	—	—	—	4961R	4963R	4962R	4960R	—	4960R	4960R	—	
CA21-98-0064	DP-1 E	21-10941	0–26	f1	fine	11/17/98	—	—	—	—	—	—	4961R	4963R	4962R	4960R	—	4960R	4960R	—	
CA21-98-0065	DP-1 E	21-10942	29–41	c3	fine	11/17/98	—	4964R	4964R	4964R	4964R	4964R	4961R	4963R	4962R	4960R	—	4960R	4960R	—	
CA21-98-0066	DP-1 E	21-10942	87–105	c3	coarse	11/17/98	—	—	—	—	—	—	4961R	4963R	4962R	—	—	4960R	4960R	—	
CA21-98-0067	DP-1 E	21-10943	0–32	f1	fine	11/17/98	—	—	—	—	—	—	—	4963R	4962R	—	—	4960R	4960R	—	

Table D-2.0-1 (continued)

Sample ID	Reach or Subreach	Location ID	Depth (cm)	Geomorphic Unit	Sediment Facies	Date Collected	Related Sample ID	Gamma Spectroscopy	Tritium	Isotopic Pu	Isotopic U	Strontium-90	Metals	pH	Particle Size	PCBs	Pesticides and PCBs	SVOCs	TPH	VOCs	Sample Notes
CA21-98-0068	DP-1 E	21-10944	0–5	c1	channel	11/17/98	—	—	—	—	—	—	4961R	4963R	4962R	—	—	4960R	4960R	—	
CA21-98-0069	DP-1 E	21-10942	29–41	c3	fine	11/17/98	CA21-98-0065	4964R	4964R	4964R	4964R	4964R	4961R	4963R	4962R	—	4960R	4960R	4960R	—	FD
CA21-98-0070	DP-2	21-05501	0–20	c3b	fine	11/18/98	—	4980R	—	4980R	—	4980R	—	—	4979R	—	—	—	—	—	
CA21-98-0072	DP-2	21-05501	55–70	c3b	fine	11/18/98	—	4980R	—	4980R	—	4980R	—	—	4979R	—	—	—	—	—	
CA21-98-0073	DP-2	21-05501	88–98	c3b	coarse	11/18/98	—	4980R	—	4980R	—	4980R	4977R	4978R	4979R	—	4975R	4975R	4975R	—	
CA21-98-0074	DP-2	21-10950	0–29	c3b	fine	11/18/98	—	4980R	—	—	—	4980R	4977R	4978R	4979R	—	4975R	4975R	4975R	—	
CA21-98-0075	DP-2	21-10950	29–51	c3b	fine	11/18/98	—	4980R	—	—	—	4980R	—	—	4979R	—	—	—	—	—	
CA21-98-0076	DP-2	21-10950	68–93	c3b	coarse	11/18/98	—	4980R	—	—	—	4980R	4977R	4978R	4979R	—	4975R	4975R	4975R	—	
CA21-98-0077	DP-2	21-10951	0–33	c3a	fine	11/18/98	—	4980R	—	4980R	—	4980R	—	—	4979R	—	—	—	—	—	
CA21-98-0078	DP-2	21-10951	33–60	c3a	fine	11/18/98	—	4980R	—	4980R	—	4980R	—	—	4979R	—	—	—	—	—	
CA21-98-0079	DP-2	21-10951	60–73	c3a	fine	11/18/98	—	4986R	—	4986R	—	4986R	—	—	4985R	—	—	—	—	—	
CA21-98-0080	DP-2	21-10951	73–97	c3a	coarse	11/19/98	—	4986R	—	4986R	—	4986R	—	—	4985R	—	—	—	—	—	
CA21-98-0081	DP-2	21-10952	0–23	f1	fine	11/19/98	—	4986R	—	—	—	4986R	—	—	4985R	—	—	—	—	—	
CA21-98-0082	DP-2	21-05500	0–20	f1	fine	11/19/98	—	4986R	—	4986R	—	4986R	4983R	4984R	4985R	—	4981R	4981R	4981R	—	
CA21-98-0083	DP-2	21-05500	20–40	f1	fine	11/19/98	0121-97-1362	—	4986R	—	—	—	—	—	—	—	—	—	—	—	Resample
CA21-98-0084	DP-2	21-05500	55–75	f1	fine	11/19/98	—	4986R	—	4986R	—	—	—	—	4985R	—	—	—	4981R	—	
CA21-98-0085	DP-2	21-05500	75–90	f1	coarse	11/19/98	—	4986R	—	—	—	4986R	—	—	4985R	—	—	—	—	—	
CA21-98-0086	DP-2	21-10954	0–21	c3b	fine	11/18/98	—	4986R	—	4986R	—	4986R	—	—	4985R	—	—	—	—	—	
CA21-98-0087	DP-2	21-10954	30–45	c3b	fine	11/18/98	—	4986R	—	4986R	—	4986R	—	—	4985R	—	—	—	—	—	
CA21-98-0088	DP-2	21-10954	54–65	c3b	fine	11/18/98	—	4986R	—	4986R	—	4986R	—	—	4985R	—	—	—	—	—	
CA21-98-0089	DP-2	21-10954	65–78	c3b	coarse	11/19/98	—	4986R	—	4986R	—	4986R	—	—	4985R	—	—	—	—	—	
CA21-98-0090	DP-2	21-10955	0–14	f1	fine	11/19/98	—	4986R	—	—	—	4986R	—	—	4985R	—	—	—	—	—	
CA21-98-0091	DP-2	21-10955	14–33	f1	fine	11/19/98	—	4986R	—	—	—	4986R	—	—	4985R	—	—	—	—	—	
CA21-98-0092	DP-2	21-05499	0–20	c3b	fine	11/19/98	—	4986R	—	4986R	—	4986R	—	—	4985R	—	—	—	—	—	
CA21-98-0094	DP-2	21-05499	40–55	c3b	fine	11/19/98	—	4986R	—	4986R	—	4986R	—	—	4985R	—	—	—	—	—	
CA21-98-0095	DP-2	21-05499	55–76	c3b	fine/coarse	11/19/98	—	4986R	—	4986R	—	4986R	—	—	4985R	—	—	—	—	—	
CA21-98-0096	DP-2	21-05502	5–20	c2	fine	11/19/98	—	4986R	—	4986R	—	4986R	4983R	4984R	4985R	—	4981R	4981R	4981R	—	
CA21-98-0099	DP-2	21-10959	0–28	f1	fine	11/19/98	—	4986R	4986R	—	—	4986R	—	—	4985R	—	—	—	—	—	
CA21-98-0100	DP-2	21-10959	39–53	f1	coarse	11/19/98	—	4986R	—	—	—	4986R	—	—	4985R	—	—	—	—	—	
CA21-98-0101	DP-2	21-10960	0–5	c1	coarse	11/19/98	—	4986R	4986R	4986R	—	4986R	4983R	4984R	4985R	—	4981R	4981R	4981R	—	
CA21-98-0102	DP-3	21-10961	8–23	c3a	fine	11/20/98	—	5000R	—	5000R	—	5000R	4997R	4998R	4999R	—	4995R	4995R	4995R	—	
CA21-98-0103	DP-3	21-10961	51–58	c3a	coarse	11/20/98	—	5000R	—	5000R	—	5000R	—	—	4999R	—	—	—	—	—	
CA21-98-0104	DP-3	21-10962	0–31	c3b	fine	11/20/98	—	5000R	5001R	5000R	—	5000R	4997R	4998R	4999R	—	4995R	4995R	4995R	—	
CA21-98-0105	DP-3	21-10962	0–0	c3b	fine	11/20/98	—	5000R	—	5001R	—	—	—	—	4999R	—	—	—	—	—	
CA21-98-0106	DP-3	21-10962	114–136	c3b	fine	11/20/98	—	5000R	—	5001R	—	—	—	—	4999R	—	—	—	—	—	
CA21-98-0107	DP-3	21-10962	136–152	c3b	coarse	11/20/98	—	5000R	—	5000R	—	5000R	—	—	4999R	—	—	—	—	—	
CA21-98-0108	DP-3	21-10963	0–17	c3b	fine	11/20/98	—	5000R	5001R	5000R	—	5000R	4997R	4998R	4999R	—	4995R	4995R	4995R	—	
CA21-98-0109	DP-3	21-10963	17–41	c3b	fine	11/20/98	—	5000R	—	5000R	—	—	—	—	4999R	—	—	—	—	—	
CA21-98-0110	DP-3	21-10963	41–61	c3b	fine	11/20/98	—	5000R	—	5000R	—	5000R	—	—	4999R	—	—	—	—	—	

Table D-2.0-1 (continued)

Sample ID	Reach or Subreach	Location ID	Depth (cm)	Geomorphic Unit	Sediment Facies	Date Collected	Related Sample ID	Gamma Spectroscopy	Tritium	Isotopic Pu	Isotopic U	Strontium-90	Metals	pH	Particle Size	PCBs	Pesticides and PCBs	SVOCs	TPH	VOCs	Sample Notes
CA21-98-0111	DP-3	21-10964	0–20	f1	fine	11/20/98	—	5000R	—	—	—	—	—	—	4999R	—	—	—	—	—	
CA21-98-0112	DP-3	21-10964	20–40	f1	fine	11/20/98	—	5001R	—	—	—	—	—	—	4999R	—	—	—	—	—	
CA21-98-0113	DP-3	21-10964	48–77	f1	fine	11/20/98	—	5000R	—	—	—	—	—	—	4999R	—	—	—	—	—	
CA21-98-0114	DP-3	21-10964	95–120	f1	fine	11/20/98	—	5000R	—	—	—	—	—	—	4999R	—	—	—	—	—	
CA21-98-0115	DP-3	21-10964	77–95	f1	fine	11/20/98	—	5000R	—	—	—	—	—	—	4999R	—	—	—	—	—	
CA21-98-0116	DP-3	21-10965	0–23	f1	fine	11/20/98	—	5000R	—	5000R	—	5000R	4997R	4998R	4999R	—	4995R	4995R	4995R	—	
CA21-98-0117	DP-3	21-10965	23–56	f1	fine	11/20/98	—	5001R	—	—	—	—	—	—	4999R	—	—	—	—	—	
CA21-98-0118	DP-3	21-10965	70–113	f1	coarse	11/20/98	—	5000R	—	—	—	—	—	—	4999R	—	—	—	—	—	
CA21-98-0119	DP-3	21-10966	0–18	f2	fine	11/20/98	—	5000R	—	—	—	—	—	—	4999R	—	—	—	—	—	
CA21-98-0120	DP-3	21-10967	0–5	c1	coarse	11/20/98	—	5000R	—	5000R	—	5000R	4997R	4998R	4999R	—	4995R	4995R	4995R	—	
CA21-98-0121	DP-4	21-10968	20–40	f1	fine	11/23/98	—	5007R	—	5007R	—	5007R	—	—	4999R	—	—	—	—	—	
CA21-98-0122	DP-4	21-10973	5–20	c2b	fine	11/23/98	—	5007R	—	5007R	—	5007R	—	—	5006R	—	—	—	—	—	
CA21-98-0123	DP-4	21-05486	14–27	c2b	fine	11/23/98	—	—	—	—	—	—	—	—	—	—	5002R	5002R	5002R	—	
CA21-98-0124	DP-4	21-05486	35–54	c2b	coarse	11/23/98	—	—	—	—	—	—	—	—	—	—	5002R	5002R	5002R	—	
CA21-98-0125	DP-4	21-05487	0–48	c2a	fine	11/23/98	—	—	—	—	—	—	—	—	—	—	5002R	5002R	5002R	—	
CA21-98-0126	DP-4	21-05491	53–83	c2b	coarse	11/23/98	—	5007R	—	5007R	—	5007R	—	—	4999R	—	—	—	—	—	
CA21-98-0127	DP-4	21-05488	0–24	c2b	coarse	11/23/98	—	—	—	—	—	—	—	—	—	—	5002R	5002R	5002R	—	
CA21-98-0129	DP-4	21-05489	69–91	c2b	coarse	11/23/98	—	—	—	—	—	—	—	—	—	—	5002R	5002R	5002R	—	
CA21-98-0130	DP-4	21-10969	0–5	c1	coarse	11/23/98	—	5007R	—	5007R	—	5007R	5004R	5005R	4999R	—	5002R	5002R	5002R	—	
CA21-98-0131	DP-4	21-05490	0–28	c2b	fine	11/23/98	—	5007R	—	5007R	—	5007R	—	—	4999R	—	—	—	—	—	
CA21-98-0132	DP-4	21-05490	28–54	c2b	fine	11/23/98	—	—	—	—	—	—	—	—	—	—	5002R	5002R	5002R	—	
CA21-98-0133	DP-4	21-05490	54–105	c2b	coarse	11/23/98	—	5007R	—	5007R	—	5007R	—	—	5006R	—	—	—	—	—	
CA21-98-0134	DP-4	21-05491	0–30	c2b	fine	11/23/98	—	—	—	5007R	—	—	—	—	—	—	5002R	5002R	5002R	—	
CA21-98-0135	DP-4	21-05491	30–41	c2b	fine	11/23/98	—	—	—	—	—	—	—	—	—	—	5002R	5002R	5002R	—	
CA21-98-0136	DP-2	21-10956	76–82	c3b	fine	11/20/98	—	5000R	—	—	5000R	5000R	—	—	4999R	—	—	—	—	—	
CA21-98-0137	DP-2	21-10956	82–103	c3b	coarse	11/20/98	—	5000R	—	—	5000R	5000R	—	—	5006R	—	—	—	—	—	
CA21-98-0148	DP-2	21-10952	23–43	f1	fine	11/19/98	—	4986R	—	—	—	4986R	—	—	4985R	—	—	—	—	—	
CA21-98-0149	DP-4	21-10968	0–20	f1	fine	11/23/98	—	5007R	—	5007R	—	5007R	—	—	5006R	—	—	—	—	—	
CA21-98-0150	DP-4	21-10968	40–70	f1	fine	11/23/98	—	5007R	—	5007R	—	5007R	—	—	5006R	—	—	—	—	—	
CA21-98-0151	DP-4	21-10973	38–50	c2b	coarse	11/23/98	—	5007R	—	5007R	—	5007R	—	—	5006R	—	—	—	—	—	
CA21-98-0152	DP-4	21-05491	53–83	c2b	fine	11/23/98	CA21-98-0126	5007R	—	5007R	—	5007R	—	—	—	—	—	—	—	—	FD
CA21-98-0153	DP-4	21-05491	0–30	c2b	fine	11/23/98	CA21-98-0134	—	—	5007R	—	—	—	—	—	—	—	—	—	—	FD
CA21-98-0154	DP-3	21-05497	105–135	c3b	coarse	11/20/98	—	5007R	5007R	5007R	—	5007R	5004R	5005R	5006R	—	5002R	5002R	5002R	—	

[a] A dash in the table means "not analyzed."

[b] FD = field duplicate.

Table D-2.0-2
DP Canyon Water Samples, Analyte Suites, and Request Numbers

Sample ID	Location ID	Filtered/ Unfiltered	Date Collected	Metals	Major Anions	Bicarbonates	Major Cations	Total Organic Carbon	Gamma Spectroscopy	Tritium	Isotopic Pu	Isotopic U	Strontium-90	PCBs	Pesticides and PCBs	SVOCs	TPH	VOCs	Sample Notes
0121-97-1381	21-05471	Unfiltered	8/22/97	3616R	—[a]	—	—	—	—	—	—	—	—	—	3615R	3615R	—	—	Sample
0121-97-1382	21-05471	Unfiltered	8/22/97	3616R	—	—	—	—	—	—	—	—	—	—	3615R	3615R	—	3615R	Sample
0121-97-1383	21-05472	Unfiltered	8/22/97	3616R	—	—	—	—	—	—	—	—	—	—	3615R	3615R	—	—	Sample
0121-97-1384	21-05472	Unfiltered	8/22/97	3616R	—	—	—	—	—	—	—	—	—	—	3615R	3615R	—	3615R	Sample
0121-97-1396	21-01811	Unfiltered	8/20/97	3609R	—	—	—	—	3610R	3610R	3610R	3610R	3610R	3608R	—	3608R	3608R	3608R	Sample
0121-97-1397	21-01811	Filtered	8/20/97	3609R	—	—	—	—	3610R	—	3610R	3610R	3610R	3608R	—	3608R	3608R	—	Sample
0121-97-1398	21-01812	Unfiltered	8/20/97	3609R	—	—	—	—	3610R	3610R	3610R	3610R	3610R	3608R	—	3608R	3608R	3608R	Sample
0121-97-1399	21-01812	Filtered	8/20/97	3609R	—	—	—	—	3610R	—	3610R	3610R	3610R	3608R	—	3608R	3608R	—	Sample
0121-97-1400	21-01854	Unfiltered	8/21/97	3609R	—	—	—	—	3610R	3610R	3610R	3610R	3610R	3608R	—	3608R	3608R	3608R	Sample
0121-97-1401	21-01854	Filtered	8/21/97	3609R	—	—	—	—	3610R	—	3610R	3610R	3610R	3608R	—	3608R	3608R	—	Sample
0121-97-1421	21-01854	Unfiltered	10/15/97	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3800R	FB[b]
0121-97-1422	21-01854	Unfiltered	10/15/97	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3800R	Sample
0121-97-1424	21-01811	Unfiltered	12/4/97	3977R	—	—	—	—	3978R	3978R	3978R	3978R	3978R	3976R	—	3976R	3976R	3976R	Sample
0121-97-1425	21-01812	Unfiltered	12/4/97	3977R	—	—	—	—	3978R	3978R	3978R	3978R	3978R	3976R	—	3976R	3976R	3976R	Sample
0121-97-1426	21-01811	Unfiltered	12/4/97	3977R	—	—	—	—	3978R	3978R	3978R	3978R	3978R	3976R	—	3976R	3976R	3976R	FD[c]
0121-97-1428	21-01811	Filtered	12/4/97	3977R	—	—	—	—	3978R	—	3978R	3978R	3978R	—	—	—	—	—	Sample
0121-97-1429	21-01812	Filtered	12/4/97	3977R	—	—	—	—	3978R	—	3978R	3978R	3978R	—	—	—	—	—	Sample
0121-97-1430	21-01811	Filtered	12/4/97	3977R	—	—	—	—	3978R	—	3978R	3978R	3978R	—	—	—	—	—	FD
CA21-98-0001	21-01811	Unfiltered	5/5/98	4253R	—	—	—	—	4254R	4254R	4254R	4254R	4254R	—	4252R	4252R	—	4252R	Sample
CA21-98-0002	21-01811	Filtered	5/5/98	4253R	—	—	—	—	4254R	—	4254R	4254R	4254R	—	—	—	—	—	Sample
CA21-98-0003	21-01812	Unfiltered	5/5/98	4253R	—	—	—	—	4254R	4254R	4254R	4254R	4254R	—	4252R	4252R	—	4252R	Sample
CA21-98-0004	21-01812	Filtered	5/5/98	4253R	—	—	—	—	4254R	—	4254R	4254R	4254R	—	—	—	—	—	Sample
CA21-98-0005	21-01854	Unfiltered	5/6/98	4256R	—	—	—	—	4257R	4257R	4257R	4257R	4257R	—	4255R	4255R	—	4255R	Sample
CA21-98-0006	21-01854	Filtered	5/6/98	4256R	—	—	—	—	4257R	—	4257R	4257R	4257R	—	—	—	—	—	Sample
CA21-98-0007	21-01811	Unfiltered	9/17/98	4644R	4644R	4644R	4644R	4643R	4645R	4645R	4645R	4645R	4645R	—	—	—	—	4643R	Sample
CA21-98-0008	21-01811	Filtered	9/17/98	4644R	4644R	4644R	4644R	4643R	4645R	—	4645R	4645R	4645R	—	—	—	4643R	—	Sample
CA21-98-0009	21-01812	Unfiltered	9/17/98	4644R	4644R	4644R	4644R	4643R	4645R	4645R	4645R	4645R	4645R	—	—	—	—	4643R	Sample
CA21-98-0010	21-01812	Filtered	9/17/98	4644R	4644R	4644R	4644R	4643R	4645R	—	4645R	4645R	4645R	—	—	—	4643R	—	Sample
CA21-98-0011	21-01854	Unfiltered	9/16/98	4641R	4641R	4641R	4641R	4640R	4642R	4642R	4642R	4642R	4642R	—	—	—	—	4640R	Sample
CA21-98-0012	21-01854	Filtered	9/16/98	4641R	4641R	4641R	4641R	4640R	4642R	—	4642R	4642R	4642R	—	—	—	—	—	Sample
CA21-98-0013	21-10816	Unfiltered	10/26/98	4927R	—	—	—	—	—	—	—	—	—	—	4926R	4926R	4926R	4926R	Sample
CA21-98-0014	21-10816	Filtered	10/26/98	4927R	4927R	4927R	4927R	—	—	—	—	—	—	—	4926R	4926R	—	—	Sample
CA21-98-0015	21-10817	Unfiltered	10/26/98	4927R	—	—	—	—	—	—	—	—	—	—	4926R	4926R	4926R	4926R	Sample
CA21-98-0016	21-10817	Filtered	10/26/98	4927R	4927R	4927R	4927R	—	—	—	—	—	—	—	4926R	—	—	—	Sample
CA21-98-0042	21-01812	Unfiltered	10/7/98	—	—	—	—	—	—	—	—	—	—	—	4843R	4843R	—	—	Sample
CA21-98-0043	21-01854	Unfiltered	10/6/98	—	—	—	—	—	—	—	—	—	—	—	4827R	4827R	—	—	Sample

[a] A dash in the table means "not analyzed."

[b] FB = field blank.

[c] FD = field duplicate.

Table D-2.0-3
DP Canyon Request Numbers, Analytical Suites, and Contract Laboratories

Request Number	Number of Samples	Analytical Suite	Contract Laboratory
3468	4 sediment samples	TAL metals[a]	RECRA Lab NET[b]
3469	4 sediment samples	Gamma spectroscopy[c] Tritium[d] Uranium isotopes[e] Plutonium isotopes[f] Strontium-90[g]	Paragon Analytics, Inc.
3608	6 groundwater samples	PCBs[h] SVOCs[i] TPH-DRO[j] VOCs[k]	Kemron Environmental Services
3609	6 groundwater samples	TAL Metals	Kemron Environmental Services[l]
3610	6 groundwater samples	Gamma spectroscopy Tritium Uranium isotopes Plutonium isotopes Strontium-90	Paragon Analytics, Inc.
3615	4 storm water samples	Pesticides/PCBs[m] VOCs	Paragon Analytics, Inc.[n]
3616	4 storm water samples	TAL metals	Paragon Analytics, Inc.
3618	9 sediment samples	SVOCs PCBs	Paragon Analytics, Inc.
3619	9 sediment samples	TAL metals	Paragon Analytics, Inc.
3620	9 sediment samples	Gamma spectroscopy Tritium Uranium isotopes Plutonium isotopes Strontium-90	Paragon Analytics, Inc.
3800	1 DP Spring sample	VOCs	Paragon Analytics, Inc.
3852	6 sediment samples	PCBs SVOCs VOCs	QST Environmental[o]
3853	4 sediment samples	TAL Metals	QST Environmental
3854	4 sediment samples	Gamma spectroscopy Tritium (2 samples) Uranium isotopes Plutonium isotopes Strontium-90	QST Environmental
3976	3 groundwater samples	PCBs SVOCs TPH-DRO VOCs	Kemron Environmental Services

Table D-2.0-3 (continued)

Request Number	Number of Samples	Analytical Suite	Contract Laboratory
3977	6 groundwater samples	TAL Metals	Kemron Environmental Services
3978	6 groundwater samples	Gamma spectroscopy Tritium (3 samples) Uranium isotopes Plutonium isotopes Strontium-90	ThermoNUtech[p]
4252	2 groundwater samples	Pesticides/PCBs SVOCs VOCs	Kemron Environmental Services
4253	4 groundwater samples	TAL metals	Kemron Environmental Services
4254	4 groundwater samples	Gamma spectroscopy Tritium (2 samples) Uranium isotopes Plutonium isotopes Strontium-90	Paragon Analytics, Inc.
4255	1 DP Spring sample	Pesticides/PCBs SVOCs VOCs	Kemron Environmental Services
4256	2 DP Spring samples	TAL metals	Kemron Environmental Services
4257	2 DP Spring samples	Gamma spectroscopy Tritium (1 sample) Uranium isotopes Plutonium isotopes Strontium-90	Paragon Analytics, Inc.
4640	1 DP Spring sample	VOCs	Kemron Environmental Services
4641	2 DP Spring samples	TAL metals	Paragon Analytics, Inc.
4642	2 DP Spring samples	Gamma spectroscopy Tritium (1 sample) Uranium isotopes Plutonium isotopes Strontium-90	Paragon Analytics, Inc.
4643	2 groundwater samples	VOCs	Kemron Environmental Services
4644	4 groundwater samples	TAL metals	Paragon Analytics, Inc.
4645	4 groundwater samples	Gamma spectroscopy Tritium (2 samples) Uranium isotopes Plutonium isotopes Strontium-90	Paragon Analytics, Inc.
4827	1 groundwater sample	Pesticides/PCBs SVOCs	Kemron Environmental Services

Table D-2.0-3 (continued)

Request Number	Number of Samples	Analytical Suite	Contract Laboratory
4843	1 groundwater sample	Pesticides/PCBs SVOCs	Kemron Environmental Services
4926	4 storm water samples	PCBs SVOCs TPH-DRO VOCs	Paragon Analytics, Inc.
4927	4 storm water samples	TAL metals	Paragon Analytics, Inc.
4960	19 sediment samples	SVOCs TPH-DRO Pesticides (4 samples) PCBs (6 samples)	Paragon Analytics, Inc.
4961	17 sediment samples	TAL metals	Paragon Analytics, Inc.
4964	5 sediment samples	Gamma spectroscopy Tritium (2 samples) Uranium isotopes Plutonium isotopes Strontium-90	Paragon Analytics, Inc.
4975	3 sediment samples	Pesticides/PCBs SVOCs TPH-DRO	Paragon Analytics, Inc.
4977	3 sediment samples	TAL metals	Paragon Analytics, Inc.
4980	8 sediment samples	Gamma spectroscopy Plutonium isotopes (5 samples) Strontium-90	Paragon Analytics, Inc.
4981	3 sediment samples	Pesticides/PCBs SVOCs TPH-DRO	Paragon Analytics, Inc.
4983	3 sediment samples	TAL metals	Paragon Analytics, Inc.
4986	21 sediment samples	Gamma spectroscopy (20 samples) Tritium (4 samples) Plutonium isotopes (13 samples) Strontium-90 (19 samples)	Paragon Analytics, Inc.
4995	5 sediment samples	Pesticides/PCBs SVOCs TPH-DRO	Paragon Analytics, Inc.
4997	5 sediment samples	TAL metals	Paragon Analytics, Inc.
5000	19 sediment samples	Gamma spectroscopy (Cs-137 & Am-241) Uranium isotopes (2 samples) Plutonium isotopes (9 samples) Strontium-90 (10 samples)	Paragon Analytics, Inc.
5001	7 sediment samples	Gamma spectroscopy (2 samples) Tritium (2 samples) Plutonium isotopes (2 samples)	Paragon Analytics, Inc.

Table D-2.0-3 (continued)

Request Number	Number of Samples	Analytical Suite	Contract Laboratory
5002	10 sediment samples	Pesticides/PCBs SVOCs TPH-DRO	Paragon Analytics, Inc.
5004	2 sediment samples	TAL metals	Paragon Analytics, Inc.
5007	13 sediment samples	Gamma spectroscopy (Cs-137 & Am-241) Tritium (1 sample) Plutonium isotopes Strontium-90 (11 samples)	Paragon Analytics, Inc.

[a] TAL = target analyte list metals; 23 metals from the EPA Contract Laboratory Program TAL List.

[b] RECRA Lab NET is located in Lionville, Pennsylvania (formerly Weston Environmental).

[c] Americium-241, cobalt-60, cesium-134, cesium-137, europium-152, sodium-22, ruthenium-106, and uranium-235 analyzed by gamma spectroscopy.

[d] Tritium analyzed by liquid scintillation.

[e] Uranium isotopes analyzed by chemical separation/alpha spectroscopy.

[f] Plutonium isotopes analyzed by chemical separation/alpha spectroscopy.

[g] Strontium-90 analyzed by beta proportional counting.

[h] PCBs = polychlorinated biphenyls analyzed by EPA Method 8082.

[i] SVOCs = semivolatile organic compounds analyzed by EPA Method 8270.

[j] TPH-DRO = total petroleum hydrocarbons-diesel range organics analyzed by EPA Method 8015M.

[k] VOCs = volatile organic compounds analyzed by EPA Method 8260.

[l] Kemron Environmental Services is located in Marietta, Ohio.

[m] Pesticides/PCBs analyzed by EPA Methods 8081/8082.

[n] Paragon Analytics, Inc., is located in Fort Collins, Colorado (formerly ATI).

[o] QST Environmental was located in Gainesville, Florida. QST has closed and was previously ESE.

[p] ThermoNUtech is located in Oak Ridge, Tennessee.

D-3.0 SUMMARY OF DP CANYON ANALYSES

Tables D-3.0-1 through D-3.0-6 present summaries of the inorganic chemical, radionuclide, and organic chemical analyses for sediment samples and for all alluvial groundwater and storm water samples from DP Canyon reaches. These tables show the number of samples, detection frequency, and concentration range for each analyte.

Table D-3.0-1
Summary of Inorganic Chemical Analyses for Sediment in DP Canyon Reaches

Analyte	Total Count	Nondetects			Detects		
		Count	Min	Max	Count	Min	Max
Target Analyte List Metals Analyzed by EPA Method 6010 (mg/kg)							
Aluminum	47	0	—*	—	47	586	7660
Antimony	47	45	0.52	7.9	2	0.96	1.4
Arsenic	47	2	0.61	0.66	45	0.66	3
Barium	47	0	—	—	47	10.5	135
Beryllium	47	0	—	—	47	0.11	0.73
Cadmium	47	25	0.04	0.69	22	0.05	0.67
Calcium	47	0	—	—	47	282	12000
Chromium, total	47	0	—	—	47	0.88	20.4
Cobalt	47	0	—	—	47	0.94	4.8
Copper	47	0	—	—	47	1.3	36.1
Iron	47	0	—	—	47	1970	9880
Lead	47	0	—	—	47	4.9	207
Magnesium	47	0	—	—	47	137	1430
Manganese	47	0	—	—	47	83.7	738
Mercury	47	19	0.01	0.06	28	0.02	0.25
Nickel	47	0	—	—	47	0.91	8.7
Potassium	47	0	—	—	47	166	1500
Selenium	47	38	0.312	0.74	9	0.37	1.3
Silver	47	38	0.105	0.29	9	0.184	0.95
Sodium	47	0	—	—	47	20.2	266
Thallium	47	47	0.19	0.88	0	—	—
Vanadium	47	0	—	—	47	2.2	17.2
Zinc	47	0	—	—	47	9.5	166
pH Analyzed by EPA Method 150.1							
pH	32	0	—	—	32	6.3	7.7

*A dash in the table means "not applicable."

Table D-3.0-2
Summary of Radionuclide Analyses for Sediment in DP Canyon Reaches

Analyte	Total Count	Nondetects			Detects		
		Count	Min (pCi/g)	Max (pCi/g)	Count	Min (pCi/g)	Max (pCi/g)
Radionuclides Analyzed by Gamma Spectroscopy							
Actinium-228	19	0	—*	—	19	0.9	2.07
Americium-241	81	28	-0.35	4.59	53	0.65	71
Annihilation radiation	19	18	-0.099	0.18	1	0.157	0.157
Barium-140	19	19	-1.8	3.6	0	—	—
Bismuth-211	14	13	0	4.7	1	1.33	1.33
Bismuth-212	19	19	-2.71	2.7	0	—	—
Bismuth-214	19	0	—	—	19	0.62	1.68
Cadmium-109	19	18	-1.49	5.47	1	4	4
Cerium-139	19	19	-0.16	0.04	0	—	—
Cerium-144	27	27	-6.27	1.12	0	—	—
Cesium-134	19	19	-0.115	0.08	0	—	—
Cesium-137	82	4	0.021	0.17	78	0.114	442
Cobalt-57	27	27	-0.076	0.081	0	—	—
Cobalt-60	27	27	-0.119	0.106	0	—	—
Europium-152	27	27	-0.686	0.767	0	—	—
Iodine-129	6	6	-1.84	0.072	0	—	—
Lanthanum-140	19	19	-66	55	0	—	—
Lead-211	19	19	-2.6	5.4	0	—	—
Lead-212	19	1	0.582	0.582	18	0.97	2.06
Lead-214	19	1	0.633	0.633	18	0.84	1.66
Manganese-54	19	19	-0.076	0.08	0	—	—
Mercury-203	19	18	-0.16	0.131	1	0.138	0.138
Neptunium-237	27	27	-0.817	0.9	0	—	—
Potassium-40	27	1	31.8	31.8	26	21.2	32.7
Protactinium-231	19	17	0.8	5.14	2	3	4.3
Protactinium-233	19	19	-0.208	0.13	0	—	—
Protactinium-234M	19	19	-10.3	16.1	0	—	—
Radium-223	19	19	-1.09	2.62	0	—	—
Radium-224	19	19	-9.78	4.85	0	—	—
Radium-226	19	17	0.85	7.49	2	3.8	3.8
Radon-219	19	19	-2.5	1.79	0	—	—
Ruthenium-106	27	27	-1.15	0.92	0	—	—
Selenium-75	19	19	-0.144	0.103	0	—	—
Sodium-22	27	27	-0.054	0.144	0	—	—
Strontium-85	19	19	-0.293	-0.001	0	—	—
Thallium-208	19	2	0.322	0.467	17	0.29	0.766

Table D-3.0-2 (continued)

Analyte	Total Count	Nondetects			Detects		
		Count	Min (pCi/g)	Max (pCi/g)	Count	Min (pCi/g)	Max (pCi/g)
Radionuclides Analyzed by Gamma Spectroscopy (continued)							
Thorium-227	19	19	-3.48	0.077	0	—	—
Thorium-234	19	19	-4	2.06	0	—	—
Tin-113	19	19	-0.129	0.406	0	—	—
Uranium-235	8	8	-0.147	0.096	0	—	—
Yttrium-88	19	19	-0.171	0.057	0	—	—
Zinc-65	19	19	-0.14	0.246	0	—	—
Tritium Analyzed by Liquid Scintillation							
Tritium	26	10	0.01	0.12	16	0.03	3
Isotopic Plutonium Analyzed by Chemical Separation/Alpha Spectroscopy							
Plutonium-238	64	16	-0.0109	0.611	47	0.041	2.79
Plutonium-239,240	64	4	0.923	4.13	60	0.0272	48.3
Isotopic Uranium Analyzed by Chemical Separation/Alpha Spectroscopy							
Uranium-234	24	0	—	—	24	0.505	1.84
Uranium-235	24	2	0.0094	0.0228	22	0.021	0.105
Uranium-238	24	0	—	—	24	0.394	2.04
Strontium-90 Analyzed by Beta Proportional Counting							
Strontium-90	70	14	-0.15	0.64	56	0.09	32.8

*A dash in the table means "not applicable."

Table D-3.0-3
Summary of Organic Chemical Analyses for Sediment in DP Canyon Reaches

Analyte	Total Count	Nondetects			Detects		
		Count	Min (mg/kg)	Max (mg/kg)	Count	Min (mg/kg)	Max (mg/kg)
Polychlorinated Biphenyls Analyzed by EPA Method 8081							
Aroclor-1016	46	46	0.0139	0.82	0	—*	—
Aroclor-1221	46	46	0.0139	1.6	0	—	—
Aroclor-1232	46	46	0.0139	0.82	0	—	—
Aroclor-1242	46	46	0.0139	0.82	0	—	—
Aroclor-1248	46	46	0.0139	0.82	0	—	—
Aroclor-1254	46	46	0.0139	0.82	0	—	—
Aroclor-1260	46	33	0.034	0.82	13	0.022	1
Aldrin	25	25	0.0017	0.041	0	—	—
α-BHC	25	25	0.0017	0.041	0	—	—
β-BHC	25	25	0.0017	0.041	0	—	—
δ-BHC	25	25	0.0017	0.041	0	—	—
γ-BHC	25	25	0.0017	0.041	0	—	—
Chlordane (technical grade)	1	1	0.041	0.041	0	—	—
α-Chlordane	31	12	0.0017	0.041	19	0.0024	0.25
γ-Chlordane	30	12	0.0017	0.02	18	0.0021	0.18
4,4'-DDD	25	25	0.0034	0.082	0	—	—
4,4'-DDE	25	22	0.0034	0.082	3	0.0022	0.0042
4,4'-DDT	31	10	0.0034	0.081	21	0.0037	0.12
Dieldrin	25	25	0.0034	0.082	0	—	—
Endosulfan I	25	25	0.0017	0.041	0	—	—
Endosulfan II	25	25	0.0034	0.082	0	—	—
Endosulfan sulfate	25	25	0.0034	0.082	0	—	—
Endrin	25	25	0.0034	0.082	0	—	—
Endrin aldehyde	25	25	0.0034	0.082	0	—	—
Endrin ketone	25	25	0.0034	0.082	0	—	—
Heptachlor	25	25	0.0017	0.041	0	—	—
Heptachlor Epoxide	25	24	0.0017	0.041	1	0.11	0.11
4,4'-Methoxychlor	25	25	0.017	0.41	0	—	—
Semivolatile Organic Compounds Analyzed by EPA Method 8270							
Acenaphthene	55	54	0.088	4.2	1	0.24	0.24
Acenaphthylene	55	55	0.34	4.2	0	—	—
Aniline	55	55	0.68	8.3	0	—	—
Anthracene	55	48	0.1	4.2	7	0.048	0.62
Azobenzene	55	55	0.68	8.3	0	—	—
Benzidine	39	39	0.35	4.2	0	—	—
Benz(a)anthracene	55	26	0.37	4.1	29	0.026	3

Table D-3.0-3 (continued)

Analyte	Total Count	Nondetects			Detects		
		Count	Min (mg/kg)	Max (mg/kg)	Count	Min (mg/kg)	Max (mg/kg)
Semivolatile Organic Compounds Analyzed by EPA Method 8270 (continued)							
Benzo(a)pyrene	55	33	0.35	4.1	22	0.03	3.2
Benzo(b)fluoranthene	55	27	0.37	4	28	0.035	3.8
Benzo(g,h,i)perylene	55	46	0.34	4.2	9	0.15	5
Benzo(k)fluoranthene	46	32	0.34	4.1	14	0.059	1.4
Benzoic acid	55	54	1.7	21	1	0.38	0.38
Benzyl alcohol	55	55	0.68	8.3	0	—	—
Bis(2-chloroethoxy)methane	55	55	0.34	4.2	0	—	—
Bis(2-chloroethyl)ether	55	55	0.34	4.2	0	—	—
Bis(2-ethylhexyl)phthalate	55	27	0.34	4.2	28	0.034	1.7
4-Bromophenyl-phenylether	55	55	0.34	4.2	0	—	—
Butylbenzylphthalate	55	49	0.34	4.2	6	0.062	0.5
Carbazole	55	51	0.34	4.2	4	0.045	0.5
4-Chloro-3-methylphenol	55	55	0.68	8.3	0	—	—
4-Chloroaniline	55	55	0.68	8.3	0	—	—
2-Chloronaphthalene	55	55	0.34	4.2	0	—	—
2-Chlorophenol	55	55	0.34	4.2	0	—	—
4-Chlorophenyl-phenyl ether	55	55	0.34	4.2	0	—	—
Chrysene	55	26	0.37	4.1	29	0.03	3.3
Dibenz(a,h)anthracene	55	54	0.34	4.2	1	0.98	0.98
Dibenzofuran	55	55	0.34	4.2	0	—	—
1,3-Dichlorobenzene	54	54	0.006	4.2	0	—	—
3,3'-Dichlorobenzidine	55	55	0.68	8.3	0	—	—
2,4-Dichlorophenol	55	55	0.34	4.2	0	—	—
Diethylphthalate	55	55	0.34	4.2	0	—	—
Dimethyl phthalate	55	54	0.34	4.2	1	0.076	0.076
2,4-Dimethylphenol	55	55	0.34	4.2	0	—	—
Di-n-butylphthalate	55	54	0.34	4.2	1	2.1	2.1
4,6-Dinitro-2-methylphenol	55	55	1.7	21	0	—	—
2,4-Dinitrophenol	55	55	1.7	21	0	—	—
2,4-Dinitrotoluene	55	55	0.34	4.2	0	—	—
2,6-Dinitrotoluene	55	55	0.34	4.2	0	—	—
Di-n-octylphthalate	55	54	0.34	4.2	1	0.16	0.16
Fluoranthene	55	26	0.22	4.1	29	0.034	4.4
Fluorene	55	53	0.34	4.2	2	0.047	0.066
Hexachlorobenzene	55	55	0.34	4.2	0	—	—
Hexachlorobutadiene	55	55	0.34	4.2	0	—	—
Hexachlorocyclopentadiene	55	55	0.34	4.2	0	—	—

Table D-3.0-3 (continued)

Analyte	Total Count	Nondetects			Detects		
		Count	Min (mg/kg)	Max (mg/kg)	Count	Min (mg/kg)	Max (mg/kg)
Semivolatile Organic Compounds Analyzed by EPA Method 8270 (continued)							
Hexachloroethane	55	55	0.34	4.2	0	—	—
Indeno(1,2,3-cd)pyrene	55	43	0.34	4.2	12	0.13	3.8
Isophorone	55	55	0.34	4.2	0	—	—
2-Methylnaphthalene	55	53	0.34	4.2	2	0.031	0.046
2-Methylphenol	55	55	0.34	4.2	0	—	—
4-Methylphenol	55	55	0.34	4.2	0	—	—
Naphthalene	55	51	0.34	4.2	4	0.071	0.62
2-Nitroaniline	55	55	0.15	21	0	—	—
3-Nitroaniline	55	55	1.7	21	0	—	—
4-Nitroaniline	55	55	0.62	8.3	0	—	—
Nitrobenzene	55	55	0.34	4.2	0	—	—
2-Nitrophenol	55	55	0.34	4.2	0	—	—
4-Nitrophenol	55	55	1.7	21	0	—	—
N-Nitrosodimethylamine	55	55	0.34	4.2	0	—	—
N-Nitroso-di-n-propylamine	55	55	0.34	4.2	0	—	—
N-Nitrosodiphenylamine	55	55	0.34	4.2	0	—	—
2,2'-Oxybis(1-chloropropane)	55	55	0.34	4.2	0	—	—
Pentachlorophenol	55	55	1.7	21	0	—	—
Phenanthrene	55	24	0.088	4.1	31	0.027	3.2
Phenol	55	55	0.34	4.2	0	—	—
Pyrene	55	17	0.37	4	38	0.051	12
Pyridine	49	49	0.34	4.2	0	—	—
Toxaphene (technical grade)	25	25	0.17	4.1	0	—	—
1,2,4-Trichlorobenzene	55	55	0.34	4.2	0	—	—
2,4,5-Trichlorophenol	55	55	1.7	21	0	—	—
2,4,6-Trichlorophenol	55	54	0.34	4.2	1	9.3	9.3
Volatile Organic Compounds Analyzed by EPA Method 8260							
Acetone	6	5	0.021	0.024	1	0.006	0.006
Benzene	6	6	0.005	0.006	0	—	—
Bromobenzene	6	6	0.005	0.006	0	—	—
Bromochloromethane	6	6	0.005	0.006	0	—	—
Bromodichloromethane	6	6	0.005	0.006	0	—	—
Bromoform	6	6	0.005	0.006	0	—	—
Bromomethane	6	6	0.01	0.012	0	—	—
2-Butanone	6	6	0.021	0.024	0	—	—
n-Butylbenzene	6	6	0.005	0.006	0	—	—
sec-Butylbenzene	6	6	0.005	0.006	0	—	—

Table D-3.0-3 (continued)

Analyte	Total Count	Nondetects			Detects		
		Count	Min (mg/kg)	Max (mg/kg)	Count	Min (mg/kg)	Max (mg/kg)
Volatile Organic Compounds Analyzed by EPA Method 8260 (continued)							
tert-Butylbenzene	6	6	0.005	0.006	0	—	—
Carbon disulfide	6	6	0.005	0.006	0	—	—
Carbon tetrachloride	6	6	0.005	0.006	0	—	—
Chlorobenzene	6	6	0.005	0.006	0	—	—
Chlorodibromomethane	6	6	0.005	0.006	0	—	—
Chloroethane	6	6	0.01	0.012	0	—	—
Chloroform	6	6	0.005	0.006	0	—	—
Chloromethane	6	6	0.01	0.012	0	—	—
2-Chlorotoluene	6	6	0.005	0.006	0	—	—
4-Chlorotoluene	6	6	0.005	0.006	0	—	—
1,2-Dibromo-3-chloropropane	6	6	0.01	0.012	0	—	—
1,2-Dibromoethane	6	6	0.005	0.006	0	—	—
Dibromomethane	6	6	0.005	0.006	0	—	—
1,2-Dichlorobenzene	55	55	0.005	4.2	0	—	—
1,4-Dichlorobenzene	55	55	0.005	4.2	0	—	—
Dichlorodifluoromethane	6	6	0.01	0.012	0	—	—
1,1-Dichloroethane	6	6	0.005	0.006	0	—	—
1,2-Dichloroethane	6	6	0.005	0.006	0	—	—
1,1-Dichloroethene	6	6	0.005	0.006	0	—	—
cis-1,2-Dichloroethene	6	6	0.005	0.006	0	—	—
trans-1,2-Dichloroethene	6	6	0.005	0.006	0	—	—
1,2-Dichloropropane	6	6	0.005	0.006	0	—	—
1,3-Dichloropropane	6	6	0.005	0.006	0	—	—
2,2-Dichloropropane	6	6	0.005	0.006	0	—	—
1,1-Dichloropropene	6	6	0.005	0.006	0	—	—
cis-1,3-Dichloropropene	6	6	0.005	0.006	0	—	—
trans-1,3-Dichloropropene	6	6	0.005	0.006	0	—	—
Ethylbenzene	6	6	0.005	0.006	0	—	—
2-Hexanone	6	6	0.021	0.024	0	—	—
Iodomethane	6	6	0.005	0.006	0	—	—
Isopropylbenzene	6	6	0.005	0.006	0	—	—
4-Isopropyltoluene	6	6	0.005	0.006	0	—	—
4-Methyl-2-pentanone	6	6	0.021	0.024	0	—	—
Methylene Chloride	6	6	0.002	0.006	0	—	—
1-Propylbenzene	6	6	0.005	0.006	0	—	—
Styrene	6	6	0.005	0.006	0	—	—
1,1,1,2-Tetrachloroethane	6	6	0.005	0.006	0	—	—

Table D-3.0-3 (continued)

Analyte	Total Count	Nondetects			Detects		
		Count	Min (mg/kg)	Max (mg/kg)	Count	Min (mg/kg)	Max (mg/kg)
Volatile Organic Compounds Analyzed by EPA Method 8260 (continued)							
1,1,2,2-Tetrachloroethane	6	6	0.005	0.006	0	—	—
Tetrachloroethene	6	6	0.005	0.006	0	—	—
Toluene	6	5	0.005	0.008	1	0.002	0.002
1,1,2-Trichloro-1,2,2-trifluoroethane	6	6	0.005	0.006	0	—	—
1,1,1-Trichloroethane	6	6	0.005	0.006	0	—	—
1,1,2-Trichloroethane	6	6	0.005	0.006	0	—	—
Trichloroethene	6	6	0.005	0.006	0	—	—
Trichlorofluoromethane	6	6	0.005	0.006	0	—	—
1,2,3-Trichloropropane	6	6	0.005	0.006	0	—	—
1,2,4-Trimethylbenzene	6	6	0.005	0.006	0	—	—
1,3,5-Trimethylbenzene	6	6	0.005	0.006	0	—	—
Vinyl chloride	6	6	0.01	0.012	0	—	—
Xylene (total)	6	6	0.005	0.006	0	—	—
Total Petroleum Hydrocarbons-Diesel Range Organics Analyzed by EPA Method 8015M							
Organics, diesel range	41	0	—	—	41	31	680

*A dash in the table means "not applicable."

Table D-3.0-4
Summary of Inorganic Chemical Analyses for Alluvial Groundwater and Storm Water in DP Canyon

Analyte	Filtered									Unfiltered								
	Nondetect			Detect			Total			Nondetect			Detect			Total		
	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)
Target Analyte List Metals Analyzed by EPA Method 6010																		
Aluminum	7	100	100	7	27.1	2100	14	27.1	2100	2	100	100	16	36.6	8100	18	36.6	8100
Antimony	14	2.5	20	—*	—	—	14	2.5	20	17	2.5	20	1	5.3	5.3	18	2.5	20
Arsenic	12	2.4	4	2	3.3	6.3	14	2.4	6.3	13	2.4	4	5	3.2	8	18	2.4	8
Barium	—	—	—	14	10.4	210	14	10.4	210	—	—	—	18	49	200	18	49	200
Beryllium	14	0.2	4	—	—	—	14	0.2	4	15	0.2	4	3	0.53	0.89	18	0.2	4
Boron	—	—	—	5	33.1	67	5	33.1	67	—	—	—	3	41.1	64.6	3	41.1	64.6
Cadmium	14	0.2	5	—	—	—	14	0.2	5	17	0.2	5	1	0.34	0.34	18	0.2	5
Calcium	—	—	—	14	4970	110000	14	4970	110000	—	—	—	18	15000	95000	18	15000	95000
Chromium, total	12	0.3	10	2	0.63	1.2	14	0.3	10	12	0.3	10	6	5.8	15.3	18	0.3	15.3
Cobalt	13	0.5	20	1	0.8	0.8	14	0.5	20	11	0.5	20	7	0.81	4.8	18	0.5	20
Copper	9	20	20	5	0.9	4.8	14	0.9	20	9	20	20	9	1.1	49.5	18	1.1	49.5
Iron	3	40	40	11	50	1050	14	40	1050	—	—	—	18	103	7760	18	103	7760
Lead	11	1	1.1	3	1	5	14	1	5	6	1	1.1	12	1	64.2	18	1	64.2
Lithium	1	1	1	4	3.9	12.1	5	1	12.1	—	—	—	3	8.5	13.5	3	8.5	13.5
Magnesium	—	—	—	14	328	6900	14	328	6900	—	—	—	18	1600	6500	18	1600	6500
Manganese	6	10	830	8	0.97	760	14	0.97	830	5	10	870	13	17.6	870	18	10	870
Mercury	14	0.02	0.2	—	—	—	14	0.02	0.2	16	0.02	0.2	2	0.03	0.06	18	0.02	0.2
Molybdenum	3	2.6	4.3	2	3.2	5.4	5	2.6	5.4	2	2.6	2.6	1	3.4	3.4	3	2.6	3.4
Nickel	9	40	40	5	1.2	2.8	14	1.2	40	9	40	40	9	2.3	11.2	18	2.3	40
Potassium	—	—	—	14	1130	17700	14	1130	17700	—	—	—	18	3030	17700	18	3030	17700
Selenium	14	2.6	4	—	—	—	14	2.6	4	17	2.6	4	1	3	3	18	2.6	4
Silver	14	0.6	10	—	—	—	14	0.6	10	18	0.6	10	—	—	—	18	0.6	10
Sodium	1	76000	76000	13	1230	110000	14	1230	110000	—	—	—	18	4900	100000	18	4900	100000

Table D-3.0-4 (continued)

Analyte	Filtered									Unfiltered								
	Nondetect			Detect			Total			Nondetect			Detect			Total		
	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)
Target Analyte List Metals Analyzed by EPA Method 6010 (continued)																		
Strontium	—	—	—	5	17	249	5	17	249	—	—	—	3	114	251	3	114	251
Thallium	11	2.6	5	3	3	6.9	14	2.6	6.9	10	3.1	5	8	2.7	6.8	18	2.7	6.8
Uranium	5	60	126	—	—	—	5	60	126	3	126	126	—	—	—	3	126	126
Vanadium	9	10	10	5	0.53	3.6	14	0.53	10	9	10	10	9	0.6	15.6	18	0.6	15.6
Zinc	4	20	20	10	1.7	70	14	1.7	70	5	20	20	13	1.7	358	18	1.7	358
General Water Quality Parameters																		
Bicarbonate	—	—	—	5	15000	190000	5	15000	190000	—	—	—	3	87000	220000	3	87000	220000
Bromide	5	200	200	—	—	—	5	200	200	3	200	200	—	—	—	3	200	200
Carbon, total organic	—	—	—	3	3800	7700	3	3800	7700	—	—	—	3	4000	7800	3	4000	7800
Chlorate	2	20	20	—	—	—	2	20	20	—	—	—	—	—	—	—	—	—
Chloride		—	—	5	850	63000	5	850	63000	—	—	—	3	27000	63000	3	27000	63000
Fluoride	2	100	100	3	820	1300	5	100	1300	—	—	—	3	770	1300	3	770	1300
Iodide	2	100	100	—	—	—	2	100	100	—	—	—	—	—	—	—	—	—
Ammonia as N	5	500	500	—	—	—	5	500	500	3	500	500	—	—	—	3	500	500
Nitrate/Nitrite as N	1	50	50	2	250	280	3	50	280	—	—	—	3	50	310	3	50	310
Nitrate as N	—	—	—	2	230	230	2	230	230	—	—	—	—	—	—	—	—	—
Nitrite as N	2	100	100	—	—	—	2	100	100	—	—	—	—	—	—	—	—	—
Orthophosphate	2	200	200	—	—	—	2	200	200	—	—	—	—	—	—	—	—	—
Phosphorus	1	100	100	2	120	140	3	100	140	1	100	100	2	110	120	3	100	120
Silica, total	—	—	—	2	1700	2600	2	1700	2600	—	—	—	—	—	—	—	—	—
Sulfate	—	—	—	5	1500	7600	5	1500	7600	—	—	—	3	1500	7900	3	1500	7900
Grand Total	**222**	**—**	**—**	**176**	**—**	**—**	**398**	**—**	**—**	**203**	**—**	**—**	**253**	**—**	**—**	**456**	**—**	**—**

*A dash in the table means "not applicable."

Table D-3.0-5
Summary of Radionuclide Analyses for Alluvial Groundwater and Storm Water in DP Canyon

Analyte	Filtered									Unfiltered								
	Nondetect			Detect			Total			Nondetect			Detect			Total		
	Count	Min (pCi/L)	Max (pCi/L)	Count	Min (pCi/L)	Max (pCi/L)	Count	Min (pCi/L)	Max (pCi/L)	Count	Min (pCi/L)	Max (pCi/L)	Count	Min (pCi/L)	Max (pCi/L)	Count	Min (pCi/L)	Max (pCi/L)
Radionuclides Analyzed by Gamma Spectroscopy																		
Actinium-228	11	-6.18	10	1	15.6	15.6	12	-6.18	15.6	12	-9.69	4.84	—*	—	—	12	-9.69	4.84
Barium-140	11	-14	14.6	1	23	23	12	-14	23	12	-9.77	35	—	—	—	12	-9.77	35
Lead-210	2	-15.82	237.6	1	94.52	94.52	3	-15.82	237.6	2	-29.62	-25.99	1	100.3	100.3	3	-29.62	100.3
Potassium-40	12	-96.3	86	—	—	—	12	-96.3	86	11	-77	54.9	1	42.27	42.27	12	-77	54.9
Protactinium-231	12	-28.27	57.8	—	—	—	12	-28.27	57.8	11	-57	60.2	1	52.9	52.9	12	-57	60.2
Protactinium-234M	12	-201.7	412	—	—	—	12	-201.7	412	10	-135	450	2	456	630	12	-135	630
Thorium-234	12	-311	61.9	—	—	—	12	-311	61.9	10	-362	-1.91	2	60.96	66.33	12	-362	66.33
Americium-241	12	-11.7	7	—	—	—	12	-11.7	7	12	-4.56	6.6	—	—	—	12	-4.56	6.6
Annihilation radiation	9	-25.5	7.3	—	—	—	9	-25.5	7.3	9	-26	6.9	—	—	—	9	-26	6.9
Bismuth-211	12	-19.4	29.5	—	—	—	12	-19.4	29.5	12	-39.5	7.97	—	—	—	12	-39.5	7.97
Bismuth-212	12	-101	60.9	—	—	—	12	-101	60.9	12	-67.9	60	—	—	—	12	-67.9	60
Bismuth-214	12	-14.8	8.41	—	—	—	12	-14.8	8.41	12	-8.93	13.5	—	—	—	12	-8.93	13.5
Cadmium-109	12	-84.6	53	—	—	—	12	-84.6	53	12	-85.49	41.3	—	—	—	12	-85.49	41.3
Cerium-139	12	-1.07	0.805	—	—	—	12	-1.07	0.805	12	-1.3	1.06	—	—	—	12	-1.3	1.06
Cerium-144	12	-3.05	14.6	—	—	—	12	-3.05	14.6	12	-4.81	7.81	—	—	—	12	-4.81	7.81
Cesium-134	12	-1.45	0.85	—	—	—	12	-1.45	0.85	12	-1.9	1.96	—	—	—	12	-1.9	1.96
Cesium-137	12	-1.2	1.68	—	—	—	12	-1.2	1.68	12	-2.21	2.84	—	—	—	12	-2.21	2.84
Cobalt-57	12	-0.446	0.592	—	—	—	12	-0.446	0.592	12	-1.31	0.9	—	—	—	12	-1.31	0.9
Cobalt-60	12	-2.41	2.54	—	—	—	12	-2.41	2.54	12	-2.91	3.04	—	—	—	12	-2.91	3.04
Europium-152	12	-5.45	2.21	—	—	—	12	-5.45	2.21	12	-4.66	2.5	—	—	—	12	-4.66	2.5
Iodine-129	3	-1.36	1.7	—	—	—	3	-1.36	1.7	3	-1.86	-0.78	—	—	—	3	-1.86	-0.78
Lanthanum-140	9	-1000	3460	—	—	—	9	-1000	3460	9	-2400	625	—	—	—	9	-2400	625
Lead-211	12	-42	54.3	—	—	—	12	-42	54.3	12	-23.9	38.12	—	—	—	12	-23.9	38.12

Table D-3.0-5 (continued)

Analyte	Filtered									Unfiltered								
	Nondetect			Detect			Total			Nondetect			Detect			Total		
	Count	Min (pCi/L)	Max (pCi/L)	Count	Min (pCi/L)	Max (pCi/L)	Count	Min (pCi/L)	Max (pCi/L)	Count	Min (pCi/L)	Max (pCi/L)	Count	Min (pCi/L)	Max (pCi/L)	Count	Min (pCi/L)	Max (pCi/L)
Radionuclides Analyzed by Gamma Spectroscopy (continued)																		
Lead-212	12	-2.33	6.61	—	—	—	12	-2.33	6.61	12	-7	5.12	—	—	—	12	-7	5.12
Lead-214	12	-13.2	5.61	—	—	—	12	-13.2	5.61	12	-7.5	8.15	—	—	—	12	-7.5	8.15
Manganese-54	12	-1.08	1.14	—	—	—	12	-1.08	1.14	12	-2.1	0.82	—	—	—	12	-2.1	0.82
Mercury-203	12	-1.84	2.23	—	—	—	12	-1.84	2.23	12	-0.94	2	—	—	—	12	-0.94	2
Neptunium-237	12	-24	11.6	—	—	—	12	-24	11.6	12	-22.4	0.42	—	—	—	12	-22.4	0.42
Protactinium-233	12	-0.806	4.05	—	—	—	12	-0.806	4.05	12	-2.83	3.92	—	—	—	12	-2.83	3.92
Radium-223	12	-74.9	33.85	—	—	—	12	-74.9	33.85	12	-42.9	25	—	—	—	12	-42.9	25
Radium-224	12	-86	30.29	—	—	—	12	-86	30.29	12	-92	39.1	—	—	—	12	-92	39.1
Radium-226	12	-35.77	105	—	—	—	12	-35.77	105	12	-33	92.6	—	—	—	12	-33	92.6
Radon-219	12	-20.8	18	—	—	—	12	-20.8	18	12	-10.7	24.7	—	—	—	12	-10.7	24.7
Ruthenium-106	12	-14.61	14.3	—	—	—	12	-14.61	14.3	12	-5.1	15.9	—	—	—	12	-5.1	15.9
Selenium-75	12	-1.22	1.82	—	—	—	12	-1.22	1.82	12	-1.59	1.42	—	—	—	12	-1.59	1.42
Sodium-22	12	-0.98	1.8	—	—	—	12	-0.98	1.8	12	-2.4	2.26	—	—	—	12	-2.4	2.26
Strontium-85	12	-8.15	1.96	—	—	—	12	-8.15	1.96	12	-8.93	1.62	—	—	—	12	-8.93	1.62
Thallium-208	12	-3.6	2.89	—	—	—	12	-3.6	2.89	12	-2.95	4.54	—	—	—	12	-2.95	4.54
Thorium-227	12	-21.1	7.1	—	—	—	12	-21.1	7.1	12	-18.5	6.9	—	—	—	12	-18.5	6.9
Tin-113	12	-1.41	2.3	—	—	—	12	-1.41	2.3	12	-2.43	1.59	—	—	—	12	-2.43	1.59
Uranium-235	12	-9.52	1.95	—	—	—	12	-9.52	1.95	12	-7.3	1	—	—	—	12	-7.3	1
Yttrium-88	12	-5	0.79	—	—	—	12	-5	0.79	12	-3.15	1	—	—	—	12	-3.15	1
Zinc-65	12	-2.48	4.7	—	—	—	12	-2.48	4.7	12	-4.09	8.4	—	—	—	12	-4.09	8.4
Isotopic Plutonium Analyzed by Chemical Separation/Alpha Spectroscopy																		
Plutonium-238	12	0	0.051	—	—	—	12	0	0.051	12	-0.024	0.09	—	—	—	12	-0.024	0.09
Plutonium-239,240	12	-0.0059	0.04	—	—	—	12	-0.0059	0.04	8	-0.018	0.08	4	0.071	0.25	12	-0.018	0.25

Table D-3.0-5 (continued)

Analyte	Filtered									Unfiltered								
	Nondetect			Detect			Total			Nondetect			Detect			Total		
	Count	Min (pCi/L)	Max (pCi/L)	Count	Min (pCi/L)	Max (pCi/L)	Count	Min (pCi/L)	Max (pCi/L)	Count	Min (pCi/L)	Max (pCi/L)	Count	Min (pCi/L)	Max (pCi/L)	Count	Min (pCi/L)	Max (pCi/L)
Isotopic Uranium Analyzed by Chemical Separation/Alpha Spectroscopy																		
Uranium-234	—	—	—	12	0.373	1.73	12	0.373	1.73	—	—	—	12	0.415	1.32	12	0.415	1.32
Uranium-235	12	0.015	0.14	—	—	—	12	0.015	0.14	11	0	0.18	1	0.057	0.057	12	0	0.18
Uranium-238	6	0.039	0.2	6	0.07	0.42	12	0.039	0.42	5	0.047	0.2	7	0.07	0.239	12	0.047	0.239
Strontium-90 Analyzed by Beta Proportional Counting																		
Strontium-90	—	—	—	12	38.9	207.83	12	38.9	207.83	—	—	—	12	40.7	195.72	12	40.7	195.72
Tritium Analyzed by Liquid Scintillation																		
Tritium	—	—	—	—	—	—	—	—	—	11	3.38	210	1	280	280	12	3.38	280
Grand Total	**531**	—	—	**33**	—	—	**564**	—	—	**532**	—	—	**44**	—	—	**576**	—	—

*A dash in the table means "not applicable."

Table D-3.0-6
Summary of Organic Chemical Analyses for Alluvial Groundwater and Storm Water in DP Canyon

Analyte	Filtered									Unfiltered								
	Nondetect			Detect			Total			Nondetect			Detect			Total		
	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)
Polychlorinated Biphenyls Analyzed by EPA Method 8081																		
Aroclor-1016	5	0.5	1.1	—*	—	—	5	0.5	1.1	17	0.5	1.7	—	—	—	17	0.5	1.7
Aroclor-1221	5	0.5	2.1	—	—	—	5	0.5	2.1	17	0.5	3.3	—	—	—	17	0.5	3.3
Aroclor-1232	5	0.5	1.1	—	—	—	5	0.5	1.1	17	0.5	1.7	—	—	—	17	0.5	1.7
Aroclor-1242	5	0.5	1.1	—	—	—	5	0.5	1.1	17	0.5	1.7	—	—	—	17	0.5	1.7
Aroclor-1248	5	0.5	1.1	—	—	—	5	0.5	1.1	17	0.5	1.7	—	—	—	17	0.5	1.7
Aroclor-1254	5	1	1.1	—	—	—	5	1	1.1	17	1	1.7	—	—	—	17	1	1.7
Aroclor-1260	5	1	1.1	—	—	—	5	1	1.1	17	1	1.7	—	—	—	17	1	1.7
Aldrin	2	0.05	0.053	—	—	—	2	0.05	0.053	11	0.05	0.083	—	—	—	11	0.05	0.083
α-BHC	2	0.05	0.053	—	—	—	2	0.05	0.053	11	0.05	0.083	—	—	—	11	0.05	0.083
β-BHC	2	0.05	0.053	—	—	—	2	0.05	0.053	11	0.05	0.083	—	—	—	11	0.05	0.083
δ-BHC	2	0.05	0.053	—	—	—	2	0.05	0.053	11	0.05	0.083	—	—	—	11	0.05	0.083
γ-BHC	2	0.05	0.053	—	—	—	2	0.05	0.053	11	0.05	0.083	—	—	—	11	0.05	0.083
α-Chlordane	2	0.05	0.053	—	—	—	2	0.05	0.053	11	0.05	0.083	—	—	—	11	0.05	0.083
γ-Chlordane	2	0.05	0.053	—	—	—	2	0.05	0.053	11	0.05	0.083	—	—	—	11	0.05	0.083
4,4'-DDD	2	0.1	0.11	—	—	—	2	0.1	0.11	11	0.1	0.17	—	—	—	11	0.1	0.17
4,4'-DDE	2	0.1	0.11	—	—	—	2	0.1	0.11	11	0.1	0.17	—	—	—	11	0.1	0.17
4,4'-DDT	2	0.1	0.11	—	—	—	2	0.1	0.11	11	0.1	0.17	—	—	—	11	0.1	0.17
Dieldrin	2	0.1	0.11	—	—	—	2	0.1	0.11	11	0.1	0.17	—	—	—	11	0.1	0.17
Endosulfan I	2	0.05	0.053	—	—	—	2	0.05	0.053	11	0.05	0.083	—	—	—	11	0.05	0.083
Endosulfan II	2	0.1	0.11	—	—	—	2	0.1	0.11	11	0.1	0.17	—	—	—	11	0.1	0.17
Endosulfan sulfate	2	0.1	0.11	—	—	—	2	0.1	0.11	11	0.1	0.17	—	—	—	11	0.1	0.17
Endrin	2	0.1	0.11	—	—	—	2	0.1	0.11	11	0.1	0.17	—	—	—	11	0.1	0.17
Endrin aldehyde	2	0.1	0.11	—	—	—	2	0.1	0.11	11	0.01	0.17	—	—	—	11	0.01	0.17

Table D-3.0-6 (continued)

Analyte	Filtered									Unfiltered								
	Nondetect			Detect			Total			Nondetect			Detect			Total		
	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)
Polychlorinated Biphenyls Analyzed by EPA Method 8081 (continued)																		
Endrin ketone	2	0.1	0.11	—	—	—	2	0.1	0.11	11	0.1	0.17	—	—	—	11	0.1	0.17
Heptachlor	2	0.05	0.053	—	—	—	2	0.05	0.053	11	0.05	0.083	—	—	—	11	0.05	0.083
Heptachlor Epoxide	2	0.05	0.053	—	—	—	2	0.05	0.053	11	0.05	0.083	—	—	—	11	0.05	0.083
4,4'-Methoxychlor	2	0.5	0.53	—	—	—	2	0.5	0.53	11	0.5	0.83	—	—	—	11	0.5	0.83
Semivolatile Organic Compounds Analyzed by EPA Method 8270																		
Acenaphthene	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
Acenaphthylene	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
Aniline	4	20	20	—	—	—	4	20	20	17	20	44	—	—	—	17	20	44
Anthracene	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
Azobenzene	4	20	20	—	—	—	4	20	20	17	20	44	—	—	—	17	20	44
Benzidine	1	10	10	—	—	—	1	10	10	6	10	22	—	—	—	6	10	22
Benz(a)anthracene	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
Benzo(a)pyrene	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
Benzo(b)fluoranthene	4	10	10	—	—	—	4	10	10	14	10	22	3	1.1	1.6	17	1.1	22
Benzo(g,h,i)perylene	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
Benzo(k)fluoranthene	4	10	10	—	—	—	4	10	10	13	10	22	—	—	—	13	10	22
Benzoic acid	3	50	50	1	6.3	6.3	4	6.3	50	17	50	110	—	—	—	17	50	110
Benzyl alcohol	4	20	20	—	—	—	4	20	20	17	20	44	—	—	—	17	20	44
Bis(2-chloroethoxy)methane	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
Bis(2-chloroethyl)ether	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
Bis(2-ethylhexyl)phthalate	2	10	10	2	22	36	4	10	36	12	10	10	5	4	9	17	4	10
4-Bromophenyl-phenylether	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
Butylbenzylphthalate	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
Carbazole	1	10	10	—	—	—	1	10	10	6	10	22	—	—	—	6	10	22

Table D-3.0-6 (continued)

Analyte	Filtered									Unfiltered								
	Nondetect			Detect			Total			Nondetect			Detect			Total		
	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)
Semivolatile Organic Compounds Analyzed by EPA Method 8270 (continued)																		
4-Chloro-3-methylphenol	4	20	20	—	—	—	4	20	20	17	20	44	—	—	—	17	20	44
4-Chloroaniline	4	20	20	—	—	—	4	20	20	17	20	44	—	—	—	17	20	44
2-Chloronaphthalene	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
2-Chlorophenol	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
4-Chlorophenyl-phenyl ether	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
Chrysene	4	10	10	—	—	—	4	10	10	16	10	22	1	1.1	1.1	17	1.1	22
Dibenz(a,h)anthracene	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
Dibenzofuran	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
1,2-Dichlorobenzene	4	10	10	—	—	—	4	10	10	22	5	22	—	—	—	22	5	22
1,3-Dichlorobenzene	4	10	10	—	—	—	4	10	10	22	5	22	—	—	—	22	5	22
1,4-Dichlorobenzene	4	10	10	—	—	—	4	10	10	22	5	22	—	—	—	22	5	22
3,3'-Dichlorobenzidine	4	20	20	—	—	—	4	20	20	17	20	44	—	—	—	17	20	44
2,4-Dichlorophenol	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
Diethylphthalate	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
Dimethyl phthalate	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
2,4-Dimethylphenol	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
Di-n-butylphthalate	4	10	10	—	—	—	4	10	10	16	10	14	1	4.1	4.1	17	4.1	14
4,6-Dinitro-2-methylphenol	4	50	50	—	—	—	4	50	50	17	50	110	—	—	—	17	50	110
2,4-Dinitrophenol	4	50	50	—	—	—	4	50	50	17	50	110	—	—	—	17	50	110
2,4-Dinitrotoluene	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
2,6-Dinitrotoluene	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
Di-n-octylphthalate	4	10	10	—	—	—	4	10	10	14	10	22	3	1	1.5	17	1	22
Fluoranthene	4	10	10	—	—	—	4	10	10	15	10	22	2	1.2	1.7	17	1.2	22
Fluorene	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22

Table D-3.0-6 (continued)

Analyte	Filtered									Unfiltered								
	Nondetect			Detect			Total			Nondetect			Detect			Total		
	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)
Semivolatile Organic Compounds Analyzed by EPA Method 8270 (continued)																		
Hexachlorobenzene	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
Hexachlorobutadiene	4	10	10	—	—	—	4	10	10	19	5	22	—	—	—	19	5	22
Hexachlorocyclopentadiene	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
Hexachloroethane	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
Indeno(1,2,3-cd)pyrene	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
Isophorone	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
2-Methylnaphthalene	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
2-Methylphenol	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
4-Methylphenol	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
Naphthalene	4	10	10	—	—	—	4	10	10	19	5	22	—	—	—	19	5	22
2-Nitroaniline	4	50	50	—	—	—	4	50	50	17	50	110	—	—	—	17	50	110
3-Nitroaniline	4	50	50	—	—	—	4	50	50	17	10	110	—	—	—	17	10	110
4-Nitroaniline	4	20	20	—	—	—	4	20	20	17	20	44	—	—	—	17	20	44
Nitrobenzene	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
2-Nitrophenol	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
4-Nitrophenol	4	50	50	—	—	—	4	50	50	17	50	110	—	—	—	17	50	110
N-Nitrosodimethylamine	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
N-Nitroso-di-n-propylamine	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
N-Nitrosodiphenylamine	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
2,2'-Oxybis(1-chloropropane)	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
Pentachlorophenol	4	50	50	—	—	—	4	50	50	17	50	110	—	—	—	17	50	110
Phenanthrene	4	10	10	—	—	—	4	10	10	16	10	22	1	1	1	17	1	22
Phenol	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
Pyrene	4	10	10	—	—	—	4	10	10	14	10	22	3	1.1	1.7	17	1.1	22

Table D-3.0-6 (continued)

Analyte	Filtered									Unfiltered								
	Nondetect			Detect			Total			Nondetect			Detect			Total		
	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)
Semivolatile Organic Compounds Analyzed by EPA Method 8270 (continued)																		
Pyridine	1	10	10	—	—	—	1	10	10	6	10	22	—	—	—	6	10	22
Toxaphene (technical grade)	2	5	5.3	—	—	—	2	5	5.3	11	5	8.3	—	—	—	11	5	8.3
1,2,4-Trichlorobenzene	4	10	10	—	—	—	4	10	10	19	5	22	—	—	—	19	5	22
2,4,5-Trichlorophenol	4	50	50	—	—	—	4	50	50	17	50	110	—	—	—	17	50	110
2,4,6-Trichlorophenol	4	10	10	—	—	—	4	10	10	17	10	22	—	—	—	17	10	22
Volatile Organic Compounds Analyzed by EPA Method 8260																		
Acetone	—	—	—	—	—	—	—	—	—	17	20	35	1	38	38	18	20	38
Benzene	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
Bromobenzene	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
Bromochloromethane	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
Bromodichloromethane	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
Bromoform	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
Bromomethane	—	—	—	—	—	—	—	—	—	18	2.7	10	—	—	—	18	2.7	10
2-Butanone	—	—	—	—	—	—	—	—	—	16	5.8	20	2	8.2	8.3	18	5.8	20
n-Butylbenzene	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
sec-Butylbenzene	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
tert-Butylbenzene	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
Carbon disulfide	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
Carbon tetrachloride	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
Chlorobenzene	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
Chlorodibromomethane	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
Chloroethane	—	—	—	—	—	—	—	—	—	18	10	10	—	—	—	18	10	10
Chloroform	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
Chloromethane	—	—	—	—	—	—	—	—	—	18	10	10	—	—	—	18	10	10

Table D-3.0-6 (continued)

Analyte	Filtered									Unfiltered								
	Nondetect			Detect			Total			Nondetect			Detect			Total		
	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)
Volatile Organic Compounds Analyzed by EPA Method 8260 (continued)																		
2-Chlorotoluene	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
4-Chlorotoluene	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
1,2-Dibromo-3-chloropropane	—	—	—	—	—	—	—	—	—	18	10	10	—	—	—	18	10	10
1,2-Dibromoethane	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
Dibromomethane	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
Dichlorodifluoromethane	—	—	—	—	—	—	—	—	—	18	10	10	—	—	—	18	10	10
1,1-Dichloroethane	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
1,2-Dichloroethane	—	—	—	—	—	—	—	—	—	17	5	5	1	7.6	7.6	18	5	7.6
1,1-Dichloroethene	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
cis-1,2-Dichloroethene	—	—	—	—	—	—	—	—	—	18	5	10	—	—	—	18	5	10
trans-1,2-Dichloroethene	—	—	—	—	—	—	—	—	—	18	5	10	—	—	—	18	5	10
1,2-Dichloropropane	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
1,3-Dichloropropane	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
2,2-Dichloropropane	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
1,1-Dichloropropene	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
cis-1,3-Dichloropropene	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
trans-1,3-Dichloropropene	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
Ethylbenzene	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
2-Hexanone	—	—	—	—	—	—	—	—	—	18	20	20	—	—	—	18	20	20
Iodomethane	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
Isopropylbenzene	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
4-Isopropyltoluene	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
4-Methyl-2-pentanone	—	—	—	—	—	—	—	—	—	18	3.8	20	—	—	—	18	3.8	20
Methylene chloride	—	—	—	—	—	—	—	—	—	18	2.3	5	—	—	—	18	2.3	5

Table D-3.0-6 (continued)

Analyte	Filtered									Unfiltered								
	Nondetect			Detect			Total			Nondetect			Detect			Total		
	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)	Count	Min (µg/L)	Max (µg/L)
Volatile Organic Compounds Analyzed by EPA Method 8260 (continued)																		
1-Propylbenzene	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
Styrene	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
1,1,1,2-Tetrachloroethane	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
1,1,2,2-Tetrachloroethane	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
Tetrachloroethene	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
Toluene	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
1,1,2-Trichloro-1,2,2-trifluoroethane	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
1,2,3-Trichlorobenzene	—	—	—	—	—	—	—	—	—	6	5	5	—	—	—	6	5	5
1,1,1-Trichloroethane	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
1,1,2-Trichloroethane	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
Trichloroethene	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
Trichlorofluoromethane	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
1,2,3-Trichloropropane	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
1,2,4-Trimethylbenzene	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
1,3,5-Trimethylbenzene	—	—	—	—	—	—	—	—	—	18	5	5	—	—	—	18	5	5
Vinyl chloride	—	—	—	—	—	—	—	—	—	18	10	10	—	—	—	18	10	10
Xylene (total)	—	—	—	—	—	—	—	—	—	18	5	10	—	—	—	18	5	10
1,2-Xylene	—	—	—	—	—	—	—	—	—	2	5	5	—	—	—	2	5	5
Total Petroleum Hydrocarbon-Diesel Range Organics Analyzed by EPA Method 8015M																		
Organics, diesel range	3	500	500	—	—	—	3	500	500	8	100	1000	—	—	—	8	100	1000
Grand Total	**352**	—	—	**3**	—	—	**355**	—	—	**2578**	—	—	**23**	—	—	**2601**	—	—

*A dash in the table means "not applicable."

D-4.0 ANALYTICAL RESULTS FOR DP CANYON DETECTED CHEMICALS AND RADIONUCLIDES

Tables D-4.0-1 through D-4.0-3 present the detected inorganic chemicals, radionuclides, and organic chemicals for DP Canyon sediment samples. Tables D-4.0-4 through D-4.0-7 present the detected inorganic chemicals, radionuclides, organic chemicals, and water quality parameters for DP Canyon water samples.

Table D-4.0-1
Analytical Results for Detected Inorganic Chemicals in Sediment in DP Canyon Reaches

Reach	Sample ID	Location ID	Geomorphic Unit	Sediment Facies	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium, Total	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Potassium	Selenium	Silver	Sodium	Vanadium	Zinc	pH
DP-4	0121-97-1347	21-05486	c2b	fine	3930	0.77 (UJ-)[a]	1.8 (J)[b]	51.4	0.57 (J)	0.09 (U)[c]	1490	5.2	2.3 (J)	13.4	6630	47.7	715 (J)	235	0.02 (U)	3 (J)	715 (J)	0.61 (U)	0.27 (U)	54.3 (J)	9.2 (J)	47.9	—[d]
DP-4	0121-97-1348	21-05488	c2b	coarse	2860	0.74 (UJ-)	1.8 (J)	42.6 (J)	0.48 (J)	0.09 (U)	1000 (J)	3.1	2 (J)	6	6120	20.9	491 (J)	245	0.03 (J)	2.4 (J)	521 (J)	0.59 (U)	0.26 (U)	20.2 (J)	7.9 (J)	36.8	—
DP-4	0121-97-1349	21-05486	c2b	fine	2250	0.74 (UJ-)	1.8 (J)	28.8 (J)	0.36 (J)	0.09 (U)	765 (J)	2.8	2 (J)	9.3	4920	17.5	407 (J)	206	0.02 (U)	2.2 (J)	414 (J)	0.59 (U)	0.26 (U)	24.8 (J)	6.9 (J)	28.9	—
DP-4	0121-97-1350	21-05487	c2a	fine	3300	0.81 (UJ-)	1.6 (J)	41.4 (J)	0.54 (J)	0.1 (U)	1070 (J)	3.9	3 (J)	15.1	6080	24.7	568 (J)	245	0.02 (U)	2.3 (J)	678 (J)	0.64 (U)	0.29 (U)	79.6 (J)	7.9 (J)	48.2	—
DP-4	0121-97-1351	21-05487	c2a	fine	3100	0.8 (UJ-)	1.7 (J)	38 (J)	0.5 (J)	0.09 (U)	963 (J)	5.9	1.8 (J)	36.1	5680	35.2	546 (J)	214	0.02 (U)	2.2 (J)	568 (J)	0.64 (U)	0.28 (U)	55.6 (J)	7.1 (J)	50.3	—
DP-4	0121-97-1352	21-05489	c2b	coarse	3190	0.76 (UJ-)	1.6 (J)	39.5 (J)	0.6 (J)	0.09 (U)	1130	3.2	2 (J)	6.2	5520	28.9	616 (J)	218	0.02 (U)	2.2 (J)	659 (J)	0.6 (U)	0.27 (U)	52.2 (J)	7.4 (J)	39.3	—
DP-4	0121-97-1353	21-05490	c2b	fine	5460	0.75 (UJ-)	2.5	126	0.73 (J)	0.09 (U)	3350	5.9	3 (J)	12.5	7600	57.7	990 (J)	277	0.05 (J)	5.1 (J)	1030 (J)	0.59 (U)	0.26 (U)	87.5 (J)	11.5	53.4	—
DP-4	0121-97-1354	21-05491	c2b	fine	3860	0.8 (UJ-)	2 (J)	46.8 (J)	0.55 (J)	0.09 (U)	3340	4.6	2.3 (J)	14.8	6470	29.5	639 (J)	270	0.03 (J)	3.2 (J)	669 (J)	0.63 (U)	0.28 (U)	33.6 (J)	8.4 (J)	40.2	—
DP-4	0121-97-1355	21-05491	c2b	fine	3800	0.77 (UJ-)	2 (J)	50.7	0.59 (J)	0.09 (U)	2460	4.4	2.3 (J)	10.7	6080	29.5	639 (J)	241	0.03 (J)	3.1 (J)	637 (J)	0.61 (U)	0.27 (U)	40.6 (J)	8.5 (J)	38.1	—
DP-2	0121-97-1361	21-05501	c3b	fine	5280	7.9 (U)	1.9	68	0.32	0.69 (U)	2500	9.8	2.1	9.6	8050	67.8	940	267	0.06 (U)	3.3	744	0.47	0.63	116	11.1	70.9	—
DP-2	0121-97-1362	21-05500	f1	fine	7660	7.6 (U)	3	112	0.63	0.65 (U)	5150	8.3	4.7	14.4	9880	76.5	1430	333	0.09	6.6	1480	0.34 (U)	0.73	138	14.9	71.7	—
DP-2	0121-97-1363	21-05499	c3b	fine	6370	7.7 (U)	2.2	84.3	0.64	0.66 (U)	5200	7.3	3.8	9.5	8810	60.7	1150	308	0.08	7	1230	0.47	0.95	122	12.6	59.9	—
DP-2	0121-97-1364	21-05498	f1	fine	6480	7.7 (U)	2.2	84.9	0.48	0.66 (U)	4030	6.9	4.2	11.1	8720	52.2	1200	293	0.05 (U)	4.8	1180	0.37	0.59	157	12.6	66.2	—
DP-1	0121-97-1431	21-05496	c3	fine	2180	0.592 (U)	2.41	51.4	0.593	0.198 (J)	1480	9.45	2.22 (J)	7.6	4960	116	550 (J)	198	0.051	3.49 (J)	404 (J)	0.355 (U)	0.184 (J)	134 (J)	9.24	72.3	—
DP-3	0121-97-1432	21-05497	c3b	fine	2250	0.52 (U)	1.95	40.1	0.533	0.402 (J)	2740	4.91	2.23 (J)	5.17	4090	51.1	515 (J)	83.7	0.059	3.47 (J)	499 (J)	0.312 (U)	0.222 (J)	254 (J)	8.05	39.5	—
DP-2	0121-97-1441	21-05502	c2	coarse	1360	0.524 (U)	1.58	103	0.42 (J)	0.105 (U)	1090	1.8	4.71 (J)	2.6 (J)	3440	19.4	281 (J)	738	0.034	2.83 (J)	275 (J)	0.315 (U)	0.105 (U)	194 (J)	6.61	21.3	—
DP-2	0121-97-1442	21-05502	c2	coarse	1810	0.529 (U)	1.53	38.5	0.403 (J)	0.106 (U)	1150	2.16	2.34 (J)	2.9	4140	16.2	364 (J)	283	0.042	2.57 (J)	357 (J)	0.318 (U)	0.106 (U)	266 (J)	7	25	—
DP-1	CA21-98-0051	21-10929	c3	fine	5020	0.65 (UJ-)	2.7	90.1	0.52 (J)	0.22 (J)	3950	12	3.4 (J)	9.4	7890	93.8 (J+)[e]	1230	217	0.1 (J)	6.5 (J)	961 (J)	0.62 (U)	0.19 (U)	169 (J)	14.6	94	7.5
DP-1	CA21-98-0052	21-10930	c1	coarse	1060	0.56 (UJ-)	0.95 (J)	28 (J)	0.11 (J)	0.04 (U)	5720	4.6	1.6 (J)	9.4	3410	21.7 (J+)	741 (J)	94.8	0.01 (U)	3.4 (J)	270 (J)	0.54 (U)	0.17 (U)	47.9 (J)	6.3 (J)	52.7	7.6
DP-1	CA21-98-0053	21-10931	c3	fine	3000	0.78 (UJ-)	2 (J)	81.1	0.34 (J)	0.31 (J)	2450	14.6	3.4 (J)	9	6940	207 (J+)	895 (J)	222	0.08 (J)	8.5 (J)	614 (J)	0.6 (U)	0.19 (U)	75.2 (J)	12.7	100	7.2
DP-1	CA21-98-0054	21-10932	c2	fine	2880	0.66 (UJ-)	1.8 (J)	63.4	0.28 (J)	0.31 (J)	2960	14.8	3.7 (J)	15	7290	71.3 (J+)	1040 (J)	187	0.06 (J)	6.5 (J)	611 (J)	0.69 (J)	0.2 (U)	72.6 (J)	15.7	166	6.9
DP-1	CA21-98-0055	21-10933	f1	fine	4580	0.76 (UJ-)	3	135	0.56 (J)	0.4 (J)	8080	8.3	3.9 (J)	12.2	7770	97.5 (J+)	1420	321	0.12 (J)	7.5 (J)	1290	1.1 (J)	0.2 (U)	75.6 (J)	15.9	74.8	7.1
DP-1	CA21-98-0056	21-10934	c1	coarse	872	1.2 (UJ-)	0.66 (J)	28.8 (J)	0.11 (J)	0.05 (J)	12000	3	1.2 (J)	11.4	2910	9.4 (J+)	580 (J)	117	0.01 (U)	2.2 (J)	247 (J)	0.54 (U)	0.17 (U)	68.7 (J)	5.4 (J)	41.7	7.5
DP-1	CA21-98-0057	21-10935	f1	fine	5460	0.81 (UJ-)	2.6	119	0.61 (J)	0.12 (J)	3750	6.3	4.2 (J)	7.5	8460	23.5 (J+)	1300 (J)	270	0.03 (J)	6.7 (J)	1260 (J)	0.75 (J)	0.21 (U)	62 (J)	17.2	41.2	7.2
DP-1	CA21-98-0058	21-10936	c3	fine	2210	1 (UJ-)	2.8	64.3	0.26 (J)	0.67 (J)	3480	13.4	2.5 (J)	12.1	5240	202 (J+)	700 (J)	247	0.25	4.2 (J)	442 (J)	0.54 (U)	0.16 (U)	64.1 (J)	10.3	99.4	7.6
DP-1	CA21-98-0059	21-10936	c3	coarse	3280	0.57 (UJ-)	2.9	65.9	0.43 (J)	0.49 (J)	2910	16.6	3.1 (J)	13.1	7240	182 (J+)	876 (J)	178	0.16	8.7	561 (J)	0.55 (U)	0.17 (U)	97.4 (J)	14.8	104	7.7
DP-1	CA21-98-0060	21-10937	f1	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6.8
DP-1	CA21-98-0061	21-10938	c1	coarse	1370	0.71 (UJ-)	1.2 (J)	30.7 (J)	0.16 (J)	0.05 (J)	5610	3	1.4 (J)	11	3910	9.8 (J+)	662 (J)	99.7	0.01 (U)	2.7 (J)	298 (J)	0.54 (U)	0.17 (U)	110 (J)	6.2 (J)	53.7	6.3
DP-1	CA21-98-0062	21-10939	c3	fine	2840	0.63 (UJ-)	2.1 (J)	91.3	0.41 (J)	0.38 (J)	3420	15.6	3.1 (J)	8.9	6130	205 (J+)	868 (J)	248	0.08 (J)	5.1 (J)	614 (J)	0.61 (U)	0.37 (J)	72.2 (J)	12.3	106	6.5
DP-1	CA21-98-0063	21-10940	c2	fine	2680	0.98 (UJ-)	2.2 (J)	51.9	0.66 (J)	0.19 (J)	1470	20.4	2.7 (J)	13.6	8010	99.6 (J+)	660 (J)	269	0.02 (J)	4.6 (J)	513 (J)	0.65 (U)	0.2 (U)	73 (J)	12.7	88.3	6.7
DP-1	CA21-98-0064	21-10941	f1	fine	4050	0.64 (UJ-)	3	88.3	0.58 (J)	0.11 (J)	5380	8.7	3.7 (J)	6.6	7310	42.8 (J+)	1010 (J)	312	0.03 (J)	5.3 (J)	892 (J)	0.61 (U)	0.19 (U)	87 (J)	13.2	50	7
DP-1	CA21-98-0065	21-10942	c3	fine	3810	0.58 (UJ-)	2.4	81.4	0.54 (J)	0.4 (J)	2210	19.6	3.1 (J)	10.4	7110	189 (J+)	832 (J)	292	0.05 (J)	5.5 (J)	652 (J)	0.56 (U)	0.17 (U)	99.3 (J)	12.1	106	6.3
DP-1	CA21-98-0066	21-10942	c3	coarse	1660	0.59 (UJ-)	1.5 (J)	29.5 (J)	0.31 (J)	0.21 (J)	795 (J)	5.1	2.1 (J)	5.4 (J)	3580	53.4 (J+)	417 (J)	255	0.03 (J)	3.5 (J)	382 (J)	0.56 (U)	0.17 (U)	54.4 (J)	6.7 (J)	54.1	6.9
DP-1	CA21-98-0067	21-10943	f1	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7
DP-1	CA21-98-0068	21-10944	c1	coarse	754	0.56 (UJ-)	0.75 (J)	21 (J)	0.33 (J)	0.04 (U)	1370	1.3 (J)	1 (J)	7.9	3040	13.8 (J+)	256 (J)	142	0.01 (U)	1.5 (J)	198 (J)	0.54 (U)	0.16 (U)	38.6 (J)	4.3 (J)	29.6	7.2

Note: Results are in mg/kg.

Table D-4.0-1 (continued)

Reach	Sample ID	Location ID	Geomorphic Unit	Sediment Facies	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium, Total	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Potassium	Selenium	Silver	Sodium	Vanadium	Zinc	pH
DP-1	CA21-98-0069	21-10942	c3	fine	3300	1.1 (UJ-)	2.8	66.5	0.52 (J)	0.37 (J)	1790	13.7	2.7 (J)	9.8	6640	161 (J+)	737 (J)	236	0.06 (J)	4.7 (J)	594 (J)	0.73 (J)	0.17 (U)	81.5 (J)	11.2	91.5	6.8
DP-2	CA21-98-0070	21-05501	c3b	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-2	CA21-98-0072	21-05501	c3b	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-2	CA21-98-0073	21-05501	c3b	coarse	2660	0.85 (UJ-)	1.7 (J)	39.4 (J)	0.47 (J)	0.22 (J)	923 (J)	3.3	2.4 (J)	14.2	5950	24.8	483 (J)	224	0.03 (J)	4.9 (J)	624 (J)	0.73 (U)	0.69 (J)	132 (J)	8.3 (J)	39.3	6.8
DP-2	CA21-98-0074	21-10950	c3b	fine	2750	0.64 (UJ-)	2.1 (J)	51.6	0.46 (J)	0.08 (J)	1890	7.4	2.9 (J)	13.9	7030	35.7	590 (J)	224	0.02 (J)	4.1 (J)	576 (J)	1.3	0.19 (U)	90.1 (J)	10.1 (J)	68.3	7.1
DP-2	CA21-98-0075	21-10950	c3b	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-2	CA21-98-0076	21-10950	c3b	coarse	1570	0.91 (UJ-)	1.5 (J)	32.4 (J)	0.35 (J)	0.05 (U)	609 (J)	3.6	2.2 (J)	2.9 (J)	8570	26.9	330 (J)	241	0.01 (U)	2.5 (J)	346 (J)	0.67 (U)	0.21 (U)	88.4 (J)	9.7 (J)	47.3	7.1
DP-2	CA21-98-0077	21-10951	c3a	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-2	CA21-98-0078	21-10951	c3a	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-2	CA21-98-0079	21-10951	c3a	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-2	CA21-98-0080	21-10951	c3a	coarse	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-2	CA21-98-0081	21-10952	f1	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-2	CA21-98-0082	21-05500	f1	fine	5170	1.4 (J)	2.9	101	0.64 (J)	0.25 (J)	4820	7.7	3.6 (J)	9.6	8460	69.3	1130 (J)	297	0.09 (J)	6 (J)	1450	0.64 (U)	0.2 (U)	169 (J)	13.7	65.7	7.5
DP-2	CA21-98-0084	21-05500	f1	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-2	CA21-98-0085	21-05500	f1	coarse	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-2	CA21-98-0086	21-10954	c3b	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-2	CA21-98-0087	21-10954	c3b	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-2	CA21-98-0088	21-10954	c3b	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-2	CA21-98-0089	21-10954	c3b	coarse	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-2	CA21-98-0090	21-10955	f1	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-2	CA21-98-0091	21-10955	f1	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-2	CA21-98-0092	21-05499	c3b	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-2	CA21-98-0094	21-05499	c3b	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-2	CA21-98-0095	21-05499	c3b	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-2	CA21-98-0096	21-05502	c2	fine	3640	0.77 (UJ-)	1.8 (J)	55.6 (J)	0.51 (J)	0.06 (U)	2130	6.5	2.7 (J)	7 (J)	6930	33.1	694 (J)	222	0.02 (J)	4.3 (J)	797 (J)	0.74 (U)	0.23 (U)	213 (J)	10.2 (J)	68	6.8
DP-2	CA21-98-0099	21-10959	f1	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-2	CA21-98-0100	21-10959	f1	coarse	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-2	CA21-98-0101	21-10960	c1	coarse	639	0.96 (J)	1.1 (J)	14 (J)	0.21 (J)	0.05 (U)	419 (J)	2.1 (J)	3 (J)	1.3 (J)	4840	6.8	221 (J)	161	0.01 (U)	2.7 (J)	213 (J)	0.71 (U)	0.22 (U)	49.5 (J)	3.7 (J)	28.6	7.1
DP-3	CA21-98-0102	21-10961	c3a	fine	2730	0.62 (UJ-)	1.6 (J)	48.3	0.45 (J)	0.14 (J)	1480	5.4	2.5 (J)	4.8 (J)	6350	37.2	560 (J)	204	0.01 (U)	4.1 (J)	633 (J)	0.59 (U)	0.18 (U)	100 (J)	9 (J)	50.6	6.9
DP-3	CA21-98-0103	21-10961	c3a	coarse	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-3	CA21-98-0104	21-10962	c3b	fine	4300	0.65 (UJ-)	1.8 (J)	78.7	0.57 (J)	0.24 (J)	4130	6.5	3.3 (J)	8	7500	43.9	904 (J)	271	0.07 (J)	5.6 (J)	1390	0.63 (U)	0.19 (U)	135 (J)	11.9 (J)	53	7.4
DP-3	CA21-98-0105	21-10962	c3b	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-3	CA21-98-0106	21-10962	c3b	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-3	CA21-98-0107	21-10962	c3b	coarse	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-3	CA21-98-0108	21-10963	c3b	fine	2750	1.1 (UJ-)	1.5 (J)	50	0.42 (J)	0.05 (U)	1650	18.3	2.3 (J)	4 (J)	6180	80.1	572 (J)	192	0.01 (U)	3.6 (J)	679 (J)	0.71 (J)	0.19 (U)	87.6 (J)	9.2 (J)	48.7	7
DP-3	CA21-98-0109	21-10963	c3b	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-3	CA21-98-0110	21-10963	c3b	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Table D-4.0-1 (continued)

Reach	Sample ID	Location ID	Geomorphic Unit	Sediment Facies	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium, Total	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Potassium	Selenium	Silver	Sodium	Vanadium	Zinc	pH
DP-3	CA21-98-0111	21-10964	f1	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-3	CA21-98-0112	21-10964	f1	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-3	CA21-98-0113	21-10964	f1	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-3	CA21-98-0114	21-10964	f1	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-3	CA21-98-0115	21-10964	f1	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-3	CA21-98-0116	21-10965	f1	fine	5040	0.68 (UJ-)	2.6	86.5	0.63 (J)	0.05 (U)	1930	5.5	4.8 (J)	4.4 (J)	8610	11.6	1150 (J)	343	0.01 (U)	5.4 (J)	1500	0.65 (U)	0.2 (U)	129 (J)	15.5	24.3	6.6
DP-3	CA21-98-0117	21-10965	f1	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-3	CA21-98-0118	21-10965	f1	coarse	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-3	CA21-98-0119	21-10966	f2	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-3	CA21-98-0120	21-10967	c1	coarse	769	0.57 (UJ-)	1.5 (J)	15.7 (J)	0.29 (J)	0.04 (U)	554 (J)	1.2 (J)	1.3 (J)	2.8 (J)	3130	9.8	187 (J)	133	0.01 (U)	1.5 (J)	212 (J)	0.55 (U)	0.17 (U)	34.2 (J)	4 (J)	27.3	6.5
DP-4	CA21-98-0121	21-10968	f1	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-4	CA21-98-0122	21-10973	c2b	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-4	CA21-98-0126	21-05491	c2b	coarse	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-4	CA21-98-0130	21-10969	c1	coarse	586	0.55 (UJ-)	0.61 (U)	10.5 (J)	0.2 (J)	0.04 (U)	282 (J)	0.88 (J)	0.94 (J)	3.8 (J)	1970	5.9	137 (J)	93.2	0.01 (U)	0.91 (J)	166 (J)	0.53 (U)	0.16 (U)	36.4 (J)	2.2 (J)	17.3	6.7
DP-4	CA21-98-0131	21-05490	c2b	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-4	CA21-98-0133	21-05490	c2b	coarse	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-2	CA21-98-0136	21-10956	c3b	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-2	CA21-98-0137	21-10956	c3b	coarse	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-2	CA21-98-0148	21-10952	f1	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-4	CA21-98-0149	21-10968	f1	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-4	CA21-98-0150	21-10968	f1	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-4	CA21-98-0151	21-10973	c2b	coarse	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-3	CA21-98-0154	21-05497	c3b	coarse	1300	0.59 (UJ-)	0.66 (U)	21.5 (J)	0.19 (J)	0.04 (U)	509 (J)	1.8 (J)	1.7 (J)	3 (J)	2880	4.9	233 (J)	116	0.01 (U)	1.4 (J)	334 (J)	0.57 (U)	0.24 (J)	47.4 (J)	4.5 (J)	9.5	7.5

[a] UJ- = The analyte was analyzed for but not detected. Reported value is an estimate of the sample-specific quantitation limit or detection limit. The estimated detection limit may be biased low.

[b] 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.

[c] U = The analyte was analyzed for but not detected. Reported value is the sample-specific estimated quantitation limit or detection limit.

[d] A dash in the table means "not analyzed."

[e] J+ = The analyte was positively identified, and the reported value is an estimate and likely biased high.

Table D-4.0-2
Analytical Results for Detected Radionuclides in Sediment in DP Canyon

Reach	Sample ID	Location ID	Geomorphic Unit	Sediment Facies	Americium-241	Cesium-137	Plutonium-238	Plutonium-239,240	Strontium-90	Tritium	Uranium-234	Uranium-235	Uranium-238
DP-4	0121-97-1347	21-05486	c2b	fine	10.5	26.9	0.602	2.1	4.8	0.05	1.72	0.092	1.225
DP-4	0121-97-1348	21-05488	c2b	coarse	0.079 (U)[a]	65.2	0.094	2.5	7.6	0.05	0.876	0.045	0.751
DP-4	0121-97-1349	21-05486	c2b	fine	0.838 (U)	80.7	0.076	2.98	1.52	0.03	0.576	0.0094 (U)	0.544
DP-4	0121-97-1350	21-05487	c2a	fine	3.41	9.18	0.233	0.879	1.41	0.02 (U)	1.43	0.046	1.23
DP-4	0121-97-1351	21-05487	c2a	fine	2.22	8.22	0.317	0.495	1	0.07	1.32	0.057	1.196
DP-4	0121-97-1352	21-05489	c2b	coarse	0.937 (U)	21.2	0.279	1.05	3.38	0.05	1.004	0.027	0.985
DP-4	0121-97-1353	21-05490	c2b	fine	6.78	149	1.192	11.88	28.3	0.09	1.43	0.049	1.243
DP-4	0121-97-1354	21-05491	c2b	fine	1.45	109	0.09	4.45	31.1	0.01 (U)	0.98	0.03	0.962
DP-4	0121-97-1355	21-05491	c2b	fine	4.28	133	1.046	48.3	26.9	0.04 (U)	1.26	0.046	1.003
DP-2	0121-97-1361	21-05501	c3b	fine	5.73	2.5	0.398 (U)	0.923 (U)	4.76	0.04 (U)	0.916	0.032	0.474
DP-2	0121-97-1362	21-05500	f1	fine	5.18	76.2	0.506 (U)	4.04 (U)	19.6	3	0.922	0.022	0.708
DP-2	0121-97-1363	21-05499	c3b	fine	1.65	94.7	0.181 (U)	4.13 (U)	32.8	0.342	0.703	0.034	0.695
DP-2	0121-97-1364	21-05498	f1	fine	4.59 (U)	32.4	0.611 (U)	2.77 (U)	7.5	0.5	0.931	0.033	0.636
DP-1	0121-97-1431	21-05496	c3	fine	0.038 (U)	0.114	-0.005 (U)	0.039	-0.15 (U)	0.066 (U)	0.575	0.021	0.63
DP-3	0121-97-1432	21-05497	c3b	fine	28.6	93.2	2.21	11.2	12.1	0.067 (U)	1.71	0.067	0.441
DP-2	0121-97-1441	21-05502	c2	coarse	1.23	36.3	0.263	2.45	3.88	—[b]	0.505	0.032	0.394
DP-2	0121-97-1442	21-05502	c2	coarse	1.22	34.6	0.187	2.1	5.22	—	0.577	0.021	0.485
DP-1	CA21-98-0053	21-10931	c3	fine	0.34R	0.206	0 (U)	0.048	0.2 (U)	0.05 (U)	0.845	0.048	0.833
DP-1	CA21-98-0055	21-10933	f1	fine	0 (U)	0.62	0.0047 (U)	0.068	0.27 (U)	0.13	1.84	0.105	2.04
DP-1	CA21-98-0057	21-10935	f1	fine	0.15 (U)	0.12 (U)	-0.0109 (U)	0.044	0.19 (U)	0.11 (U)	0.918	0.047	0.958
DP-1	CA21-98-0065	21-10942	c3	fine	-0.18 (U)	0.159	0.0049 (U)	0.075	0.05 (U)	0.05	0.919	0.052	0.967
DP-1	CA21-98-0069	21-10942	c3	fine	0.4 (U)	0.101 (U)	0.0013 (U)	0.061	0.22 (U)	0.05	0.899	0.065	0.874
DP-2	CA21-98-0070	21-05501	c3b	fine	1.03	0.69	0.08	0.2	0.11 (U)	—	—	—	—
DP-2	CA21-98-0072	21-05501	c3b	fine	5.9	14.4	0.347	1.411	5.8	—	—	—	—
DP-2	CA21-98-0073	21-05501	c3b	coarse	7.3	134	1.286	11.11	1.12	—	—	—	—
DP-2	CA21-98-0074	21-10950	c3b	fine	0.65	0.96	—	—	0.13 (U)	—	—	—	—
DP-2	CA21-98-0075	21-10950	c3b	fine	0.94 (U)	1.35	—	—	0.33 (U)	—	—	—	—
DP-2	CA21-98-0076	21-10950	c3b	coarse	0.23 (U)	1.08	—	—	0.7	—	—	—	—
DP-2	CA21-98-0077	21-10951	c3a	fine	1.56	3.43	0.068	0.28	0.56 (U)	—	—	—	—
DP-2	CA21-98-0078	21-10951	c3a	fine	2.5	3.66	0.112	0.475	0.54 (U)	—	—	—	—
DP-2	CA21-98-0079	21-10951	c3a	fine	4.1	4.85	0.229	0.915	0.76	—	—	—	—
DP-2	CA21-98-0080	21-10951	c3a	coarse	1.21	1.37	0.086	0.133	1.13	—	—	—	—
DP-2	CA21-98-0081	21-10952	f1	fine	14.4	6.7	—	—	1.58	—	—	—	—
DP-2	CA21-98-0082	21-05500	f1	fine	13.4	51.1	0.703	3.41	11.3	—	—	—	—
DP-2	CA21-98-0083	21-05500	f1	fine	—	—	—	—	—	0.23	—	—	—
DP-2	CA21-98-0084	21-05500	f1	fine	1.9	25.7	0.151	5.56	—	—	—	—	—
DP-2	CA21-98-0085	21-05500	f1	coarse	0.65	4.13	—	—	3.29	—	—	—	—
DP-2	CA21-98-0086	21-10954	c3b	fine	18.4	11.4	0.549	1.238	1.26	—	—	—	—

Note: Results are in pCi/g.

Table D-4.0-2 (continued)

Reach	Sample ID	Location ID	Geomorphic Unit	Sediment Facies	Americium-241	Cesium-137	Plutonium-238	Plutonium-239,240	Strontium-90	Tritium	Uranium-234	Uranium-235	Uranium-238
DP-2	CA21-98-0087	21-10954	c3b	fine	29.8	25.8	0.989	3.77	7.4	—	—	—	—
DP-2	CA21-98-0088	21-10954	c3b	fine	3.4	442	0.158	3.95	3.74	—	—	—	—
DP-2	CA21-98-0089	21-10954	c3b	coarse	2.6 (J)[c]	128	0.192	4.15	1.68	—	—	—	—
DP-2	CA21-98-0090	21-10955	f1	fine	0.63 (U)	3.98	—	—	1.77	—	—	—	—
DP-2	CA21-98-0091	21-10955	f1	fine	0.75 (U)	3.64	—	—	1.49	—	—	—	—
DP-2	CA21-98-0092	21-05499	c3b	fine	5.3	88	0.218	2.97	15.1	—	—	—	—
DP-2	CA21-98-0094	21-05499	c3b	fine	0.75	8.6	0.047	2.45	11.9	—	—	—	—
DP-2	CA21-98-0095	21-05499	c3b	fine	1.3 (U)	9.6	0.096	3.46	15.9	—	—	—	—
DP-2	CA21-98-0096	21-05502	c2	fine	1.19	6.8	0.053	0.355	2.43	—	—	—	—
DP-2	CA21-98-0099	21-10959	f1	fine	1.7 (U)	16.5	—	—	3.76	0.48	—	—	—
DP-2	CA21-98-0100	21-10959	f1	coarse	0.21 (U)	0.219	—	—	0.19 (U)	—	—	—	—
DP-2	CA21-98-0101	21-10960	c1	coarse	-0.19 (U)	0.27	0.0127 (U)	0.0272	0.64 (U)	0.12 (U)	—	—	—
DP-3	CA21-98-0102	21-10961	c3a	fine	13	10.3	0.81	2.47	2.38	—	—	—	—
DP-3	CA21-98-0103	21-10961	c3a	coarse	5.3	10.8	0.371	0.922	1.35	—	—	—	—
DP-3	CA21-98-0104	21-10962	c3b	fine	6	111	0.445	9.73	17.1	0.13	—	—	—
DP-3	CA21-98-0105	21-10962	c3b	fine	4.2	85	0.649	8.8	—	—	—	—	—
DP-3	CA21-98-0106	21-10962	c3b	fine	0.2 (U)	2.48	0.0258 (U)	0.606	—	—	—	—	—
DP-3	CA21-98-0107	21-10962	c3b	coarse	0.37 (U)	6.5	0.085 (U)	1.407	4.08	—	—	—	—
DP-3	CA21-98-0108	21-10963	c3b	fine	7.6	10.4	0.402	1.255	1.99	0.12	—	—	—
DP-3	CA21-98-0109	21-10963	c3b	fine	71	90	2.79	7.44	—	—	—	—	—
DP-3	CA21-98-0110	21-10963	c3b	fine	7	192	0.941	10.08	2.35	—	—	—	—
DP-3	CA21-98-0111	21-10964	f1	fine	16.6	15.4	—	—	—	—	—	—	—
DP-3	CA21-98-0112	21-10964	f1	fine	21.7	18.7	—	—	—	—	—	—	—
DP-3	CA21-98-0113	21-10964	f1	fine	25.9	22.5	—	—	—	—	—	—	—
DP-3	CA21-98-0114	21-10964	f1	fine	12.6	57.8	—	—	—	—	—	—	—
DP-3	CA21-98-0115	21-10964	f1	fine	8.3	64	—	—	—	—	—	—	—
DP-3	CA21-98-0116	21-10965	f1	fine	-0.35 (U)	0.17 (U)	0.0071 (U)	0.102	1.06	—	—	—	—
DP-3	CA21-98-0117	21-10965	f1	fine	0.11 (U)	0.021 (U)	—	—	—	—	—	—	—
DP-3	CA21-98-0118	21-10965	f1	coarse	0.12 (U)	2.28	—	—	—	—	—	—	—
DP-3	CA21-98-0119	21-10966	f2	fine	1.05 (U)	2.2	—	—	—	—	—	—	—
DP-3	CA21-98-0120	21-10967	c1	coarse	-0.22 (U)	1.03	0.0207 (U)	0.084	0.39 (U)	—	—	—	—
DP-4	CA21-98-0121	21-10968	f1	fine	4.5	12.9	0.356	0.991	2.64 (J)	—	—	—	—
DP-4	CA21-98-0122	21-10973	c2b	fine	32.7	31.8	1.34	4.18	6.7 (J)	—	—	—	—
DP-4	CA21-98-0126	21-05491	c2b	coarse	1.55	3.32	0.041	4.3	0.99 (J)	—	—	—	—
DP-4	CA21-98-0130	21-10969	c1	coarse	0.18 (U)	1.11	0.0139 (U)	0.054	0.09 (J)	—	—	—	—
DP-4	CA21-98-0131	21-05490	c2b	fine	6.3	78	0.944	4.9	12.2 (J)	—	—	—	—
DP-4	CA21-98-0133	21-05490	c2b	coarse	0.06 (U)	11.5	0.053	0.475	5.7 (J)	—	—	—	—
DP-4	CA21-98-0134	21-05491	c2b	fine	—	—	0.335	10.87	—	—	—	—	—
DP-2	CA21-98-0136	21-10956	c3b	fine	2.95	6.2	—	—	12.8	—	1.46	0.103	0.989
DP-2	CA21-98-0137	21-10956	c3b	coarse	0.15 (U)	14.5	—	—	1.55	—	0.528	0.0228 (U)	0.421

Table D-4.0-2 (continued)

Reach	Sample ID	Location ID	Geomorphic Unit	Sediment Facies	Americium-241	Cesium-137	Plutonium-238	Plutonium-239,240	Strontium-90	Tritium	Uranium-234	Uranium-235	Uranium-238
DP-2	CA21-98-0148	21-10952	f1	fine	8.4	11.2	—	—	2.31	—	—	—	—
DP-4	CA21-98-0149	21-10968	f1	fine	1.8	4.12	0.07	0.357	1.33 (J)	—	—	—	—
DP-4	CA21-98-0150	21-10968	f1	fine	16.2	25.6	1.312	2.54	5.5 (J)	—	—	—	—
DP-4	CA21-98-0151	21-10973	c2b	coarse	0.38 (U)	6.7	0.0231 (U)	0.488	2.51 (J)	—	—	—	—
DP-4	CA21-98-0152	21-05491	c2b	fine	1.45	3.61	0.058	4.5	0.54 (J)	—	—	—	—
DP-4	CA21-98-0153	21-05491	c2b	fine	—	—	0.225	4	—	—	—	—	—
DP-3	CA21-98-0154	21-05497	c3b	coarse	0.77	12.9	0.066	0.393	1.11 (J)	0.05 (U)	—	—	—

[a] U = The analyte was analyzed for but not detected. Reported value is the sample-specific estimated quantitation limit or detection limit.

[b] A dash in the table means "not analyzed."

[c] 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.

Table D-4.0-3
Analytical Results for Detected Organic Chemicals in Pesticide and PCB Suites and in SVOC Suites in Sediment in DP Canyon

Part 1

Reach	Sample ID	Location ID	Geomorphic Unit	Sediment Facies	Acenaphthene	Acetone	Anthracene	Aroclor-1260	Benz(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Benzoic Acid	Bis(2-ethylhexyl)phthalate	Butylbenzylphthalate	Carbazole	α-Chlordane	γ-Chlordane	Chrysene	4,4'-DDE
DP-4	0121-97-1347	21-05486	c2b	fine	3.8 (U)[a]	—[b]	3.8 (U)	0.038 (U)	3.8 (U)	3.8 (U)	3.8 (U)	3.8 (U)	—	19 (U)	3.8 (U)	3.8 (U)	3.8 (U)	—	—	3.8 (U)	—
DP-4	0121-97-1348	21-05488	c2b	coarse	3.6 (U)	—	3.6 (U)	0.036 (U)	3.6 (U)	3.6 (U)	3.6 (U)	3.6 (U)	—	18 (U)	3.6 (U)	3.6 (U)	3.6 (U)	—	—	3.6 (U)	—
DP-4	0121-97-1349	21-05486	c2b	fine	3.6 (U)	—	3.6 (U)	0.036 (U)	3.6 (U)	3.6 (U)	3.6 (U)	3.6 (U)	—	18 (U)	3.6 (U)	3.6 (U)	3.6 (U)	—	—	3.6 (U)	—
DP-4	0121-97-1350	21-05487	c2a	fine	4 (U)	—	4 (U)	0.04 (U)	4 (U)	4 (U)	4 (U)	4 (U)	—	20 (U)	4 (U)	4 (U)	4 (U)	—	—	4 (U)	—
DP-4	0121-97-1351	21-05487	c2a	fine	3.9 (U)	—	3.9 (U)	0.039 (U)	3.9 (U)	3.9 (U)	3.9 (U)	3.9 (U)	—	20 (U)	3.9 (U)	3.9 (U)	3.9 (U)	—	—	3.9 (U)	—
DP-4	0121-97-1352	21-05489	c2b	coarse	3.7 (U)	—	3.7 (U)	0.037 (U)	3.7 (U)	3.7 (U)	3.7 (U)	3.7 (U)	—	19 (U)	3.7 (U)	3.7 (U)	3.7 (U)	—	—	3.7 (U)	—
DP-4	0121-97-1353	21-05490	c2b	fine	3.7 (U)	—	3.7 (U)	0.041	3.7 (U)	3.7 (U)	3.7 (U)	3.7 (U)	—	18 (U)	3.7 (U)	3.7 (U)	3.7 (U)	—	—	3.7 (U)	—
DP-4	0121-97-1354	21-05491	c2b	fine	3.9 (U)	—	3.9 (U)	0.039 (U)	3.9 (U)	3.9 (U)	3.9 (U)	3.9 (U)	—	20 (U)	3.9 (U)	3.9 (U)	3.9 (U)	—	—	3.9 (U)	—
DP-4	0121-97-1355	21-05491	c1	coarse	3.8 (U)	—	3.8 (U)	0.038	3.8 (U)	3.8 (U)	3.8 (U)	3.8 (U)	—	19 (U)	3.8 (U)	3.8 (U)	3.8 (U)	—	—	3.8 (U)	—
DP-1	0121-97-1431	21-05496	c3	fine	0.088 (U)	0.024 (U)	0.1 (U)	0.0663	0.24	0.31 (J)[c]	0.25	0.39 (UJ)[d]	0.3	3.9 (U)	0.2	0.39 (UJ)	0.39 (U)	0.00894	0.011	0.27	—
DP-3	0121-97-1432	21-05497	c3b	fine	0.4 (U)	0.024 (U)	0.4 (U)	0.054	0.4 (UJ)	0.4 (UJ)	0.4 (UJ)	0.4 (UJ)	0.4 (UJ)	4 (U)	0.16 (J)	0.062 (J)	0.4 (U)	0.00714	0.00898	0.4 (UJ)	—
DP-2	0121-97-1433	21-05498	f1	fine	0.36 (U)	0.022 (U)	0.36 (U)	0.0993	0.24 (J)	0.37 (J)	0.42 (J)	0.36 (UJ)	0.31 (J)	3.6 (U)	0.14 (J)	0.36 (UJ)	0.36 (U)	0.011	0.0119	0.34 (J)	—
DP-2	0121-97-1434	21-05499	c3b	fine	0.34 (U)	0.021 (U)	0.34 (U)	0.128	0.13	0.15	0.14	0.15	0.14	3.4 (U)	0.34 (U)	0.34 (U)	0.34 (U)	0.031	0.0338	0.16	—
DP-2	0121-97-1435	21-05500	f1	fine	0.39 (U)	0.006 (J)	0.048	0.175	0.16 (J)	0.19 (J)	0.39 (UJ)	0.18 (J)	0.39 (UJ)	3.9 (U)	0.59 (J)	0.39 (UJ)	0.39 (U)	0.031	0.0336	0.2 (J)	—
DP-2	0121-97-1440	21-05501	c3b	fine	0.4 (U)	0.024 (UJ-)[e]	0.4 (U)	0.0491	0.36 (J)	0.46 (J)	0.5 (J)	0.4 (UJ)	0.37 (J)	4 (U)	0.92 (J)	0.53 (U)	0.4 (U)	0.00708	0.00756	0.44 (J)	—
DP-1	CA21-98-0051	21-10929	c3	fine	3.9 (UJ)	—	3.9 (UJ)	—	0.3 (J)	3.9 (UJ)	0.49 (J)	3.9 (UJ)	3.9 (UJ)	20 (UJ)	0.28 (J)	3.9 (UJ)	3.9 (UJ)	—	—	0.31 (J)	—
DP-1	CA21-98-0052	21-10930	c1	coarse	3.5 (UJ)	—	3.5 (UJ)	—	0.8 (J)	0.74 (J)	1.2 (J)	3.5 (UJ)	3.5 (UJ)	17 (UJ)	0.8 (J)	3.5 (UJ)	3.5 (UJ)	—	—	0.91 (J)	—
DP-1	CA21-98-0053	21-10931	c3	fine	3.9 (UJ)	—	0.42 (J)	0.39 (U)	0.93 (J)	1.1 (J)	1.3 (J)	3.9 (UJ)	0.54 (J)	20 (UJ)	0.54 (J)	3.9 (UJ)	3.9 (UJ)	0.011 (J)	0.02 (U)	1.2 (J)	0.039 (U)
DP-1	CA21-98-0054	21-10932	c2	fine	4.1 (UJ)	—	0.62 (J)	0.81 (U)	3 (J)	3.2 (J)	3.8 (J)	5 (J)	1.4 (J)	20 (UJ)	1.7 (J)	0.32 (J)	0.5 (J)	0.041 (U)	—	3.3 (J)	0.081 (U)
DP-1	CA21-98-0055	21-10933	f1	fine	4.1 (UJ)	—	4.1 (UJ)	0.82 (U)	0.62 (J)	0.49 (J)	0.9 (J)	4.1 (UJ)	4.1 (UJ)	21 (UJ)	4.1 (UJ)	4.1 (UJ)	4.1 (UJ)	0.25	0.18	0.62 (J)	0.082 (U)
DP-1	CA21-98-0056	21-10934	c1	coarse	3.4 (UJ)	—	3.4 (UJ)	—	0.42 (J)	3.4 (UJ)	0.68 (J)	3.4 (UJ)	3.4 (UJ)	17 (UJ)	0.72 (J)	3.4 (UJ)	3.4 (UJ)	—	—	0.49 (J)	—
DP-1	CA21-98-0057	21-10935	f1	fine	0.44 (UJ)	—	0.44 (UJ)	0.044 (U)	0.039 (J)	0.44 (UJ)	0.44 (UJ)	0.44 (UJ)	0.44 (UJ)	2.2 (UJ)	0.053 (J)	0.44 (UJ)	0.44 (UJ)	—	—	0.041 (J)	—
DP-1	CA21-98-0058	21-10936	c3	fine	0.24 (J)	—	0.33 (J)	1	0.8 (J)	0.75 (J)	0.77 (J)	3.5 (UJ)	0.25 (J)	17 (UJ)	1.1 (J)	0.5 (J)	3.5 (UJ)	—	—	0.7 (J)	—
DP-1	CA21-98-0059	21-10936	c3	coarse	3.5 (UJ)	—	3.5 (UJ)	—	3.5 (UJ)	3.5 (UJ)	3.5 (UJ)	3.5 (UJ)	3.5 (UJ)	18 (UJ)	3.5 (UJ)	3.5 (UJ)	3.5 (UJ)	—	—	3.5 (UJ)	—
DP-1	CA21-98-0060	21-10937	f1	fine	0.38 (UJ)	—	0.38 (UJ)	0.038 (U)	0.38 (UJ)	0.38 (UJ)	0.38 (UJ)	0.38 (UJ)	0.38 (UJ)	1.9 (UJ)	0.049 (J)	0.38 (UJ)	0.38 (UJ)	—	—	0.38 (UJ)	—
DP-1	CA21-98-0061	21-10938	c1	coarse	3.5 (UJ)	—	3.5 (UJ)	—	1.2 (J)	3.5 (UJ)	1.7 (J)	3.5 (UJ)	3.5 (UJ)	18 (UJ)	0.6 (J)	3.5 (UJ)	0.27 (J)	—	—	0.99 (J)	—
DP-1	CA21-98-0062	21-10939	c3	fine	3.8 (UJ)	—	3.8 (UJ)	—	0.37 (J)	3.8 (UJ)	3.8 (UJ)	3.8 (UJ)	3.8 (UJ)	19 (UJ)	0.32 (J)	3.8 (UJ)	3.8 (UJ)	—	—	0.4 (J)	—
DP-1	CA21-98-0063	21-10940	c2	fine	4.2 (UJ)	—	4.2 (UJ)	0.022 (J)	0.96 (J)	0.83 (J)	1.2 (J)	4.2 (UJ)	0.39 (J)	21 (UJ)	4.2 (UJ)	4.2 (UJ)	4.2 (UJ)	—	—	0.9 (J)	—
DP-1	CA21-98-0064	21-10941	f1	fine	3.9 (UJ)	—	3.9 (UJ)	0.024 (J)	0.64 (J)	0.51 (J)	0.7 (J)	3.9 (UJ)	3.9 (UJ)	20 (UJ)	3.9 (UJ)	3.9 (UJ)	3.9 (UJ)	—	—	0.64 (J)	—
DP-1	CA21-98-0065	21-10942	c3	fine	3.6 (UJ)	—	3.6 (UJ)	0.077	3.6 (UJ)	3.6 (UJ)	3.6 (UJ)	3.6 (UJ)	3.6 (UJ)	18 (UJ)	0.46 (J)	3.6 (UJ)	3.6 (UJ)	—	—	3.6 (UJ)	—
DP-1	CA21-98-0066	21-10942	c3	coarse	3.6 (UJ)	—	3.6 (UJ)	—	3.6 (UJ)	3.6 (UJ)	3.6 (UJ)	3.6 (UJ)	3.6 (UJ)	18 (UJ)	0.42 (J)	3.6 (UJ)	3.6 (UJ)	—	—	3.6 (UJ)	—
DP-1	CA21-98-0067	21-10943	f1	fine	0.41 (UJ)	—	0.41 (UJ)	—	0.41 (UJ)	0.41 (UJ)	0.41 (UJ)	0.41 (UJ)	0.41 (UJ)	2 (UJ)	0.41 (UJ)	0.45 (J)	0.41 (UJ)	—	—	0.41 (UJ)	—
DP-1	CA21-98-0068	21-10944	c1	coarse	0.35 (UJ)	—	0.069 (J)	—	0.29 (J)	0.26 (J)	0.28 (J)	0.27 (J)	0.083 (J)	1.7 (UJ)	0.13 (J)	0.35 (UJ)	0.045 (J)	—	—	0.29 (J)	—
DP-1	CA21-98-0069	21-10942	c3	fine	3.9 (UJ)	—	3.9 (UJ)	0.39 (U)	3.9 (UJ)	3.9 (UJ)	3.9 (UJ)	3.9 (UJ)	3.9 (UJ)	20 (UJ)	0.72 (J)	0.28 (J)	3.9 (UJ)	0.017 (J)	0.012 (J)	3.9 (UJ)	0.039 (U)
DP-2	CA21-98-0073	21-05501	c3b	coarse	0.92 (U)	—	0.11 (J)	0.046 (U)	0.17 (J)	0.17 (J)	0.18 (J)	0.92 (U)	0.084 (J)	4.6 (U)	0.92 (U)	0.92 (U)	0.92 (U)	0.0024	0.0028	0.17 (J)	0.0046 (U)
DP-2	CA21-98-0074	21-10950	c3b	fine	2 (U)	—	2 (U)	0.16 (U)	0.69 (J)	0.68 (J)	1 (J)	0.59 (J)	0.32 (J)	9.9 (U)	0.56 (J)	2 (U)	2 (U)	0.0079 (U)	0.0079 (U)	0.81 (J)	0.016 (U)
DP-2	CA21-98-0076	21-10950	c3b	coarse	2 (U)	—	2 (U)	0.082 (U)	0.26 (J)	2 (U)	0.36 (J)	2 (U)	2 (U)	10 (U)	2 (U)	2 (U)	2 (U)	0.0041 (U)	0.0041 (U)	0.28 (J)	0.0082 (U)
DP-2	CA21-98-0082	21-05500	f1	fine	0.82 (UJ)	—	0.82 (UJ)	0.16 (U)	0.19 (J)	0.2 (J)	0.26 (J)	0.24 (J)	0.1 (J)	4.1 (UJ)	0.13 (J)	0.82 (UJ)	0.82 (UJ)	0.02	0.014	0.2 (J)	0.016 (U)
DP-2	CA21-98-0084	21-05500	f1	fine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DP-2	CA21-98-0096	21-05502	c2	fine	0.95 (UJ)	—	0.95 (UJ)	0.19 (U)	0.77 (J)	0.72 (J)	0.86 (J)	0.7 (J)	0.4 (J)	4.8 (UJ)	0.82 (J)	0.95 (UJ)	0.13 (J)	0.0095 (U)	0.0095 (U)	0.83 (J)	0.019 (U)
DP-2	CA21-98-0101	21-10960	c1	coarse	0.84 (UJ)	—	0.84 (UJ)	0.042 (U)	0.84 (UJ)	0.84 (UJ)	0.84 (UJ)	0.84 (UJ)	0.84 (UJ)	4.2 (UJ)	0.075 (J)	0.84 (UJ)	0.84 (UJ)	0.0021 (U)	0.0021 (U)	0.84 (UJ)	0.0042 (U)

Note: Results are in mg/kg.

Table D-4.0-3 (continued)

Part 1 (continued)

Reach	Sample ID	Location ID	Geomorphic Unit	Sediment Facies	Acenaphthene	Acetone	Anthracene	Aroclor-1260	Benz(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Benzoic Acid	Bis(2-ethylhexyl)phthalate	Butylbenzylphthalate	Carbazole	α-Chlordane	γ-Chlordane	Chrysene	4,4'-DDE
DP-3	CA21-98-0102	21-10961	c3a	fine	1.9 (U)	—	1.9 (U)	0.15 (UJ-)	0.35 (J)	0.4 (J)	0.63 (J)	1.9 (U)	1.9 (U)	9.4 (U)	1.9 (U)	1.9 (U)	1.9 (U)	0.0075 (UJ-)	0.0075 (UJ-)	0.31 (J)	0.015 (UJ-)
DP-3	CA21-98-0104	21-10962	c3b	fine	4.1 (U)	—	4.1 (U)	0.091 (J)	4.1 (U)	4.1 (U)	0.44 (J)	4.1 (U)	4.1 (U)	20 (U)	4.1 (U)	4.1 (U)	4.1 (U)	0.011	0.0082	4.1 (U)	0.016 (U)
DP-3	CA21-98-0108	21-10963	c3b	fine	3.9 (U)	—	3.9 (U)	0.16 (UJ-)	0.66 (J)	0.72 (J)	1.3 (J)	3.9 (U)	3.9 (U)	20 (U)	3.9 (U)	3.9 (U)	3.9 (U)	0.0078 (UJ-)	0.0078 (UJ-)	0.66 (J)	0.016 (UJ-)
DP-3	CA21-98-0116	21-10965	f1	fine	0.41 (UJ-)	—	0.41 (UJ-)	0.041 (U)	0.41 (UJ-)	0.41 (UJ-)	0.41 (UJ-)	0.41 (UJ-)	0.41 (UJ-)	0.38 (J)	0.41 (UJ-)	0.41 (UJ-)	0.41 (UJ-)	0.0021 (U)	0.0021 (U)	0.41 (UJ-)	0.0041 (U)
DP-3	CA21-98-0120	21-10967	c1	coarse	0.35 (UJ-)	—	0.35 (UJ-)	0.071 (U)	0.026 (J)	0.35 (UJ-)	0.037 (J)	0.35 (UJ-)	0.35 (UJ-)	1.8 (UJ-)	0.17 (J)	0.35 (UJ-)	0.35 (UJ-)	0.0035 (U)	0.0035 (U)	0.033 (J)	0.0071 (U)
DP-4	CA21-98-0123	21-05486	c2b	fine	1.8 (UJ)	—	1.8 (UJ)	0.074 (U)	1.8 (UJ)	1.8 (UJ)	1.8 (UJ)	1.8 (UJ)	1.8 (UJ)	9.2 (UJ)	1.8 (UJ)	0.17 (J)	1.8 (UJ)	0.0052	0.0028 (J)	1.8 (UJ)	0.0074 (U)
DP-4	CA21-98-0124	21-05486	c2b	coarse	0.7 (UJ)	—	0.7 (UJ)	0.035 (U)	0.7 (UJ)	0.7 (UJ)	0.7 (UJ)	0.7 (UJ)	0.7 (UJ)	3.5 (UJ)	0.7 (UJ)	0.7 (UJ)	0.7 (UJ)	0.004	0.0026	0.7 (UJ)	0.0022 (J)
DP-4	CA21-98-0125	21-05487	c2a	fine	0.82 (UJ)	—	0.066 (J+)[f]	0.082 (U)	0.29 (J+)	0.35 (J+)	0.62 (J+)	0.33 (J+)	0.82 (UJ)	4.1 (UJ)	0.073 (J+)	0.82 (UJ)	0.82 (UJ)	0.0041 (U)	0.0041 (U)	0.37 (J+)	0.0082 (U)
DP-4	CA21-98-0127	21-05488	c2b	coarse	0.74 (UJ)	—	0.74 (UJ)	0.037 (U)	0.74 (UJ)	0.74 (UJ)	0.74 (UJ)	0.74 (UJ)	0.74 (UJ)	3.7 (UJ)	0.74 (UJ)	0.74 (UJ)	0.74 (UJ)	0.0034	0.0021	0.74 (UJ)	0.0038
DP-4	CA21-98-0129	21-05489	c2b	coarse	0.36 (UJ)	—	0.36 (UJ)	0.073 (U)	0.1 (J+)	0.12 (J+)	0.14 (J+)	0.16 (J+)	0.059 (J+)	1.8 (UJ)	0.063 (J+)	0.36 (UJ)	0.36 (UJ)	0.0039	0.0029 (J)	0.11 (J+)	0.0073 (U)
DP-4	CA21-98-0130	21-10969	c1	coarse	0.34 (UJ)	—	0.34 (UJ)	0.034 (U)	0.031 (J+)	0.03 (J+)	0.035 (J+)	0.34 (UJ)	0.34 (UJ)	1.7 (UJ)	0.034 (J+)	0.34 (UJ)	0.34 (UJ)	0.0017 (U)	0.0017 (U)	0.03 (J+)	0.0034 (U)
DP-4	CA21-98-0132	21-05490	c2b	fine	1.8 (UJ)	—	1.8 (UJ)	0.15 (UJ-)	1.8 (UJ)	1.8 (UJ)	0.19 (J+)	1.8 (UJ)	1.8 (UJ)	9.1 (UJ)	1.8 (UJ)	1.8 (UJ)	1.8 (UJ)	0.024 (J-)	0.017 (J-)	1.8 (UJ)	0.015 (UJ-)
DP-4	CA21-98-0134	21-05491	c2b	fine	1.8 (UJ)	—	1.8 (UJ)	0.074 (U)	1.8 (UJ)	1.8 (UJ)	1.8 (UJ)	1.8 (UJ)	1.8 (UJ)	9.2 (UJ)	1.8 (UJ)	1.8 (UJ)	1.8 (UJ)	0.0052	0.0031 (J)	1.8 (UJ)	0.0074 (U)
DP-4	CA21-98-0135	21-05491	c2b	fine	0.82 (UJ)	—	0.82 (UJ)	0.041 (U)	0.82 (UJ)	0.82 (UJ)	0.82 (UJ)	0.82 (UJ)	0.82 (UJ)	4.1 (UJ)	0.82 (UJ)	0.82 (UJ)	0.82 (UJ)	0.0081	0.0065	0.82 (UJ)	0.0042
DP-3	CA21-98-0154	21-05497	c3b	coarse	0.37 (U)	—	0.37 (U)	0.037 (U)	0.37 (U)	0.37 (U)	0.37 (U)	0.37 (U)	0.37 (U)	1.8 (U)	0.95	0.37 (U)	0.37 (U)	0.0018 (U)	0.0018 (U)	0.37 (U)	0.0037 (U)

Part 2

Reach	Sample ID	Location ID	Geomorphic Unit	Sediment Facies	4,4'-DDT	Dibenz(a,h)anthracene	Dimethyl Phthalate	Di-n-butylphthalate	Di-n-octylphthalate	Fluoranthene	Fluorene	Heptachlor Epoxide	Indeno(1,2,3-cd)pyrene	2-Methylnaphthalene	Naphthalene	Organics, diesel range	Phenanthrene	Pyrene	Toluene	2,4,6-Trichlorophenol
DP-4	0121-97-1347	21-05486	c2b	fine	—	3.8 (U)	3.8 (U)	3.8 (U)	3.8 (U)	3.8 (U)	3.8 (U)	—	3.8 (U)	3.8 (U)	3.8 (U)	—	3.8 (U)	3.8 (U)	—	3.8 (U)
DP-4	0121-97-1348	21-05488	c2b	coarse	—	3.6 (U)	3.6 (U)	3.6 (U)	3.6 (U)	3.6 (U)	3.6 (U)	—	3.6 (U)	3.6 (U)	3.6 (U)	—	3.6 (U)	3.6 (U)	—	3.6 (U)
DP-4	0121-97-1349	21-05486	c2b	fine	—	3.6 (U)	3.6 (U)	3.6 (U)	3.6 (U)	3.6 (U)	3.6 (U)	—	0.36 (U)	3.6 (U)	3.6 (U)	—	3.6 (U)	3.6 (U)	—	3.6 (U)
DP-4	0121-97-1350	21-05487	c2a	fine	—	4 (U)	4 (U)	4 (U)	4 (U)	4 (U)	4 (U)	—	4 (U)	4 (U)	4 (U)	—	4 (U)	4 (U)	—	4 (U)
DP-4	0121-97-1351	21-05487	c2a	fine	—	3.9 (U)	3.9 (U)	3.9 (U)	3.9 (U)	3.9 (U)	3.9 (U)	—	3.9 (U)	3.9 (U)	3.9 (U)	—	3.9 (U)	3.9 (U)	—	3.9 (U)
DP-4	0121-97-1352	21-05489	c2b	coarse	—	3.7 (U)	3.7 (U)	3.7 (U)	3.7 (U)	3.7 (U)	3.7 (U)	—	3.7 (U)	3.7 (U)	3.7 (U)	—	3.7 (U)	3.7 (U)	—	3.7 (U)
DP-4	0121-97-1353	21-05490	c2b	fine	—	3.7 (U)	3.7 (U)	3.7 (U)	3.7 (U)	3.7 (U)	3.7 (U)	—	3.7 (U)	3.7 (U)	3.7 (U)	—	3.7 (U)	3.7 (U)	—	3.7 (U)
DP-4	0121-97-1354	21-05491	c2b	fine	—	3.9 (U)	3.9 (U)	3.9 (U)	3.9 (U)	3.9 (U)	3.9 (U)	—	3.9 (U)	3.9 (U)	3.9 (U)	—	3.9 (U)	3.9 (U)	—	3.9 (U)
DP-4	0121-97-1355	21-05491	c2b	fine	—	3.8 (U)	3.8 (U)	3.8 (U)	3.8 (U)	3.8 (U)	3.8 (U)	—	3.8 (U)	3.8 (U)	3.8 (U)	—	3.8 (U)	3.8 (U)	—	3.8 (U)
DP-1	0121-97-1431	21-05496	c3	fine	0.0207	0.39 (UJ)	0.39 (U)	0.39 (U)	0.39 (UJ)	0.29 (U)	0.047	—	0.21	0.39 (U)	0.11	—	0.48 (U)	0.94	0.006 (U)	0.39 (U)
DP-3	0121-97-1432	21-05497	c3b	fine	0.0106	0.4 (UJ)	0.4 (U)	0.4 (U)	0.4 (UJ)	0.075	0.4 (U)	—	0.4 (UJ)	0.4 (U)	0.4 (U)	—	0.088 (U)	0.22 (J)	0.006 (U)	0.4 (U)
DP-2	0121-97-1433	21-05498	f1	fine	0.0602	0.36 (U)	0.36 (U)	0.36 (U)	0.36 (UJ)	0.3	0.36 (U)	—	0.36 (UJ)	0.36 (U)	0.36 (U)	—	0.26	0.96 (J)	0.005 (U)	0.36 (U)
DP-2	0121-97-1434	21-05499	c3b	fine	0.119	0.34 (U)	0.34 (U)	0.34 (U)	0.34 (U)	0.32	0.34 (U)	—	0.34 (U)	0.34 (U)	0.34 (U)	—	0.34	0.43	0.008 (U)	0.34 (U)
DP-2	0121-97-1435	21-05500	f1	fine	0.114	0.39 (UJ)	0.39 (U)	0.39 (U)	0.39 (UJ)	0.22 (U)	0.39 (U)	—	0.39 (UJ)	0.39 (U)	0.39 (U)	—	0.24 (U)	0.67 (J)	0.006 (U)	0.39 (U)
DP-2	0121-97-1440	21-05501	c3b	fine	0.013	0.4 (UJ)	0.4 (U)	0.4 (U)	0.4 (UJ)	0.43	0.4 (U)	—	0.28 (J)	0.4 (U)	0.4 (U)	—	0.4	1.4 (J)	0.002 (J)	0.4 (U)
DP-1	CA21-98-0051	21-10929	c3	fine	—	3.9 (UJ)	3.9 (UJ)	3.9 (UJ)	3.9 (UJ)	0.38 (J)	3.9 (UJ)	—	3.9 (UJ)	3.9 (UJ)	3.9 (UJ)	310	0.32 (J)	0.75 (J)	—	3.9 (UJ)
DP-1	CA21-98-0052	21-10930	c1	coarse	—	3.5 (UJ)	3.5 (UJ)	3.5 (UJ)	3.5 (UJ)	1.2 (J)	3.5 (UJ)	—	0.55 (J)	3.5 (UJ)	3.5 (UJ)	320	0.92 (J)	2.5 (J)	—	3.5 (UJ)
DP-1	CA21-98-0053	21-10931	c3	fine	0.039 (U)	3.9 (UJ)	3.9 (UJ)	3.9 (UJ)	3.9 (UJ)	1.4 (J)	3.9 (UJ)	0.02 (U)	0.81 (J)	3.9 (UJ)	0.62 (J)	370	2 (J)	3.2 (J)	—	3.9 (UJ)
DP-1	CA21-98-0054	21-10932	c2	fine	0.081 (U)	0.98 (J)	4.1 (UJ)	4.1 (UJ)	4.1 (UJ)	4.4 (J)	4.1 (UJ)	0.041 (U)	3.8 (J)	4.1 (UJ)	4.1 (UJ)	680	3.2 (J)	12 (J)	—	4.1 (UJ)

Table D-4.0-3 (continued)

Part 2 (continued)

Reach	Sample ID	Location ID	Geomorphic Unit	Sediment Facies	4,4'-DDT	Dibenz(a,h)anthracene	Dimethyl Phthalate	Di-n-butylphthalate	Di-n-octylphthalate	Fluoranthene	Fluorene	Heptachlor Epoxide	Indeno(1,2,3-cd)pyrene	2-Methylnaphthalene	Naphthalene	Organics, diesel range	Phenanthrene	Pyrene	Toluene	2,4,6-Trichlorophenol
DP-1	CA21-98-0055	21-10933	f1	fine	0.12	4.1 (UJ)	4.1 (UJ)	4.1 (UJ)	4.1 (UJ)	4.1 (UJ)	4.1 (UJ)	0.11	4.1 (UJ)	4.1 (UJ)	4.1 (UJ)	240	0.97 (J)	2.5 (J)	—	4.1 (UJ)
DP-1	CA21-98-0056	21-10934	c1	coarse	—	3.4 (UJ)	3.4 (UJ)	3.4 (UJ)	3.4 (UJ)	0.52 (J)	3.4 (UJ)	—	3.4 (UJ)	3.4 (UJ)	3.4 (UJ)	260	0.44 (J)	1.6 (J)	—	3.4 (UJ)
DP-1	CA21-98-0057	21-10935	f1	fine	—	0.44 (UJ)	0.44 (UJ)	0.44 (UJ)	0.44 (UJ)	0.036 (J)	0.44 (UJ)	—	0.44 (UJ)	0.046 (J)	0.44 (UJ)	87	0.048 (J)	0.099 (J)	—	0.44 (UJ)
DP-1	CA21-98-0058	21-10936	c3	fine	—	3.5 (UJ)	3.5 (UJ)	3.5 (UJ)	3.5 (UJ)	0.75 (J)	3.5 (UJ)	—	3.5 (UJ)	3.5 (UJ)	0.34 (J)	530	1.8 (J)	2.8 (J)	—	3.5 (UJ)
DP-1	CA21-98-0059	21-10936	c3	coarse	—	3.5 (UJ)	3.5 (UJ)	3.5 (UJ)	3.5 (UJ)	3.5 (UJ)	3.5 (UJ)	—	3.5 (UJ)	3.5 (UJ)	3.5 (UJ)	490 (J+)	0.31 (J)	0.69 (J)	—	3.5 (UJ)
DP-1	CA21-98-0060	21-10937	f1	fine	—	0.38 (UJ)	0.38 (UJ)	0.38 (UJ)	0.38 (UJ)	0.38 (UJ)	0.38 (UJ)	—	0.38 (UJ)	0.38 (UJ)	0.38 (UJ)	59	0.38 (UJ)	0.38 (UJ)	—	0.38 (UJ)
DP-1	CA21-98-0061	21-10938	c1	coarse	—	3.5 (UJ)	3.5 (UJ)	3.5 (UJ)	3.5 (UJ)	2.2 (J)	3.5 (UJ)	—	3.5 (UJ)	3.5 (UJ)	3.5 (UJ)	320	1.1 (J)	3.6 (J)	—	3.5 (UJ)
DP-1	CA21-98-0062	21-10939	c3	fine	—	3.8 (UJ)	3.8 (UJ)	3.8 (UJ)	3.8 (UJ)	0.69 (J)	3.8 (UJ)	—	3.8 (UJ)	3.8 (UJ)	3.8 (UJ)	270	0.65 (J)	1.8 (J)	—	3.8 (UJ)
DP-1	CA21-98-0063	21-10940	c2	fine	—	4.2 (UJ)	4.2 (UJ)	4.2 (UJ)	4.2 (UJ)	1.7 (J)	4.2 (UJ)	—	4.2 (UJ)	4.2 (UJ)	4.2 (UJ)	290	0.83 (J)	2.9 (J)	—	4.2 (UJ)
DP-1	CA21-98-0064	21-10941	f1	fine	—	3.9 (UJ)	3.9 (UJ)	3.9 (UJ)	3.9 (UJ)	3.9 (UJ)	3.9 (UJ)	—	3.9 (UJ)	3.9 (UJ)	3.9 (UJ)	64	0.61 (J)	1.9 (J)	—	3.9 (UJ)
DP-1	CA21-98-0065	21-10942	c3	fine	—	3.6 (UJ)	3.6 (UJ)	3.6 (UJ)	3.6 (UJ)	0.45 (J)	3.6 (UJ)	—	3.6 (UJ)	3.6 (UJ)	3.6 (UJ)	330 (J+)	0.56 (J)	1.3 (J)	—	3.6 (UJ)
DP-1	CA21-98-0066	21-10942	c3	coarse	—	3.6 (UJ)	3.6 (UJ)	3.6 (UJ)	3.6 (UJ)	3.6 (UJ)	3.6 (UJ)	—	3.6 (UJ)	3.6 (UJ)	3.6 (UJ)	250	3.6 (UJ)	0.34 (J)	—	3.6 (UJ)
DP-1	CA21-98-0067	21-10943	f1	fine	—	0.41 (UJ)	0.41 (UJ)	0.41 (UJ)	0.41 (UJ)	0.41 (UJ)	0.41 (UJ)	—	0.41 (UJ)	0.031 (J)	0.41 (UJ)	57	0.03 (J)	0.051 (J)	—	0.41 (UJ)
DP-1	CA21-98-0068	21-10944	c1	coarse	—	0.35 (UJ)	0.35 (UJ)	0.35 (UJ)	0.35 (UJ)	0.22 (J)	0.35 (UJ)	—	0.24 (J)	0.35 (UJ)	0.35 (UJ)	63	0.31 (J)	0.78 (J)	—	0.35 (UJ)
DP-1	CA21-98-0069	21-10942	c3	fine	0.039 (U)	3.9 (UJ)	3.9 (UJ)	3.9 (UJ)	3.9 (UJ)	3.9 (UJ)	3.9 (UJ)	0.02 (U)	3.9 (UJ)	3.9 (UJ)	3.9 (UJ)	460 (J+)	0.31 (J)	0.54 (J)	—	3.9 (UJ)
DP-2	CA21-98-0073	21-05501	c3b	coarse	0.0037 (J)	0.92 (U)	0.92 (U)	0.92 (U)	0.92 (U)	0.41 (J)	0.066 (J)	0.0023 (U)	0.92 (U)	0.92 (U)	0.071 (J)	47	0.47 (J)	0.34 (J)	—	0.92 (U)
DP-2	CA21-98-0074	21-10950	c3b	fine	0.016 (U)	2 (U)	2 (U)	2 (U)	0.16 (J)	1.4 (J)	2 (U)	0.0079 (U)	0.5 (J)	2 (U)	2 (U)	160	0.73 (J)	1.5 (J)	—	2 (U)
DP-2	CA21-98-0076	21-10950	c3b	coarse	0.0082 (U)	2 (U)	2 (U)	2 (U)	2 (U)	0.81 (J)	2 (U)	0.0041 (U)	2 (U)	2 (U)	2 (U)	97	0.47 (J)	0.59 (J)	—	2 (U)
DP-2	CA21-98-0082	21-05500	f1	fine	0.06	0.82 (UJ)	0.82 (UJ)	0.82 (UJ)	0.82 (UJ)	0.38 (J)	0.82 (UJ)	0.0082 (U)	0.18 (J)	0.82 (UJ)	0.82 (UJ)	99	0.25 (J)	0.64 (J)	—	0.82 (UJ)
DP-2	CA21-98-0084	21-05500	f1	fine	—	—	—	—	—	—	—	—	—	—	—	77	—	—	—	—
DP-2	CA21-98-0096	21-05502	c2	fine	0.015 (J)	0.95 (UJ)	0.95 (UJ)	0.95 (UJ)	0.95 (UJ)	1.4 (J)	0.95 (UJ)	0.0095 (U)	0.62 (J)	0.95 (UJ)	0.95 (UJ)	260	0.79 (J)	2.5 (J)	—	0.95 (UJ)
DP-2	CA21-98-0101	21-10960	c1	coarse	0.0042 (U)	0.84 (UJ)	0.84 (UJ)	0.84 (UJ)	0.84 (UJ)	0.84 (UJ)	0.84 (UJ)	0.0021 (U)	0.84 (UJ)	0.84 (UJ)	0.84 (UJ)	47	0.84 (UJ)	0.84 (UJ)	—	0.84 (UJ)
DP-3	CA21-98-0102	21-10961	c3a	fine	0.015 (J-)	1.9 (U)	1.9 (U)	1.9 (U)	1.9 (U)	0.51 (J)	1.9 (U)	0.0075 (UJ-)	0.24 (J)	1.9 (U)	1.9 (U)	87	0.3 (J)	0.77 (J)	—	1.9 (U)
DP-3	CA21-98-0104	21-10962	c3b	fine	0.056	4.1 (U)	4.1 (U)	4.1 (U)	4.1 (U)	0.45 (J)	4.1 (U)	0.0081 (U)	4.1 (U)	4.1 (U)	4.1 (U)	61	4.1 (U)	0.38 (J)	—	4.1 (U)
DP-3	CA21-98-0108	21-10963	c3b	fine	0.016 (J-)	3.9 (U)	3.9 (U)	2.1 (J)	3.9 (U)	1.5 (J)	3.9 (U)	0.0078 (UJ-)	3.9 (U)	3.9 (U)	3.9 (U)	78	0.8 (J)	1.6 (J)	—	9.3
DP-3	CA21-98-0116	21-10965	f1	fine	0.0041 (U)	0.41 (UJ-)	0.41 (UJ-)	0.41 (UJ-)	0.41 (UJ-)	0.41 (UJ-)	0.41 (UJ-)	0.0021 (U)	0.41 (UJ-)	0.41 (UJ-)	0.41 (UJ-)	60	0.41 (UJ-)	0.41 (UJ-)	—	0.41 (UJ-)
DP-3	CA21-98-0120	21-10967	c1	coarse	0.0071 (U)	0.35 (UJ-)	0.35 (UJ-)	0.35 (UJ-)	0.35 (UJ-)	0.046 (J)	0.35 (UJ-)	0.0035 (U)	0.35 (UJ-)	0.35 (UJ-)	0.35 (UJ-)	46	0.027 (J)	0.097 (J)	—	0.35 (UJ-)
DP-4	CA21-98-0123	21-05486	c2b	fine	0.0067 (J)	1.8 (UJ)	1.8 (UJ)	1.8 (UJ)	1.8 (UJ)	1.8 (UJ)	1.8 (UJ)	0.0037 (U)	1.8 (UJ)	1.8 (UJ)	1.8 (UJ)	60	1.8 (UJ)	1.8 (UJ)	—	1.8 (UJ)
DP-4	CA21-98-0124	21-05486	c2b	coarse	0.0069	0.7 (UJ)	0.7 (UJ)	0.7 (UJ)	0.7 (UJ)	0.7 (UJ)	0.7 (UJ)	0.0017 (U)	0.7 (UJ)	0.7 (UJ)	0.7 (UJ)	44	0.7 (UJ)	0.7 (UJ)	—	0.7 (UJ)
DP-4	CA21-98-0125	21-05487	c2a	fine	0.0058 (J)	0.82 (UJ)	0.82 (UJ)	0.82 (UJ)	0.82 (UJ)	0.51 (J+)	0.82 (UJ)	0.0041 (U)	0.28 (J+)	0.82 (UJ)	0.82 (UJ)	58	0.34 (J+)	1.1 (J+)	—	0.82 (UJ)
DP-4	CA21-98-0127	21-05488	c2b	coarse	0.007	0.74 (UJ)	0.74 (UJ)	0.74 (UJ)	0.74 (UJ)	0.74 (UJ)	0.74 (UJ)	0.0018 (U)	0.74 (UJ)	0.74 (UJ)	0.74 (UJ)	48	0.74 (UJ)	0.06 (J)	—	0.74 (UJ)
DP-4	CA21-98-0129	21-05489	c2b	coarse	0.0062 (J)	0.36 (UJ)	0.36 (UJ)	0.36 (UJ)	0.36 (UJ)	0.12 (J+)	0.36 (UJ)	0.0036 (U)	0.13 (J+)	0.36 (UJ)	0.36 (UJ)	59	0.091 (J+)	0.33 (J+)	—	0.36 (UJ)
DP-4	CA21-98-0130	21-10969	c1	coarse	0.0034 (U)	0.34 (UJ)	0.34 (UJ)	0.34 (UJ)	0.34 (UJ)	0.034 (J+)	0.34 (UJ)	0.0017 (U)	0.34 (UJ)	0.34 (UJ)	0.34 (UJ)	31	0.34 (UJ)	0.075 (J+)	—	0.34 (UJ)
DP-4	CA21-98-0132	21-05490	c2b	fine	0.045 (J-)	1.8 (UJ)	1.8 (UJ)	1.8 (UJ)	1.8 (UJ)	0.17 (J+)	1.8 (UJ)	0.0073 (UJ-)	1.8 (UJ)	1.8 (UJ)	1.8 (UJ)	82	0.17 (J+)	0.3 (J+)	—	1.8 (UJ)
DP-4	CA21-98-0134	21-05491	c2b	fine	0.0095	1.8 (UJ)	1.8 (UJ)	1.8 (UJ)	1.8 (UJ)	1.8 (UJ)	1.8 (UJ)	0.0037 (U)	1.8 (UJ)	1.8 (UJ)	1.8 (UJ)	52	1.8 (UJ)	1.8 (UJ)	—	1.8 (UJ)
DP-4	CA21-98-0135	21-05491	c2b	fine	0.012	0.82 (UJ)	0.076 (J)	0.82 (UJ)	0.82 (UJ)	0.82 (UJ)	0.82 (UJ)	0.0021 (U)	0.82 (UJ)	0.82 (UJ)	0.82 (UJ)	50	0.82 (UJ)	0.82 (UJ)	—	0.82 (UJ)
DP-3	CA21-98-0154	21-05497	c3b	coarse	0.0037 (U)	0.37 (U)	0.37 (U)	0.37 (U)	0.37 (U)	0.37 (U)	0.37 (U)	0.0018 (U)	0.37 (U)	0.37 (U)	0.37 (U)	34	0.37 (U)	0.37 (U)	—	0.37 (U)

[a] U = The analyte was analyzed for but not detected. Reported value is the sample-specific estimated quantitation limit or detection limit.
[b] A dash in the table means "not analyzed."
[c] 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.
[d] UJ = The analyte was analyzed for but not detected. Reported value is an estimate of the sample-specific quantitation limit or detection limit.
[e] UJ- = The analyte was analyzed for but not detected. Reported value is an estimate of the sample-specific quantitation limit or detection limit. The estimated detection limit may be biased low.
[f] J+ = The analyte was positively identified, and the reported value is an estimate and likely biased high.

Table D-4.0-4
Analytical Results for Detected Inorganic Chemicals in Alluvial Groundwater and Storm Water in DP Canyon

Sample ID	Location ID	Filtered/ Unfiltered	Date Collected	Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Calcium	Chromium, total	Cobalt	Copper	Iron	Lead	Lithium	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Potassium	Selenium	Sodium	Strontium	Thallium	Vanadium	Zinc
0121-97-1381	21-05471	Unfiltered	8/22/97	3250 (J+)[a]	3.4 (U)[b]	2.6 (U)	138 (J)[c]	0.4 (U)	—[d]	0.4 (U)	24900	9.9 (J)	3.1 (J)	24.5 (J)	3130	42.6	—	2160 (J)	226	0.03 (U)	—	5.8 (J)	3930 (J)	2.7 (U)	7340	—	2.7 (J)	8.4 (J)	353
0121-97-1382	21-05471	Unfiltered	8/22/97	3310 (J+)	3.4 (U)	2.6 (U)	137 (J)	0.4 (U)	—	0.4 (U)	24500	9.8 (J)	3 (J)	22.1 (J)	3150	42.1	—	2130 (J)	222	0.03 (U)	—	6.1 (J)	3900 (J)	2.7 (U)	7210	—	4.8 (J)	8.4 (J)	347
0121-97-1383	21-05472	Unfiltered	8/22/97	4750 (J+)	3.4 (U)	3.5 (J)	180 (J)	0.85 (J)	—	0.4 (U)	21400	8.5 (J)	4.7 (J)	27.7	3860	60.2	—	2260 (J)	450	0.03 (U)	—	7.4 (J)	3680 (J)	2.7 (U)	7020	—	4.7 (J)	11.9 (J)	276
0121-97-1384	21-05472	Unfiltered	8/22/97	6480 (J+)	3.4 (U)	2.6 (U)	183 (J)	0.89 (J)	—	0.4 (U)	21200	10.4	4.8 (J)	28.5	5120	59.8	—	2580 (J)	447	0.03 (U)	—	8.6 (J)	4100 (J)	2.7 (U)	7200	—	3 (J)	13.4 (J)	282
0121-97-1396	21-01811	Unfiltered	8/20/97	800 (J-)[e]	20 (U)	4 (U)	90	4 (U)	—	5 (U)	42000	10 (U)	20 (U)	20 (UJ)[f]	220	6 (J-)	—	2700	40	0.2 (U)	—	40 (U)	9000	4 (U)	49000	—	5 (U)	10 (U)	130 (J)
0121-97-1397	21-01811	Filtered	8/20/97	100 (UJ-)[g]	20 (U)	4 (U)	90	4 (U)	—	5 (U)	38000	10 (U)	20 (U)	20 (UJ)	40 (U)	5 (J-)	—	2500	20	0.2 (U)	—	40 (U)	9000	4 (U)	49000	—	5 (U)	10 (U)	20 (J)
0121-97-1398	21-01812	Unfiltered	8/20/97	1100 (J-)	20 (U)	8	190	4 (U)	—	5 (U)	45000	10 (U)	20 (U)	20 (UJ)	6700	3 (J-)	—	3500	790	0.2 (U)	—	40 (U)	17000	4 (U)	50000	—	5 (U)	10 (U)	30 (J)
0121-97-1399	21-01812	Filtered	8/20/97	100 (UJ-)	20 (U)	4 (U)	120	4 (U)	—	5 (U)	42000	10 (U)	20 (U)	20 (UJ)	40 (U)	1 (U)	—	3400	720	0.2 (U)	—	40 (U)	17000	4 (U)	49000	—	5 (U)	10 (U)	10 (J)
0121-97-1400	21-01854	Unfiltered	8/21/97	2600 (J-)	20 (U)	4 (U)	50	4 (U)	—	5 (U)	15000	10 (U)	20 (U)	20 (UJ)	1300	4 (J-)	—	1600	10 (U)	0.2 (U)	—	40 (U)	9000	4 (U)	32000	—	5 (U)	10 (U)	50 (J)
0121-97-1401	21-01854	Filtered	8/21/97	2100 (J-)	20 (U)	4 (U)	40	4 (U)	—	5 (U)	15000	10 (U)	20 (U)	20 (UJ)	940	3 (J-)	—	1600	10 (U)	0.2 (U)	—	40 (U)	9000	4 (U)	33000	—	5 (U)	10 (U)	70
0121-97-1421	21-01854	Unfiltered	10/15/97	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
0121-97-1422	21-01854	Unfiltered	10/15/97	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
0121-97-1424	21-01811	Unfiltered	12/4/97	1100	20 (U)	4 (U)	200	4 (U)	—	5 (U)	95000	10 (U)	20 (U)	20 (U)	780	1	—	6400	80 (U)	0.2 (U)	—	40 (U)	11000	4 (U)	71000	—	5 (U)	10 (U)	20 (U)
0121-97-1425	21-01812	Unfiltered	12/4/97	100 (U)	20 (U)	4 (U)	110	4 (U)	—	5 (U)	50000	10 (U)	20 (U)	20 (U)	580	1 (U)	—	4000	870 (U)	0.2 (U)	—	40 (U)	14000	4 (U)	61000	—	5 (U)	10 (U)	20
0121-97-1426	21-01811	Unfiltered	12/4/97	1000	20 (U)	4 (U)	200	4 (U)	—	5 (U)	95000	10 (U)	20 (U)	20 (U)	680	1	—	6500	80 (U)	0.2 (U)	—	40 (U)	12000	4 (U)	74000	—	5 (U)	10 (U)	20 (U)
0121-97-1428	21-01811	Filtered	12/4/97	100 (U)	20 (U)	4 (U)	210	4 (U)	—	5 (U)	110000	10 (U)	20 (U)	20 (U)	60	1 (U)	—	6900	40 (U)	0.2 (U)	—	40 (U)	12000	4 (U)	81000	—	5 (U)	10 (U)	20
0121-97-1429	21-01812	Filtered	12/4/97	100 (U)	20 (U)	4 (U)	100	4 (U)	—	5 (U)	52000	10 (U)	20 (U)	20 (U)	80	1 (U)	—	4200	830 (U)	0.2 (U)	—	40 (U)	14000	4 (U)	59000	—	5 (U)	10 (U)	20
0121-97-1430	21-01811	Filtered	12/4/97	100 (U)	20 (U)	4 (U)	200	4 (U)	—	5 (U)	100000	10 (U)	20 (U)	20 (U)	50	1 (U)	—	6600	30 (U)	0.2 (U)	—	40 (U)	11000	4 (U)	76000 (U)	—	5 (U)	10 (U)	20 (U)
CA21-98-0001	21-01811	Unfiltered	5/5/98	1600	20 (U)	4 (U)	140	4 (U)	—	5 (U)	46000	10 (U)	20 (U)	20 (U)	1200	3	—	3700	30	0.2 (U)	—	40 (U)	9000	4 (UJ-)	100000	—	5 (U)	10 (U)	20 (U)
CA21-98-0002	21-01811	Filtered	5/5/98	300	20 (U)	4 (U)	130	4 (U)	—	5 (U)	47000	10 (U)	20 (U)	20 (U)	190	1	—	3700	10 (U)	0.2 (U)	—	40 (U)	10000	4 (UJ-)	110000	—	5 (U)	10 (U)	20 (U)
CA21-98-0003	21-01812	Unfiltered	5/5/98	100 (U)	20 (U)	4 (U)	140	4 (U)	—	5 (U)	59000	10 (U)	20 (U)	20 (U)	2600	1 (U)	—	4500	870	0.2 (U)	—	40 (U)	14000	4 (UJ-)	84000	—	5 (U)	10 (U)	20 (U)
CA21-98-0004	21-01812	Filtered	5/5/98	100 (U)	20 (U)	4 (U)	130	4 (U)	—	5 (U)	58000	10 (U)	20 (U)	20 (U)	470	1 (U)	—	4400	760	0.2 (U)	—	40 (U)	14000	4 (UJ-)	84000	—	5 (U)	10 (U)	20 (U)
CA21-98-0005	21-01854	Unfiltered	5/6/98	100	20 (U)	4 (U)	80	4 (U)	—	5 (U)	30000	10 (U)	20 (U)	20 (U)	180	1 (U)	—	3200	10 (U)	0.2 (U)	—	40 (U)	15000	4 (UJ-)	54000	—	5 (U)	10 (U)	20 (U)
CA21-98-0006	21-01854	Filtered	5/6/98	100 (U)	20 (U)	4 (U)	80	4 (U)	—	5 (U)	30000	10 (U)	20 (U)	20 (U)	40 (U)	1 (U)	—	3100	10 (U)	0.2 (U)	—	40 (U)	14000	4 (U)	50000	—	5 (U)	10 (U)	20 (U)
CA21-98-0007	21-01811	Unfiltered	9/17/98	137 (J)	2.5 (U)	2.4 (U)	100 (J)	0.2 (U)	59 (J)	0.2 (U)	36400	0.3 (U)	0.5 (U)	2.4 (J)	103	1.1 (U)	8.5 (J)	2670 (J)	37.1	0.02 (U)	2.6 (U)	2.9 (J)	9740	2.9 (U)	38300	171	6.8 (J)	2.5 (J)	3.3 (J)
CA21-98-0008	21-01811	Filtered	9/17/98	62.8 (J)	2.5 (U)	2.4 (U)	97.8 (J)	0.2 (U)	53.6 (J)	0.2 (U)	36700	0.3 (U)	0.5 (U)	2.5 (J)	68 (J)	1.1 (U)	9 (J)	2650 (J)	33.9	0.02 (U)	5.4 (J)	2.8 (J)	9600	2.9 (U)	37800	169	3 (J)	2.3 (J)	3.9 (J)
CA21-98-0009	21-01812	Unfiltered	9/17/98	36.6 (J)	2.5 (U)	3.2 (J)	116 (J)	0.2 (U)	64.6 (J)	0.2 (U)	52400	0.3 (U)	0.81 (J)	1.1 (J)	1050	1.1 (U)	9 (J)	4110 (J)	729	0.02 (U)	2.6 (U)	2.3 (J)	17700	2.9 (U)	43600	251	6.4 (J)	0.6 (J)	1.7 (J)
CA21-98-0010	21-01812	Filtered	9/17/98	27.1 (J)	2.5 (U)	3.3 (J)	115 (J)	0.2 (U)	67 (J)	0.2 (U)	51500	0.3 (U)	0.8 (J)	0.9 (J)	1050	1.1 (U)	10	4080 (J)	726	0.02 (U)	2.6 (U)	2.2 (J)	17700	2.9 (U)	43900	249	3.5 (J)	0.53 (J)	1.7 (J)
CA21-98-0011	21-01854	Unfiltered	9/16/98	751	2.5 (U)	2.4 (U)	49 (J)	0.2 (U)	41.1 (J)	0.2 (U)	17800	0.3 (U)	0.5 (U)	2.5 (J)	326	1.1 (U)	13.5	1960 (J)	17.6	0.02 (U)	3.4 (J)	2.7 (J)	10600	2.9 (U)	33200	114	4.7 (J)	4.1 (J)	5.1 (J)
CA21-98-0012	21-01854	Filtered	9/16/98	186 (J)	2.5 (U)	2.4 (U)	44.4 (J)	0.2 (U)	46.6 (J)	0.2 (U)	17700	0.3 (U)	0.5 (U)	2.1 (J)	114	1.1 (U)	12.1	1920 (J)	0.97 (J)	0.02 (U)	3.2 (J)	1.4 (J)	10400	2.9 (U)	33000	112	2.6 (U)	3.6 (J)	2 (J)
CA21-98-0013	21-10816	Unfiltered	10/26/98	2340	5.3 (J)	5.6 (J)	64.8 (J)	0.3 (U)	—	0.2 (U)	33300	5.8 (J)	2 (J)	23.6 (J)	2060	17.7	—	1760 (J)	102	0.03 (J)	—	5.5 (J)	3030 (J)	3 (J)	5580	—	5.1 (J)	7.1 (J)	245
CA21-98-0014	21-10816	Filtered	10/26/98	71.1 (J)	2.7 (U)	6.3 (J)	10.4 (J)	0.3 (U)	39.3 (J)	0.2 (U)	4970 (J)	0.63 (J)	0.5 (U)	2.6 (J)	92 (J)	1 (U)	1 (U)	328 (J)	15.8	0.02 (U)	4.3 (U)	1.2 (J)	1130 (J)	2.6 (U)	1230 (J)	17	6.9 (J)	1.7 (J)	32.1
CA21-98-0015	21-10817	Unfiltered	10/26/98	8100	2.7 (U)	5.7 (J)	185 (J)	0.53 (J)	—	0.34 (J)	26400	15.3	4.7 (J)	49.5	7760	64.2	—	2800 (J)	309	0.06 (J)	—	11.2 (J)	4290 (J)	2.6 (U)	4900 (J)	—	3.1 (U)	15.6 (J)	358
CA21-98-0016	21-10817	Filtered	10/26/98	74.2 (J)	2.7 (U)	3 (U)	23.1 (J)	0.3 (U)	33.1 (J)	0.2 (U)	13800	1.2 (J)	0.5 (U)	4.8 (J)	105	1 (U)	3.9 (J)	671 (J)	1.7 (J)	0.02 (U)	4.3 (U)	1.8 (J)	1880 (J)	2.6 (U)	3520 (J)	41.4	3.1 (U)	1.6 (J)	31.1
CA21-98-0042	21-01812	Unfiltered	10/7/98	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CA21-98-0043	21-01854	Unfiltered	10/6/98	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
AAB1336	LAO-B	Unfiltered	6/13/94	1100	2 (U)	2 (U)	28	1 (U)	10 (U)	3 (U)	9300	66	4 (U)	17	1000	3	—	3000	320	100 (U)	2 (U)	10 (U)	2400	2 (U)	6300	60	2 (U)	4 (U)	20 (U)

Note: Results are in μg/L.

Table D-4.0-4 (continued)

Sample ID	Location ID	Filtered/ Unfiltered	Date Collected	Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Calcium	Chromium, total	Cobalt	Copper	Iron	Lead	Lithium	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Potassium	Selenium	Sodium	Strontium	Thallium	Vanadium	Zinc
AAB1341	LAO-B	Unfiltered	6/14/94	460	0.2 (U)	0.2 (U)	20	—	5	0.5 (U)	8850	2 (U)	2 (U)	2	200	2 (U)	10 (U)	2670	10 (U)	0.2 (U)	2 (U)	2 (U)	2350	0.2 (U)	7000	70	—	—	10
AAB1380	LAO-B	Unfiltered	6/13/94	100 (U)	2 (U)	2 (U)	19	1 (U)	10 (U)	3 (U)	9300	4 (U)	4 (U)	4 (U)	100 (U)	2 (U)	—	3000	2 (U)	100 (U)	8 (U)	10 (U)	2700	2 (U)	6300	59	2 (U)	4 (U)	20 (U)
AAB3592	LAO-B	Unfiltered	10/19/94	240	0.2 (U)	0.2	30	2 (U)	10	1.8	9700	2 (U)	2 (U)	2	60	2 (U)	10 (U)	3400	10 (U)	0.2 (U)	2 (U)	2 (U)	3150	0.02 (U)	7860	70	—	10	20
AAB8403	LAO-B	Unfiltered	1/17/95	530	2 (U)	2 (U)	20	2 (U)	3	2 (U)	8460	2 (U)	2 (U)	2 (U)	220	3	10 (U)	2470	10 (U)	0.2 (U)	2 (U)	2 (U)	2240	2 (U)	6890	60	—	7	10 (U)
AAB8495	LAO-B	Unfiltered	10/19/94	580	1 (U)	2 (U)	31	3 (U)	19	3 (U)	11000	4 (U)	4 (U)	4 (U)	480	1 (U)	6	3500	18	200	8 (U)	10 (U)	6000	2 (U)	6000	3500	1 (U)	4 (U)	20 (U)
AAB8509	LAO-B	Unfiltered	10/19/94	100 (U)	1 (U)	3 (U)	25	3 (U)	10 (U)	3 (U)	11000	4 (U)	4 (U)	37	100 (U)	51	8	3300	3 (U)	200	8 (U)	20 (U)	5600	2 (U)	5600	3300	1 (U)	4 (U)	20 (U)
AAB8559	LAO-B	Unfiltered	1/15/95	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
0441-95-0013	LAO-B	Unfiltered	5/9/95	2710	2 (U)	2.2 (U)	33 (U)	3.3 (U)	11 (U)	3.3 (U)	9740	7 (U)	4.4 (U)	4.4 (U)	1150	2 (U)	6 (U)	3080 (U)	9 (U)	200 (U)	9 (U)	11 (U)	2600 (U)	1 (U)	7650	70.3	2 (U)	4 (U)	20 (U)
0441-95-0014	LAO-B	Unfiltered	5/9/95	345	2 (U)	2.2 (U)	26 (U)	3.3 (U)	11 (U)	3.3 (U)	9130	6 (U)	4.4 (U)	4.4 (U)	148	2 (U)	4 (U)	2840 (U)	3 (U)	200 (U)	9 (U)	17 (U)	2200 (U)	1 (U)	7150	65.3	2 (U)	4 (U)	20 (U)
0441-95-0033	LAO-B	Unfiltered	5/9/95	1190	2 (U)	2 (U)	20	2 (U)	10	0.2 (U)	7660	2 (U)	2 (U)	2 (U)	460	2 (U)	10 (U)	2370	10 (U)	0.2 (U)	2 (U)	2 (U)	2100	2 (U)	6560	50	2 (U)	2 (U)	10 (U)
EPA	21-01811	Unfiltered	9/4/98	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
EPA	21-01812	Unfiltered	9/4/98	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
EPA	21-01854	Unfiltered	9/2/98	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
NMED	21-01854	Unfiltered	10/6/98	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

[a] J+ = The analyte was positively identified, and the reported value is an estimate and likely biased high.

[b] U = The analyte was analyzed for but not detected. Reported value is the sample-specific estimated quantitation limit or detection limit.

[c] 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.

[d] A dash in the table means "not analyzed."

[e] J- = The analyte was positively identified, and the reported value is an estimate and likely biased low.

[f] UJ = The analyte was analyzed for but not detected. Reported value is an estimate of the sample-specific quantitation limit or detection limit.

[g] UJ- = The analyte was analyzed for but not detected. Reported value is an estimate of the sample-specific quantitation limit or detection limit. The estimated detection limit may be biased low.

Table D-4.0-5
Analytical Results for Detected Radionuclides in Alluvial Groundwater and Storm Water in DP Canyon

Sample ID	Location ID	Filtered/ Unfiltered	Date Collected	Plutonium-239,240	Strontium-90	Tritium	Uranium-234	Uranium-235	Uranium-238
0121-97-1381	21-05471	Unfiltered	8/22/97	—[a]	—	—	—	—	—
0121-97-1382	21-05471	Unfiltered	8/22/97	—	—	—	—	—	—
0121-97-1383	21-05472	Unfiltered	8/22/97	—	—	—	—	—	—
0121-97-1384	21-05472	Unfiltered	8/22/97	—	—	—	—	—	—
0121-97-1396	21-01811	Unfiltered	8/20/97	-0.018 (U)[b]	105	52 (U)	1.23	0.056 (U)	0.239
0121-97-1397	21-01811	Filtered	8/20/97	-0.0059 (U)	100	—	0.779	0.015 (U)	0.063 (U)
0121-97-1398	21-01812	Unfiltered	8/20/97	0.16	81	130 (U)	0.93	0.004 (U)	0.166
0121-97-1399	21-01812	Filtered	8/20/97	0.0048 (U)	108	—	0.687	0.02 (U)	0.15
0121-97-1400	21-01854	Unfiltered	8/21/97	0.071	40.7	5 (U)	0.561	0.034 (U)	0.098
0121-97-1401	21-01854	Filtered	8/21/97	0.035 (U)	38.9	—	0.636	0.043 (U)	0.094
0121-97-1421	21-01854	Unfiltered	10/15/97	—	—	—	—	—	—
0121-97-1422	21-01854	Unfiltered	10/15/97	—	—	—	—	—	—
0121-97-1424	21-01811	Unfiltered	12/4/97	0.08 (U)	176.47 (J-)[c]	3.38 (U)	1.32	0.18 (U)	0.2 (U)
0121-97-1425	21-01812	Unfiltered	12/4/97	0.06 (U)	68.51 (J-)	120.09 (U)	0.78	0 (U)	0.14 (U)
0121-97-1426	21-01811	Unfiltered	12/4/97	0.25	195.72 (J-)	156.63 (U)	1.02	0.11 (U)	0.17 (U)
0121-97-1428	21-01811	Filtered	12/4/97	0.02 (U)	207.83 (J-)	—	1.73	0.04 (U)	0.2 (U)
0121-97-1429	21-01812	Filtered	12/4/97	0 (U)	77.99 (J-)	—	0.84	0.14 (U)	0.18 (U)
0121-97-1430	21-01811	Filtered	12/4/97	0.04 (U)	204.78 (J-)	—	1.25	0.11 (U)	0.42
CA21-98-0001	21-01811	Unfiltered	5/5/98	0.223	151	120 (U)	0.545	0.018 (U)	0.058 (U)
CA21-98-0002	21-01811	Filtered	5/5/98	0.008 (U)	153	—	0.523	0.029 (U)	0.056 (U)
CA21-98-0003	21-01812	Unfiltered	5/5/98	0.0027 (U)	100	280	0.526	0.015 (U)	0.084
CA21-98-0004	21-01812	Filtered	5/5/98	0.0061 (U)	103	—	0.595	0.023 (U)	0.07
CA21-98-0005	21-01854	Unfiltered	5/6/98	0.007 (U)	111	120 (U)	0.415	0.022 (U)	0.047 (U)
CA21-98-0006	21-01854	Filtered	5/6/98	0.0037 (U)	119	—	0.373	0.034 (U)	0.04 (U)
CA21-98-0007	21-01811	Unfiltered	9/17/98	0.009 (U)	92	65 (U)	0.835	0.057	0.07
CA21-98-0008	21-01811	Filtered	9/17/98	0.0146 (U)	96	—	0.825	0.043 (U)	0.096
CA21-98-0009	21-01812	Unfiltered	9/17/98	0.0063 (U)	85	210 (U)	0.49	0.027 (U)	0.081

Note: Results are in pCi/L.

Table D-4.0-5 (continued)

Sample ID	Location ID	Filtered/ Unfiltered	Date Collected	Plutonium-239,240	Strontium-90	Tritium	Uranium-234	Uranium-235	Uranium-238
CA21-98-0010	21-01812	Filtered	9/17/98	-0.0021 (U)	81	—	0.403	0.016 (U)	0.039 (U)
CA21-98-0011	21-01854	Unfiltered	9/16/98	0.005 (U)	57	20 (U)	0.557	0.024 (U)	0.075
CA21-98-0012	21-01854	Filtered	9/16/98	0.0086 (U)	54	—	0.574	0.03 (U)	0.087
CA21-98-0013	21-10816	Unfiltered	10/26/98	—	—	—	—	—	—
CA21-98-0014	21-10816	Filtered	10/26/98	—	—	—	—	—	—
CA21-98-0015	21-10817	Unfiltered	10/26/98	—	—	—	—	—	—
CA21-98-0016	21-10817	Filtered	10/26/98	—	—	—	—	—	—
CA21-98-0042	21-01812	Unfiltered	10/7/98	—	—	—	—	—	—
CA21-98-0043	21-01854	Unfiltered	10/6/98	—	—	—	—	—	—
AAB1336	LAO-B	Unfiltered	6/13/94	—	—	—	—	—	—
AAB1341	LAO-B	Unfiltered	6/14/94	—	—	—	—	—	—
AAB1380	LAO-B	Unfiltered	6/13/94	—	—	—	—	—	—
AAB3592	LAO-B	Unfiltered	10/19/94	—	—	—	—	—	—
AAB8403	LAO-B	Unfiltered	1/17/95	—	—	—	—	—	—
AAB8495	LAO-B	Unfiltered	10/19/94	—	—	—	—	—	—
AAB8509	LAO-B	Unfiltered	10/19/94	—	—	—	—	—	—
AAB8559	LAO-B	Unfiltered	1/15/95	—	—	—	—	—	—
0441-95-0013	LAO-B	Unfiltered	5/9/95	—	—	—	—	—	—
0441-95-0014	LAO-B	Unfiltered	5/9/95	—	—	—	—	—	—
0441-95-0033	LAO-B	Unfiltered	5/9/95	—	—	—	—	—	—
EPA	21-01811	Unfiltered	9/4/98	—	43.2	—	0.5	0.06 (U)	0.32
EPA	21-01812	Unfiltered	9/4/98	—	45.7	186	0.82	-0.08 (U)	0.31 (U)
EPA	21-01854	Unfiltered	9/2/98	—	40.7	156	1.14	0.1 (U)	0.26
NMED	21-01854	Unfiltered	10/6/98	—	50.4	—	—	—	—

[a] A dash in the table means "not analyzed."

[b] U = The analyte was analyzed for but not detected. Reported value is the sample-specific estimated quantitation limit or detection limit.

[c] J- = The analyte was positively identified, and the reported value is an estimate and likely biased low.

Table D-4.0-6
Analytical Results for Detected Organic Chemicals in Alluvial Groundwater and Storm Water in DP Canyon

Sample ID	Location ID	Filtered/Unfiltered	Date Collected	Acetone	Benzo(b)fluoranthene	Benzoic Acid	Bis(2-ethylhexyl)phthalate	2-Butanone	Chrysene	1,2-Dichloroethane	Di-n-butylphthalate	Di-n-octylphthalate	Fluoranthene	Phenanthrene	Pyrene
0121-97-1381	21-05471	Unfiltered	8/22/97	—[a]	1.4 (J)[b]	50 (UJ)[c]	9 (J)	—	10 (UJ)	—	10 (UJ)	1.5 (J)	1.2 (J)	10 (UJ)	1.3 (J)
0121-97-1382	21-05471	Unfiltered	8/22/97	33 (U)[d]	1.6 (J)	50 (UJ)	6.2 (J)	8.2 (J)	1.1 (J)	5 (U)	10 (UJ)	1 (J)	1.7 (J)	1 (J)	1.7 (J)
0121-97-1383	21-05472	Unfiltered	8/22/97	—	1.1 (J)	50 (UJ)	6.2 (J)	—	10 (UJ)	—	10 (UJ)	1.1 (J)	10 (UJ)	10 (UJ)	1.1 (J)
0121-97-1384	21-05472	Unfiltered	8/22/97	35 (U)	10 (UJ)	50 (UJ)	10 (UJ)	8.3 (J)	10 (UJ)	5 (U)	10 (UJ)	10 (UJ)	10 (UJ)	10 (UJ)	10 (UJ)
0121-97-1396	21-01811	Unfiltered	8/20/97	30 (U)	10 (U)	50 (U)	10 (U)	20 (U)	10 (U)	5 (U)	10 (U)	10 (U)	10 (U)	10 (U)	10 (U)
0121-97-1397	21-01811	Filtered	8/20/97	—	10 (U)	50 (U)	22	—	10 (U)	—	10 (U)	10 (U)	10 (U)	10 (U)	10 (U)
0121-97-1398	21-01812	Unfiltered	8/20/97	20 (U)	10 (U)	50 (U)	10 (U)	20 (U)	10 (U)	5 (U)	10 (U)	10 (U)	10 (U)	10 (U)	10 (U)
0121-97-1399	21-01812	Filtered	8/20/97	—	10 (U)	50 (U)	36	—	10 (U)	—	10 (U)	10 (U)	10 (U)	10 (U)	10 (U)
0121-97-1400	21-01854	Unfiltered	8/21/97	20 (U)	10 (U)	50 (U)	10 (U)	20 (U)	10 (U)	7.6	10 (U)	10 (U)	10 (U)	10 (U)	10 (U)
0121-97-1401	21-01854	Filtered	8/21/97	—	10 (U)	50 (U)	10 (U)	—	10 (U)	—	10 (U)	10 (U)	10 (U)	10 (U)	10 (U)
0121-97-1421	21-01854	Unfiltered	10/15/97	20 (U)	—	—	—	20 (U)	—	5 (U)	—	—	—	—	—
0121-97-1422	21-01854	Unfiltered	10/15/97	20 (U)	—	—	—	20 (U)	—	5 (U)	—	—	—	—	—
0121-97-1424	21-01811	Unfiltered	12/4/97	20 (U)	10 (U)	50 (U)	10 (U)	20 (U)	10 (U)	5 (U)	10 (U)	10 (U)	10 (U)	10 (U)	10 (U)
0121-97-1425	21-01812	Unfiltered	12/4/97	20 (U)	10 (UJ-)[e]	50 (UJ-)	10 (UJ-)	20 (U)	10 (UJ-)	5 (U)	10 (UJ-)	10 (UJ-)	10 (UJ-)	10 (UJ-)	10 (UJ-)
0121-97-1426	21-01811	Unfiltered	12/4/97	20 (U)	10 (UJ-)	50 (UJ-)	10 (UJ-)	20 (U)	10 (UJ-)	5 (U)	10 (UJ-)	10 (UJ-)	10 (UJ-)	10 (UJ-)	10 (UJ-)
0121-97-1428	21-01811	Filtered	12/4/97	—	—	—	—	—	—	—	—	—	—	—	—
0121-97-1429	21-01812	Filtered	12/4/97	—	—	—	—	—	—	—	—	—	—	—	—
0121-97-1430	21-01811	Filtered	12/4/97	—	—	—	—	—	—	—	—	—	—	—	—
CA21-98-0001	21-01811	Unfiltered	5/5/98	20 (U)	10 (U)	50 (U)	10 (U)	20 (U)	10 (U)	5 (U)	10 (U)	10 (U)	10 (U)	10 (U)	10 (U)
CA21-98-0002	21-01811	Filtered	5/5/98	—	—	—	—	—	—	—	—	—	—	—	—

Note: Results are in μg/L.

Table D-4.0-6 (continued)

Sample ID	Location ID	Filtered/Unfiltered	Date Collected	Acetone	Benzo(b)fluoranthene	Benzoic Acid	Bis(2-ethylhexyl)phthalate	2-Butanone	Chrysene	1,2-Dichloroethane	Di-n-butylphthalate	Di-n-octylphthalate	Fluoranthene	Phenanthrene	Pyrene
CA21-98-0003	21-01812	Unfiltered	5/5/98	20 (U)	10 (U)	50 (U)	10 (U)	20 (U)	10 (U)	5 (U)	10 (U)	10 (U)	10 (U)	10 (U)	10 (U)
CA21-98-0004	21-01812	Filtered	5/5/98	—	—	—	—	—	—	—	—	—	—	—	—
CA21-98-0005	21-01854	Unfiltered	5/6/98	20 (U)	10 (U)	50 (U)	10 (U)	20 (U)	10 (U)	5 (U)	10 (U)	10 (U)	10 (U)	10 (U)	10 (U)
CA21-98-0006	21-01854	Filtered	5/6/98	—	—	—	—	—	—	—	—	—	—	—	—
CA21-98-0007	21-01811	Unfiltered	9/17/98	20 (U)	—	—	—	20 (U)	—	5 (U)	—	—	—	—	—
CA21-98-0008	21-01811	Filtered	9/17/98	—	—	—	—	—	—	—	—	—	—	—	—
CA21-98-0009	21-01812	Unfiltered	9/17/98	20 (U)	—	—	—	20 (U)	—	5 (U)	—	—	—	—	—
CA21-98-0010	21-01812	Filtered	9/17/98	—	—	—	—	—	—	—	—	—	—	—	—
CA21-98-0011	21-01854	Unfiltered	9/16/98	20 (U)	—	—	—	20 (U)	—	5 (U)	—	—	—	—	—
CA21-98-0012	21-01854	Filtered	9/16/98	—	—	—	—	—	—	—	—	—	—	—	—
CA21-98-0013	21-10816	Unfiltered	10/26/98	38	22 (U)	110 (U)	5.8 (J)	5.8 (U)	22 (U)	5 (U)	4.1 (J)	22 (U)	22 (U)	22 (U)	22 (U)
CA21-98-0014	21-10816	Filtered	10/26/98	—	10 (U)	6.3 (J)	10 (U)	—	10 (U)	—	10 (U)	10 (U)	10 (U)	10 (U)	10 (U)
CA21-98-0015	21-10817	Unfiltered	10/26/98	20 (U)	14 (U)	71 (U)	4 (J)	20 (U)	14 (U)	5 (U)	14 (U)	14 (U)	14 (U)	14 (U)	14 (U)
CA21-98-0016	21-10817	Filtered	10/26/98	—	—	—	—	—	—	—	—	—	—	—	—
CA21-98-0042	21-01812	Unfiltered	10/7/98	—	10 (U)	50 (U)	10 (U)	—	10 (U)	—	10 (U)	10 (U)	10 (U)	10 (U)	10 (U)
CA21-98-0043	21-01854	Unfiltered	10/6/98	—	10 (U)	50 (U)	10 (U)	—	10 (U)	—	10 (U)	10 (U)	10 (U)	10 (U)	10 (U)
AAB1336	LAO-B	Unfiltered	6/13/94	—	—	—	—	—	—	—	—	—	—	—	—
AAB1341	LAO-B	Unfiltered	6/14/94	—	—	—	—	—	—	—	—	—	—	—	—
AAB1380	LAO-B	Unfiltered	6/13/94	—	—	—	—	—	—	—	—	—	—	—	—
AAB3592	LAO-B	Unfiltered	10/19/94	—	—	—	—	—	—	—	—	—	—	—	—
AAB8403	LAO-B	Unfiltered	1/17/95	—	—	—	—	—	—	—	—	—	—	—	—
AAB8495	LAO-B	Unfiltered	10/19/94	—	—	—	—	—	—	—	—	—	—	—	—

Table D-4.0-6 (continued)

Sample ID	Location ID	Filtered/Unfiltered	Date Collected	Acetone	Benzo(b)fluoranthene	Benzoic Acid	Bis(2-ethylhexyl)phthalate	2-Butanone	Chrysene	1,2-Dichloroethane	Di-n-butylphthalate	Di-n-octylphthalate	Fluoranthene	Phenanthrene	Pyrene
AAB8509	LAO-B	Unfiltered	10/19/94	—	—	—	—	—	—	—	—	—	—	—	—
AAB8559	LAO-B	Unfiltered	1/15/95	—	—	—	—	—	—	—	—	—	—	—	—
0441-95-0013	LAO-B	Unfiltered	5/9/95	—	—	—	—	—	—	—	—	—	—	—	—
0441-95-0014	LAO-B	Unfiltered	5/9/95	—	—	—	—	—	—	—	—	—	—	—	—
0441-95-0033	LAO-B	Unfiltered	5/9/95	—	—	—	—	—	—	—	—	—	—	—	—
EPA	21-01811	Unfiltered	9/4/98	—	—	—	—	—	—	—	—	—	—	—	—
EPA	21-01812	Unfiltered	9/4/98	—	—	—	—	—	—	—	—	—	—	—	—
EPA	21-01854	Unfiltered	9/2/98	—	—	—	—	—	—	—	—	—	—	—	—
NMED	21-01854	Unfiltered	10/6/98	—	—	—	—	—	—	—	—	—	—	—	—

[a] A dash in the table means "not analyzed."

[b] 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.

[c] UJ = The analyte was analyzed for but not detected. Reported value is an estimate of the sample-specific quantitation limit or detection limit.

[d] U = The analyte was analyzed for but not detected. Reported value is the sample-specific estimated quantitation limit or detection limit.

[e] UJ- = The analyte was analyzed for but not detected. Reported value is an estimate of the sample-specific quantitation limit or detection limit. The estimated detection limit may be biased low.

Table D-4.0-7
Analytical Results for Water Chemistry Parameters in Alluvial Groundwater and Storm Water in DP Canyon Reaches

Sample ID	Location ID	Filtered/Unfiltered	Date Collected	Bicarbonate	Carbon, Total Organic	Chloride	Fluoride	Nitrate/Nitrite as N	Nitrate as NO_3	Phosphorus	Silica, Total	Sulfate
0121-97-1381	21-05471	Unfiltered	8/22/97	—[a]	—	—	—	—	—	—	—	—
0121-97-1382	21-05471	Unfiltered	8/22/97	—	—	—	—	—	—	—	—	—
0121-97-1383	21-05472	Unfiltered	8/22/97	—	—	—	—	—	—	—	—	—
0121-97-1384	21-05472	Unfiltered	8/22/97	—	—	—	—	—	—	—	—	—
0121-97-1396	21-01811	Unfiltered	8/20/97	—	—	—	—	—	—	—	—	—
0121-97-1397	21-01811	Filtered	8/20/97	—	—	—	—	—	—	—	—	—
0121-97-1398	21-01812	Unfiltered	8/20/97	—	—	—	—	—	—	—	—	—
0121-97-1399	21-01812	Filtered	8/20/97	—	—	—	—	—	—	—	—	—
0121-97-1400	21-01854	Unfiltered	8/21/97	—	—	—	—	—	—	—	—	—
0121-97-1401	21-01854	Filtered	8/21/97	—	—	—	—	—	—	—	—	—
0121-97-1421	21-01854	Unfiltered	10/15/97	—	—	—	—	—	—	—	—	—
0121-97-1422	21-01854	Unfiltered	10/15/97	—	—	—	—	—	—	—	—	—
0121-97-1424	21-01811	Unfiltered	12/4/97	—	—	—	—	—	—	—	—	—
0121-97-1425	21-01812	Unfiltered	12/4/97	—	—	—	—	—	—	—	—	—
0121-97-1426	21-01811	Unfiltered	12/4/97	—	—	—	—	—	—	—	—	—
0121-97-1428	21-01811	Filtered	12/4/97	—	—	—	—	—	—	—	—	—
0121-97-1429	21-01812	Filtered	12/4/97	—	—	—	—	—	—	—	—	—
0121-97-1430	21-01811	Filtered	12/4/97	—	—	—	—	—	—	—	—	—
CA21-98-0001	21-01811	Unfiltered	5/5/98	—	—	—	—	—	—	—	—	—
CA21-98-0002	21-01811	Filtered	5/5/98	—	—	—	—	—	—	—	—	—
CA21-98-0003	21-01812	Unfiltered	5/5/98	—	—	—	—	—	—	—	—	—

Note: Results are in μg/L.

Table D-4.0-7 (continued)

Sample ID	Location ID	Filtered/Unfiltered	Date Collected	Bicarbonate	Carbon, Total Organic	Chloride	Fluoride	Nitrate/Nitrite as N	Nitrate as NO_3	Phosphorus	Silica, Total	Sulfate
CA21-98-0004	21-01812	Filtered	5/5/98	—	—	—	—	—	—	—	—	—
CA21-98-0005	21-01854	Unfiltered	5/6/98	—	—	—	—	—	—	—	—	—
CA21-98-0006	21-01854	Filtered	5/6/98	—	—	—	—	—	—	—	—	—
CA21-98-0007	21-01811	Unfiltered	9/17/98	160000	7800	27000	770	230	—	100 (U)[b]	—	7900
CA21-98-0008	21-01811	Filtered	9/17/98	180000	7700	27000	820	250	—	100 (U)	—	7600
CA21-98-0009	21-01812	Unfiltered	9/17/98	220000	6500	63000	1300	50	—	110	—	1500
CA21-98-0010	21-01812	Filtered	9/17/98	190000	6700	63000	1300	50 (U)	—	140	—	1500
CA21-98-0011	21-01854	Unfiltered	9/16/98	87000	4000	35000	1100	310	—	120	—	6600
CA21-98-0012	21-01854	Filtered	9/16/98	91000	3800	34000	1100	280	—	120	—	6600
CA21-98-0013	21-10816	Unfiltered	10/26/98	—	—	—	—	—	—	—	—	—
CA21-98-0014	21-10816	Filtered	10/26/98	15000	—	850	100 (U)	—	230	—	1700	2900
CA21-98-0015	21-10817	Unfiltered	10/26/98	—	—	—	—	—	—	—	—	—
CA21-98-0016	21-10817	Filtered	10/26/98	39000	—	2500	100 (U)	—	230	—	2600	4900
CA21-98-0042	21-01812	Unfiltered	10/7/98	—	—	—	—	—	—	—	—	—
CA21-98-0043	21-01854	Unfiltered	10/6/98	—	—	—	—	—	—	—	—	—
AAB1336	LAO-B	Unfiltered	6/13/94	—	—	8000	160	—	—	—	15000	5000
AAB1341	LAO-B	Unfiltered	6/14/94	38800	—	8810	110	—	—	—	—	4960
AAB1380	LAO-B	Unfiltered	6/13/94	—	—	7000	110	—	—	—	14000	5000
AAB3592	LAO-B	Unfiltered	10/19/94	51500	—	9600	50	—	—	—	—	3190
AAB8403	LAO-B	Unfiltered	1/17/95	36000	—	9850	50	—	—	—	—	4710
AAB8495	LAO-B	Unfiltered	10/19/94	—	—	8400	100	—	—	—	17000	4200
AAB8509	LAO-B	Unfiltered	10/19/94	—	—	8200	110	—	—	—	17000	4200

Table D-4.0-7 (continued)

Sample ID	Location ID	Filtered/Unfiltered	Date Collected	Bicarbonate	Carbon, Total Organic	Chloride	Fluoride	Nitrate/Nitrite as N	Nitrate as NO_3	Phosphorus	Silica, Total	Sulfate
AAB8559	LAO-B	Unfiltered	1/15/95	—	—	—	—	—	—	—	—	—
0441-95-0013	LAO-B	Unfiltered	5/9/95	—	—	—	10 (U)	—	—	—	—	1000 (U)
0441-95-0014	LAO-B	Unfiltered	5/9/95	—	—	—	10 (U)	—	—	—	—	1000 (U)
0441-95-0033	LAO-B	Unfiltered	5/9/95	33500	—	8750	70	—	—	—	—	4790
EPA	21-01811	Unfiltered	9/4/98	—	—	—	—	—	—	—	—	—
EPA	21-01812	Unfiltered	9/4/98	—	—	—	—	—	—	—	—	—
EPA	21-01854	Unfiltered	9/2/98	—	—	—	—	—	—	—	—	—
NMED	21-01854	Unfiltered	10/6/98	—	—	—	—	—	—	—	—	—

[a] A dash in the table means "not analyzed."

[b] U = The analyte was analyzed for but not detected. Reported value is the sample-specific estimated quantitation limit or detection limit.

Appendix E

Statistical Analyses

E-1.0 STATISTICAL EVALUATIONS OF SEDIMENT INORGANIC CHEMICAL DATA

The objective of this section is to present detailed statistical and graphical analyses that compare inorganic chemical data from DP Canyon reaches with Laboratory background sediment data. These analyses are used to determine whether the reach data show evidence of contaminant releases through a systematic increase in concentration of one or more analytes greater than concentrations observed in the background data.

The figures and tables for this section are placed at the end of the section; the figures appear first, followed by the tables.

E-1.1 Data Analysis Methods

Three types of data analyses were used to evaluate the concentrations of inorganic chemicals in the reach samples as compared with background data. The first type of analysis is a graphical comparison of reach and background sample results. Second, the results of formal statistical testing are presented. Third, relationships of inorganic chemicals to concentration of aluminum and particle size are graphically presented. Each of these methods is discussed below in more detail.

E-1.1.1 Comparisons of Inorganic Chemical Data by Reach

These comparisons use graphical displays called "box plots," which show the actual values for each inorganic chemical. The ends of each box represent the "interquartile" range of the data distribution, which is specified by the 25th percentile and 75th percentile of the data distribution. The horizontal line within each box is the median (50th percentile) of the data distribution (if the number of samples is four or fewer, the horizontal line is not displayed). Thus, each box indicates concentration values for the central half of the data, and concentration shifts can be readily assessed by comparing the boxes. If most of the data are represented by a single concentration value (usually the detection limit), the box is reduced to a single line.

In these statistical plots, a different symbol is used for the laboratory results for each reach and for the background data (BKG), and the symbols are used consistently in all statistical plots in this section. Background data are represented by a circle, reach DP-1 data by an inverted triangle, reach DP-2 data by a square, reach DP-3 data by a diamond, and reach DP-4 data by a triangle. Note that the DP-1 data are presented in three groups to show the concentration trends between western (DP-1w), central (DP-1c) and eastern (DP-1e) subreaches of DP-1. The lowercase letters are used to designate subreaches so that the box plot labels would not overlap. Also note that nondetected sample results are plotted as the detection limit value and the symbol is shaded in a light gray pattern.

E-1.1.2 Statistical Testing

Because the data for these inorganic chemicals do not appear to typically satisfy conditions of statistical normality, nonparametric statistical tests are preferred for background comparisons. The Gehan test was used for statistical testing. The purpose of this test is to detect whether the reach data show evidence of a release of any analyte through a systematic increase in concentration greater than that observed in the background data. The Gehan test pools site and background data into one aggregate set and determines whether the average rank of site data is greater than that of the background data. The Gehan test is most sensitive to detecting cases where most of the reach data are greater than the average or median value observed in the background data. More discussion of these tests is contained in Ryti et al. (1996, 53953).

The metrics used to determine if a statistically significant difference between reach data and background data exists are the calculated significance levels (p-values) for the tests. A low p-value (near zero) indicates that reach data are greater than background data, whereas a p-value approaching 1 indicates no difference between reach data and background data. If a p-value is less than some small probability (0.05), then there is some reason to suspect that the reach statistical distribution may be elevated above the background distribution; otherwise, no difference is indicated.

E-1.1.3 Interelement Correlations

One way to evaluate the applicability of Laboratory-wide background sediment data to reach sediment data is to evaluate the data through interelement correlations. Typically, there are significant correlations between major elements (aluminum, iron, and potassium) and trace elements (arsenic, beryllium, copper, nickel, vanadium, and zinc). The correlations are presented and the geochemical basis is discussed in "Natural Background Geochemistry and Statistical Analysis of Selected Soil Profiles, Sediments, and Bandelier Tuff," Los Alamos, New Mexico (Longmire et al. 1995, 52227). For most inorganic chemicals, these strong correlations result in a consistent ratio of trace to major elements. A significantly elevated ratio of a given trace element to a major element can be used to indicate a release of that trace element. Scatter plots of trace elements to major elements are one way to visually display the ratios for background and reach data. Scatter plots of all inorganic chemicals versus aluminum are presented as a graphical assessment of the similarity between the reach data and the Laboratory-wide sediment background data. The relationship of the concentration of inorganic chemicals to the abundance of fine-sized particles provides another measure of the natural development and accumulation of metals in sediments. The total content (in percent) of silt and clay-sized particles was used as a measure of the abundance of fine particles in the samples. The concentration of all inorganic chemicals was plotted against aluminum as well as silt and clay content. These plots show five groups of data: the Laboratory sediment background, reach DP-1, reach DP-2, reach DP-3 and reach DP-4. Aluminum was selected as the major element for these plots for two reasons. First, knowledge of Laboratory releases (see Section 1.3.2) has not implicated aluminum as a possible Laboratory contaminant. Second, the results of statistical testing of the DP Canyon reach data also suggest no evidence for aluminum concentrations to be shifted above background levels (see Section E-1.2.1).

E-1.2 Results

The results of the statistical analyses are presented for each inorganic chemical and includes a discussion of statistical tests that compare sample results from each reach with sediment background data.

E-1.2.1 Aluminum

Results of the statistical testing (Table E-1.0-1) suggest that the reach data are not greater than the sediment background data. A review of the data plotted by reach (Figure E-1.2-1a) and the correlation with silt and clay abundance (Figure E-1.2-1c) confirms these results. Figure E-1.2-1b shows the relationship of aluminum to itself. The only result of note is that most aluminum sample results for DP Canyon tend to be in the lower quartile of the sediment background data. The particle size plot shows that there is a correlation of both background data and the DP Canyon data with silt and clay, but the slopes of the relationship visually differ. The slope of the background data would suggest greater aluminum than was measured in the DP Canyon samples. The reason for the apparently lower-than-expected sample results for aluminum is not known, but based on the particle size relationship of the DP Canyon aluminum sample results, the DP Canyon aluminum data are consistent with a natural concentration distribution. Thus, aluminum is not retained as a chemical of potential concern (COPC).

E-1.2.2 Antimony

There are only two detected antimony sample results for the DP Canyon reach sediment samples; thus, statistical testing is not appropriate. The statistical plots show the range of the nondetected and detected values by reach (Figure E-1.2-2a) and the correlation of the nondetected values with aluminum (Figure E-1.2-2b) and silt and clay (Figure E-1.2-2c). Note that the antimony sediment background data presented in Figure E-1.2-2a were analyzed by inductively coupled plasma emission spectroscopy (ICPES), which has detection limits above the soil background value. The soil background value is used as a surrogate sediment background value. Because the two detected values are greater than the antimony background value, antimony is retained as a COPC. It is important to note that most of the samples have detection limits less than the background value, which helps to place an upper bound on the amount of antimony possibly released into the DP Canyon watershed.

E-1.2.3 Arsenic

Results of the statistical testing (Table E-1.2-1) suggest that the reach data are not greater than the sediment background data. A review of the data plotted by reach (Figure E-1.2-3a) and versus aluminum (Figure E-1.2-3b) and silt and clay (Figure E-1.2-3c) confirms these results. Thus, arsenic is not retained as a COPC.

E-1.2.4 Barium

Results of the statistical testing (Table E-1.2-1) suggest that the reach data are not greater than the sediment background data. A review of the data plotted by reach (Figure E-1.2-4a) and versus silt and clay (Figure E-1.2-4c) confirms these results with the exception of a single suspect value on the silt and clay plot. Sample 0121-97-1441 has a barium result of 103 mg/kg for a silt and clay content of 20%. The field duplicate (0121-97-1442) for this sample had a result of 38.5 mg/kg, which is more consistent with the expected value of barium given the silt and clay content. Although the barium versus aluminum plot (Figure E-1.2-4b) shows several suspect elevated values in DP Canyon, the correlation of barium with silt and clay suggests that barium concentrations in DP Canyon are not different from natural background concentrations. Thus, barium is not retained as a COPC.

E-1.2.5 Beryllium

Results of the statistical testing (Table E-1.2-1) suggest that the reach data are not greater than the sediment background data. A review of the data plotted by reach (Figure E-1.2-5a) and versus aluminum (Figure E-1.2-5b) confirms these results. Most of the DP Canyon beryllium sample results are less than the median background concentration. The beryllium versus silt and clay scatter plot (Figure E-1.2-5c) shows a pattern similar to aluminum, suggesting that concentrations of beryllium in DP Canyon samples are less than the values expected given the silt and clay content. The reason for the apparently lower-than-expected sample results for beryllium is not known, but based on the particle size relationship of the DP Canyon beryllium sample results, the DP Canyon beryllium data are consistent with a natural concentration distribution. Thus, beryllium is not retained as a COPC.

E-1.2.6 Cadmium

Cadmium was not usually detected in the reach or background samples, thus statistical testing is not appropriate. The statistical plots show the range of detected and nondetected values by reach (Figure E-1.2-6a) and the correlation of the mostly nondetected values with aluminum (Figure E-1.2-6b) or silt and clay (Figure E-1.2-6c). There are two detected cadmium sample results from reach DP-1c greater

than the background value. It is important to recognize that the apparently elevated sample results in reach DP-2 are all nondetected values. Because some detected sample results and detection limits are greater than the cadmium background value of 0.4 mg/kg, cadmium is retained as a COPC.

E-1.2.7 Calcium

Results of the statistical testing (Table E-1.2-1) suggest that reach DP-1 results are greater than background. A review of the data plotted by reach (Figure E-1.2-7a) and versus aluminum (Figure E-1.2-7b) or silt and clay (Figure E-1.2-7c) confirms these results. The highest concentrations are noted in reach DP-1w, which suggests a source for calcium from the Los Alamos townsite. Because of the statistical difference between reach DP-1 and background and the observation of three sample results above background value in reach DP-2, calcium is retained as a COPC.

E-1.2.8 Chromium, Total

Results of the statistical testing (Table E-1.2-1) suggest that reach DP-1 results are greater than background. A review of the data plotted by reach (Figure E-1.2-8a) and versus aluminum (Figure E-1.2-8b) or silt and clay (Figure E-1.2-8c) confirms these results. There is also one sample result greater than the background value in reach DP-3. Because of the statistical difference between reach DP-1 and background and the observation of one sample result above background value in reach DP-3, total chromium is retained as a COPC.

E-1.2.9 Cobalt

Results of the statistical testing (Table E-1.2-1) suggest that reach DP-2 results are greater than background. A review of the data plotted by reach (Figure E-1.2-9a) confirms these results. Review of the data plotted by reach (Figure E-1.2-9a) and versus aluminum (Figure E-1.2-9b) and silt and clay (Figure E-1.2-9c) confirms these results. However, one of the suspect elevated cobalt values on the silt and clay plot is sample 0121-97-1441 collected in reach DP-2, which had a cobalt result of 4.71 mg/kg for a silt and clay content of 20%. The field duplicate (0121-97-1442) for this sample had a result of 2.34 mg/kg, which is more consistent with the expected value of cobalt, given the silt and clay content. There is one result for reach DP-3 marginally greater than the background value. Because of the statistical difference between reach DP-2 and background, cobalt is retained as a COPC.

E-1.2.10 Copper

Results of the statistical testing (Table E-1.2-1) suggest there are significant differences between reaches DP-1, DP-2, and DP-4 data and background data. A review of the data plotted by reach (Figure E-1.2-10a) and versus aluminum (Figure E-1.2-10b) and silt and clay (Figure E-1.2-10c) confirms these results but also shows that the overall magnitude of most background exceedances are small (less than 5 mg/kg above the background value of 10.5 mg/kg). An exception is the maximum copper sample result in reach DP-4, which was measured at about three times the background value. Thus, copper is retained as a COPC.

E-1.2.11 Iron

Results of the statistical testing (Table E-1.2-1) suggest that the reach data are not greater than the sediment background data. A review of the data plotted by reach (Figure E-1.2-11a) and versus aluminum (Figure E-1.2-11b) confirms these results. The iron versus silt and clay scatter plot

(Figure E-1.2-11c) shows a pattern similar to aluminum, suggesting that concentrations of iron in DP Canyon samples are less than the values expected, given the silt and clay content. The reason for the apparently lower-than-expected sample results for iron is not known, but based on the particle size relationship of the DP Canyon iron sample results, the DP Canyon iron data are consistent with a natural concentration distribution. Thus, iron is not retained as a COPC.

E-1.2.12 Lead

Results of the statistical testing (Table E-1.2-1) suggest there are significant differences between reaches DP-1, DP-2, DP-3 and DP-4 data and background data. A review of the data plotted by reach (Figure E-1.2-12a) and versus aluminum (Figure E-1.2-12b) and silt and clay (Figure E-1.2-12c) confirms these results. Lead concentrations are greatest in reach DP-1, which suggests a Los Alamos townsite source for lead contamination. Thus, lead is retained as a COPC.

E-1.2.13 Magnesium

Results of the statistical testing (Table E-1.2-1) suggest that the reach data are not greater than the sediment background data. A review of the data plotted by reach (Figure E-1.2-13a) and versus aluminum (Figure E-1.2-13b) confirms these results. The magnesium-versus-silt-and -clay scatter plot (Figure E-1.2-13c) shows a pattern similar to aluminum, suggesting that concentrations of magnesium in DP Canyon samples are less than the values expected, given the silt and clay content. The reason for the apparently lower than expected sample results for magnesium is not known, but based on the particle size relationship of the DP Canyon magnesium sample results, the DP Canyon magnesium data are consistent with a natural concentration distribution. Thus, magnesium is not retained as a COPC.

E-1.2.14 Manganese

Results of the statistical testing (Table E-1.2-1) suggest that the reach data are not greater than the sediment background data. A review of the data plotted by reach (Figure E-1.2-14a) shows one "outlier" sample result in reach DP-2 (738 mg/kg for sample ID 0121-97-1441). This same sample result is the only DP Canyon outlier on the plots versus aluminum (Figure E-1.2-14b) and versus silt and clay (Figure E-1.2-14c). The field duplicate (0121-97-1442) for this sample had a result of 283 mg/kg, which is more consistent with the expected value of manganese given the silt and clay content (20%). It is also worth noting there are a few outlier values for the background data on the aluminum and silt and clay plots. The available evidence suggests that DP Canyon manganese is derived from a natural concentration distribution. Thus, magnesium is not retained as a COPC.

E-1.2.15 Mercury

Mercury was not usually detected in the reach or background samples, thus statistical testing is not appropriate. The statistical plots show the range of detected and nondetected values by reach (Figure E-1.2-15a) and the correlation of the nondetected values with aluminum (Figure E-1.2-15b) and versus silt and clay (Figure E-1.2-15c). There are three detected mercury values greater than the background value in reach DP-1. Thus, mercury is retained as a COPC.

E-1.2.16 Nickel

Results of the statistical testing (Table E-1.2-1) suggest that the reach data are not greater than the sediment background data. A review of the data plotted by reach (Figure E-1.2-16a) confirms these

results. The plots versus aluminum (Figure E-1.2-16b) and versus silt and clay (Figure E-1.2-16c) show two suspect values in reach DP-1. Because these values are within the range of nickel for the background silt and clay content, they are not interpreted to represent a release. In addition, no nickel sample results are greater than the background value. Thus, nickel is not retained as a COPC.

E-1.2.17 Potassium

Results of the statistical testing (Table E-1.2-1) suggest that the reach data are not greater than the sediment background data. A review of the data plotted by reach (Figure E-1.2-17a) and versus aluminum (Figure E-1.2-17b) confirms these results. The potassium versus silt and clay scatter plot (Figure E-1.2-17c) shows a pattern similar to aluminum, suggesting that concentrations of potassium in DP Canyon samples are less than the values expected, given the silt and clay content. The reason for the apparently lower-than -expected sample results for potassium is not known, but based on the particle size relationship of the DP Canyon potassium sample results, the DP Canyon potassium data are consistent with a natural concentration distribution. Thus, potassium is not retained as a COPC.

E-1.2.18 Selenium

Selenium was not usually detected in the reach or background samples, thus statistical testing is not appropriate. The statistical plots show the range of detected and nondetected values by reach (Figure E-1.2-18a) and the correlation of the nondetected values with aluminum (Figure E-1.2-18b) and versus silt and clay (Figure E-1.2-18c). It is important to recognize that most of the sample results that are apparently greater than background values in DP Canyon are nondetected values. Because some detected sample results and detection limits are greater than the selenium background value of 0.3 mg/kg, selenium is retained as a COPC.

E-1.2.19 Silver

Silver was not usually detected in the reach or background samples, thus statistical testing is not appropriate. The statistical plots show the range of detected and nondetected values by reach (Figure E-1.2-19a) and the correlation of the nondetected values to aluminum (Figure E-1.2-19b) and versus silt and clay scatter plot (Figure E-1.2-19c). Because no detected sample results nor detection limits are greater than the silver background value of 1.0 mg/kg, silver is not retained as a COPC.

E-1.2.20 Sodium

Results of the statistical testing (Table E-1.2-1) suggest that the reach data are not greater than the sediment background data. A review of the data plotted by reach (Figure E-1.2-20a) confirms these results. The plots of sodium versus aluminum (Figure E-1.2-20b) and versus silt and clay (Figure E-1.2-20c) are noninformative because of a lack of correlation of sodium with either variable. Based on the results of the statistical tests and visual inspection of the box plot, sodium is not retained as a COPC.

E-1.2.21 Thallium

Thallium was not detected in any reach sample, and most nondetected sample results were less than the thallium background value of 0.73 mg/kg. The maximum detection limit for thallium in the DP Canyon sediment samples was 0.88 mg/kg, or about 20% greater than the background value. The statistical plots show the range of detected and nondetected values by reach (Figure E-1.2-21a) and the correlation of the nondetected values with aluminum (Figure E-1.2-21b) and versus silt and clay (Figure E-1.2-21c).

Because thallium was not detected in any DP Canyon sediment samples, and detection limits were typically less than the background value, thallium is not retained as a COPC.

E-1.2.22 Vanadium

Results of the statistical testing (Table E-1.2-1) suggest that the reach data are not greater than the sediment background data. A review of the data plotted by reach (Figure E-1.2-22a), versus aluminum (Figure E-1.2-22b), and versus silt and clay (Figure E-1.2-22c) confirms these results. Thus, vanadium is not retained as a COPC.

E-1.2.23 Zinc

Results of the statistical testing (Table E-1.2-1) suggest there are significant differences between reaches DP-1, DP-2, and DP-4 data and background data. A review of the data plotted by reach (Figure E-1.2-23a), versus aluminum (Figure E-1.2-23b) and versus silt and clay (Figure E-1.2-23c) confirms these results. The highest zinc values are in reach DP-1, which suggests a Los Alamos townsite source for zinc releases. Zinc is retained as a COPC.

E-1.2.24 Physical Parameters

Physical parameters (pH and particle size analysis) were measured on some of the DP Canyon sediment samples. This information is provided to assist in interpreting contaminant fate and transport. Statistical plots are provided to evaluate differences between reaches in these parameters, not to evaluate these parameters as COPCs.

Plots are provided for pH (Figure E-1.2-24a, b, c), gravel content (Figure E-1.2-25a, b, c), percent organic matter (Figure E-1.2-26a, b, c), total clay content (Figure E-1.2-27a, b, c), total silt content (Figure E-1.2-28a, b, c), and silt and clay content (Figure E-1.2-29a, b, c). Values for pH show little variability between samples, and suggest near neutral sediment chemistry. The gravel content is highest and most variable in reaches DP-1w and DP-1c, but is still variable in downstream reaches. Organic matter, clay, and silt all show similar trends with the highest content in reach DP-1.

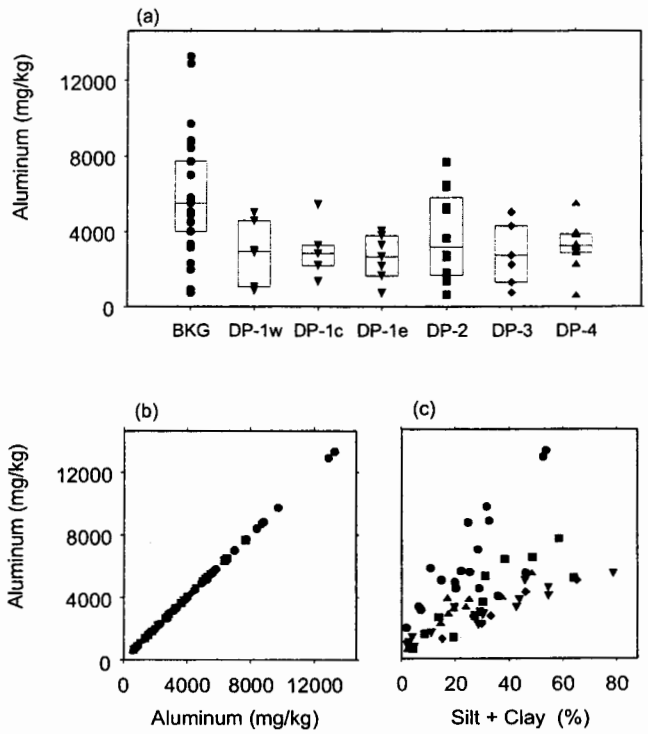


Figure E-1.2-1. **(a) Box plot for aluminum; (b) scatter plot for aluminum versus aluminum; (c) scatter plot for aluminum versus silt and clay**

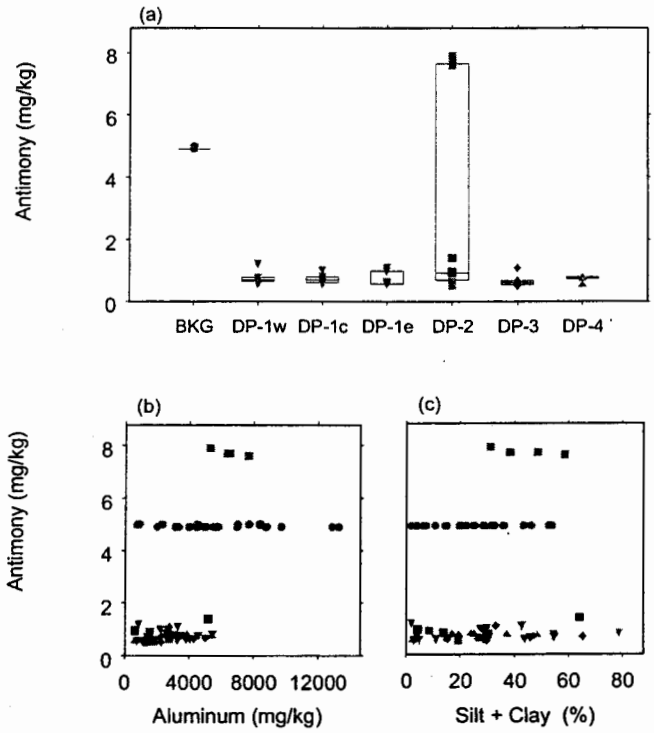


Figure E-1.2-2. **(a) Box plot for antimony; (b) scatter plot for antimony versus aluminum; (c) scatter plot for antimony versus silt and clay**

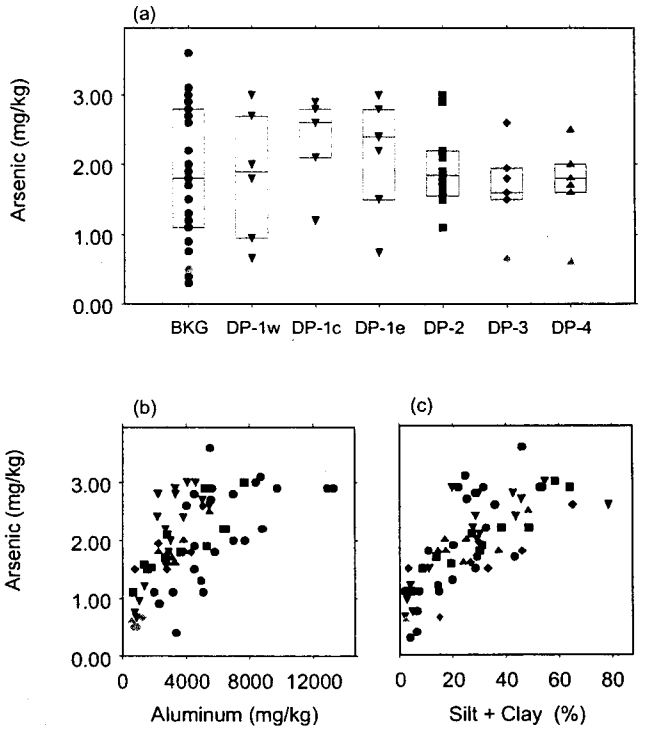


Figure E-1.2-3. (a) Box plot for arsenic; (b) scatter plot for arsenic versus aluminum; (c) scatter plot for arsenic versus silt and clay

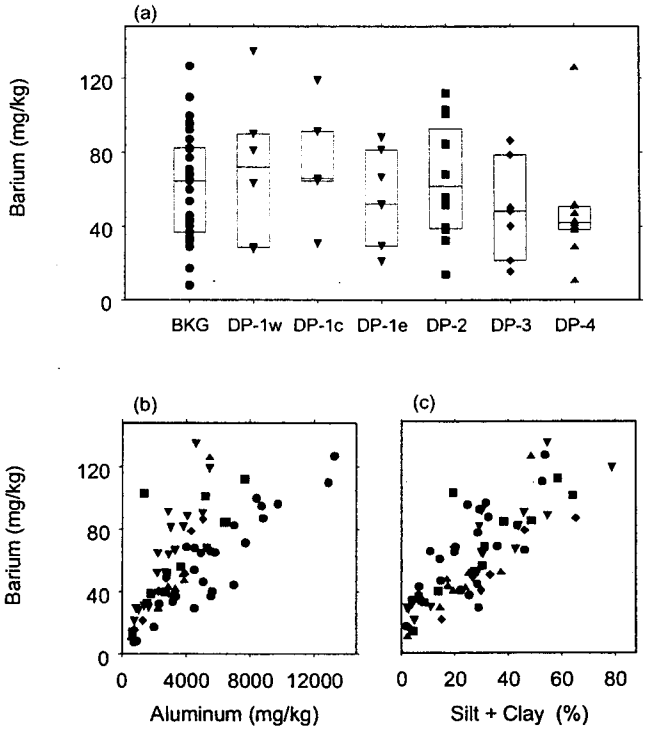


Figure E-1.2-4. (a) Box plot for barium; (b) scatter plot for barium versus aluminum; (c) scatter plot for barium versus silt and clay

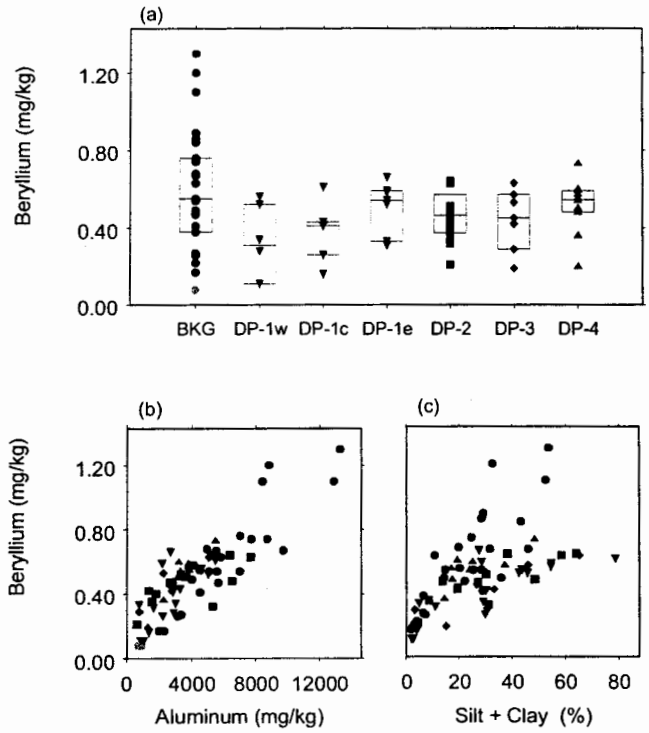


Figure E-1.2-5. (a) Box plot for beryllium; (b) scatter plot for beryllium versus aluminum; (c) scatter plot for beryllium versus silt and clay

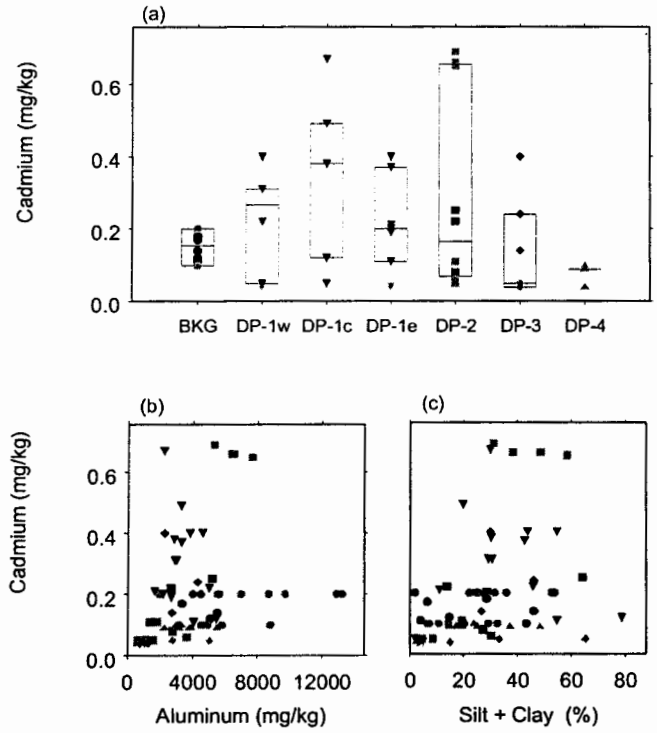


Figure E-1.2-6. (a) Box plot for cadmium; (b) scatter plot for cadmium versus aluminum; (c) scatter plot for cadmium versus silt and clay

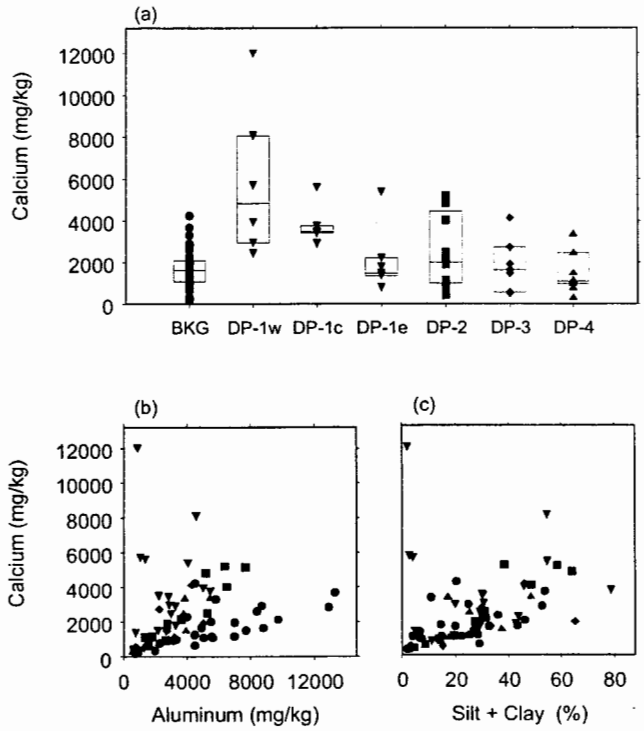


Figure E-1.2-7. (a) Box plot for calcium; (b) scatter plot for calcium versus aluminum; (c) scatter plot for calcium versus silt and clay

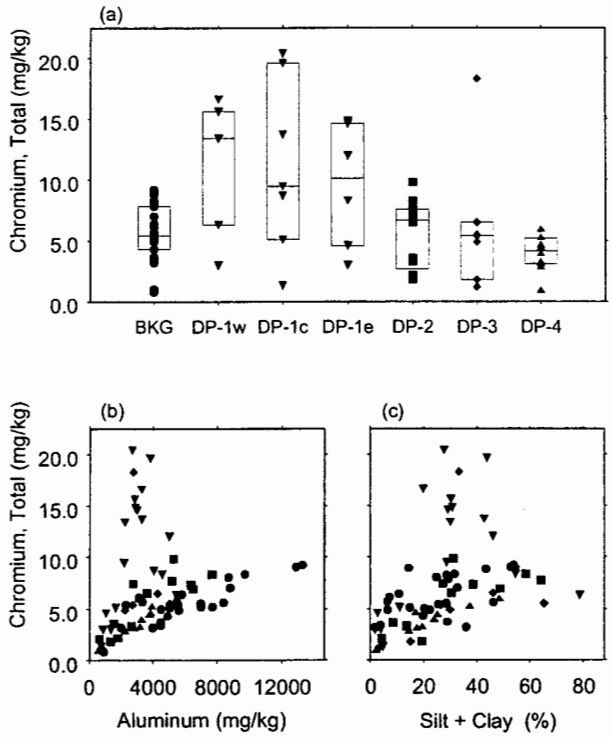


Figure E-1.2-8. (a) Box plot for chromium; (b) scatter plot for chromium versus aluminum; (c) scatter plot for chromium versus silt and clay

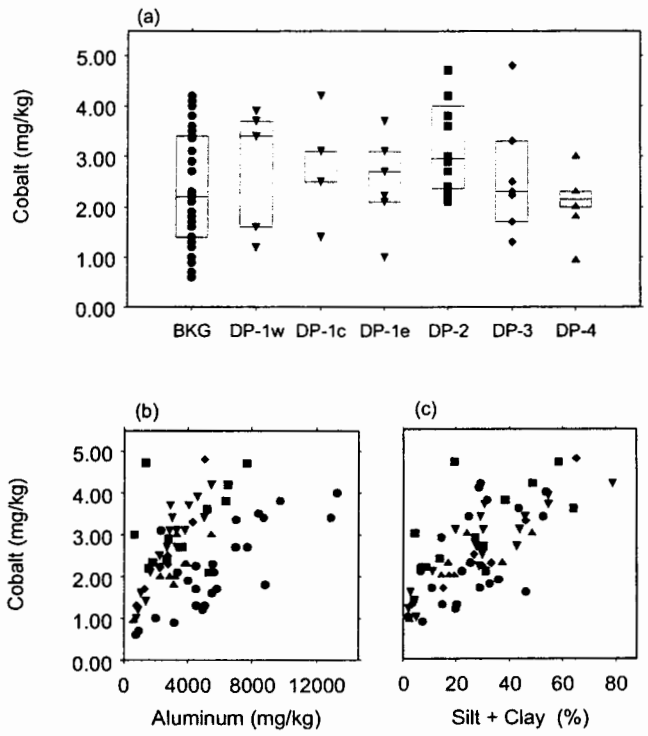


Figure E-1.2-9. (a) Box plot for cobalt; (b) scatter plot for cobalt versus aluminum; (c) scatter plot for cobalt versus silt and clay

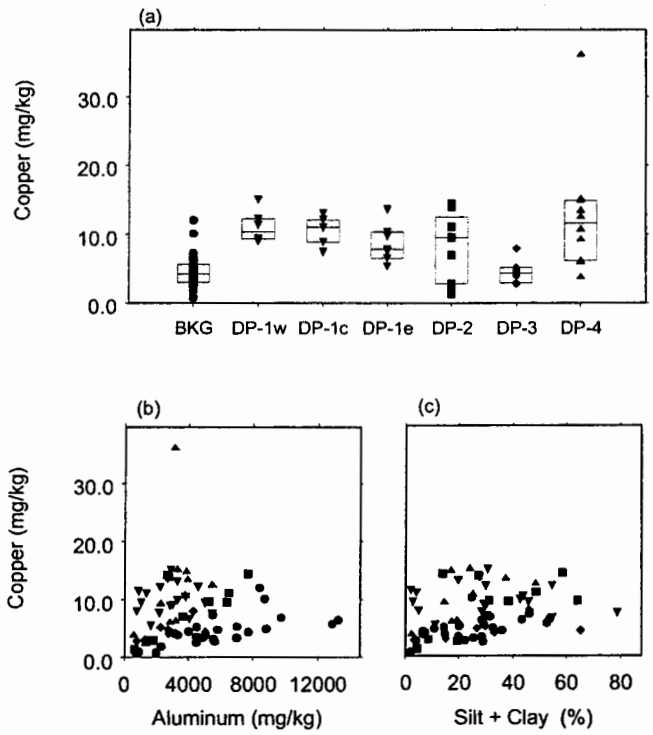


Figure E-1.2-10. (a) Box plot for copper; (b) scatter plot for copper versus aluminum; (c) scatter plot for copper versus silt and clay

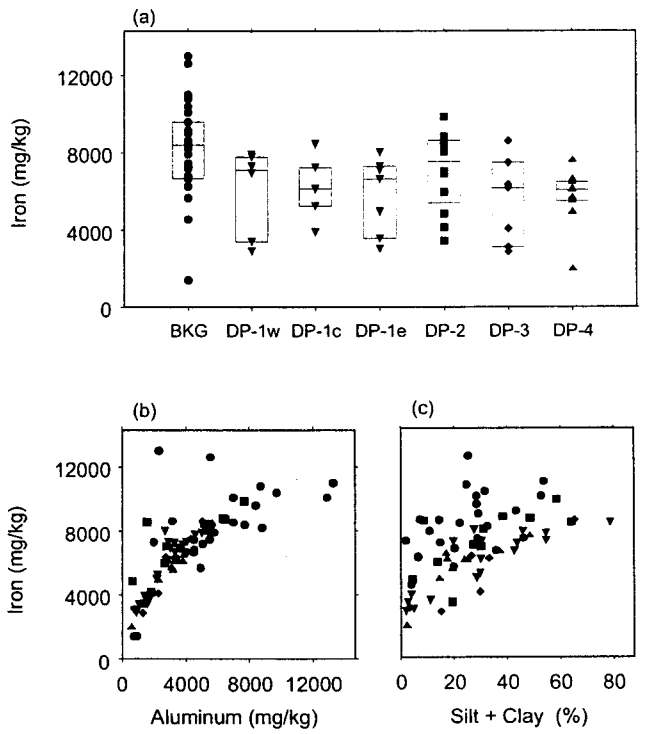


Figure E-1.2-11. (a) Box plot for iron; (b) scatter plot for iron versus aluminum; (c) scatter plot for iron versus silt and clay

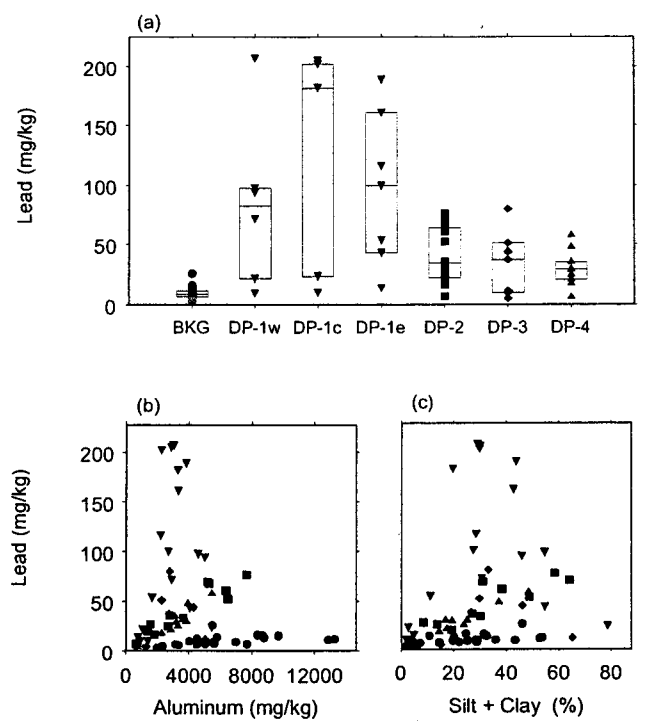


Figure E-1.2-12. (a) Box plot for lead; (b) scatter plot for lead versus aluminum; (c) scatter plot for lead versus silt and clay

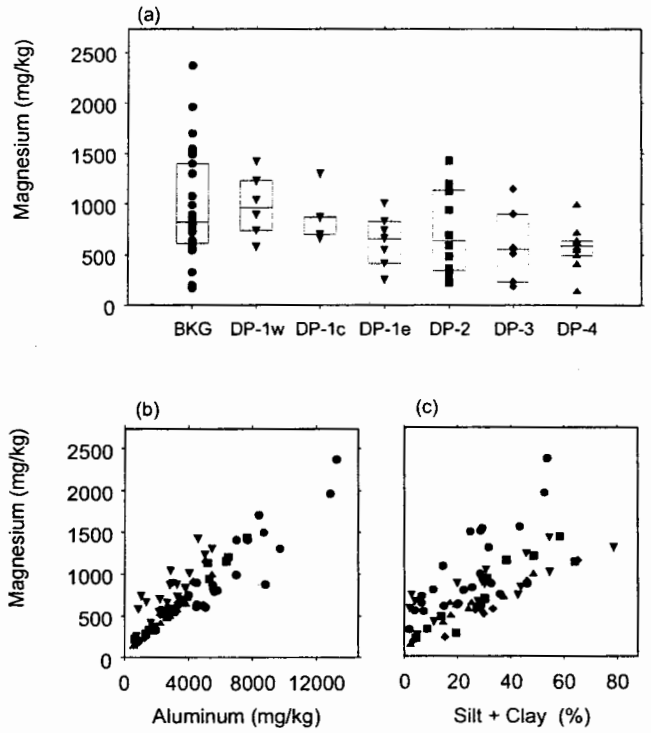


Figure E-1.2-13. (a) Box plot for magnesium; (b) scatter plot for magnesium versus aluminum; (c) scatter plot for magnesium versus silt and clay

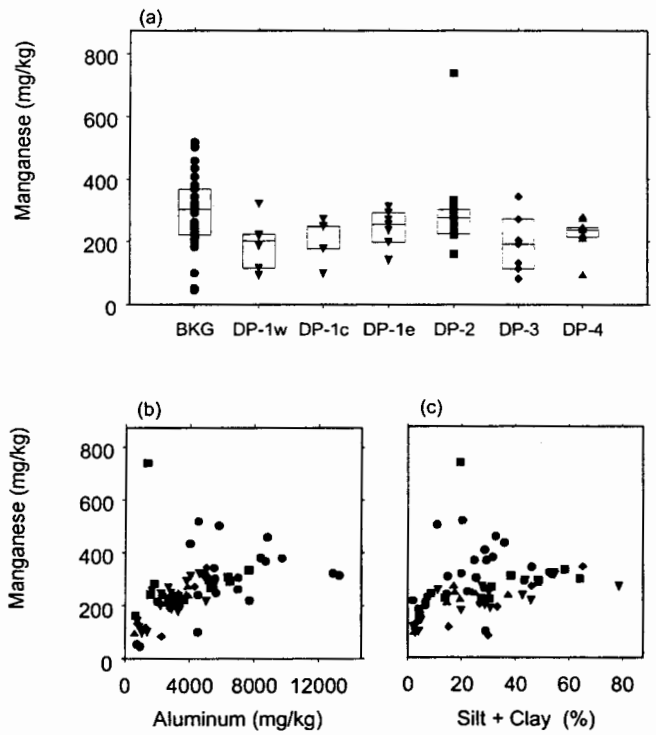


Figure E-1.2-14. (a) Box plot for manganese; (b) scatter plot for manganese versus aluminum; (c) scatter plot for manganese versus silt and clay

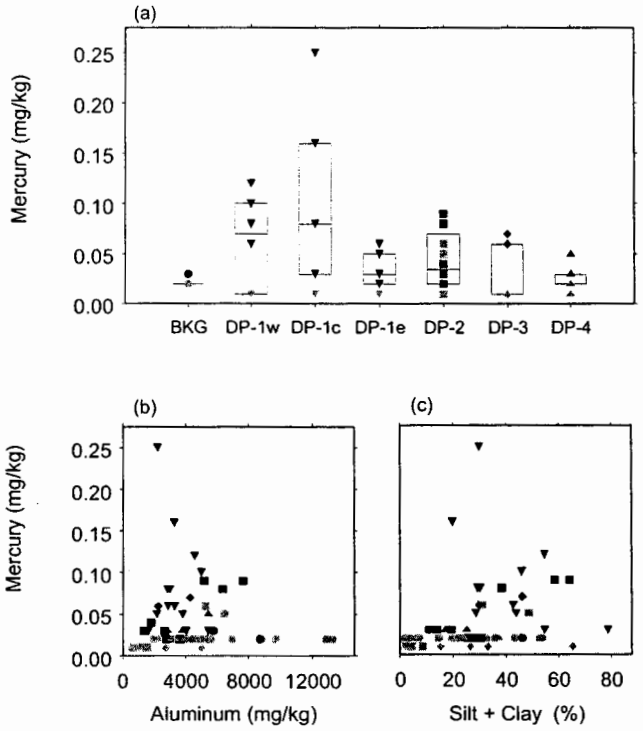


Figure E-1.2-15. (a) Box plot for mercury; (b) scatter plot for mercury versus aluminum; (c) scatter plot for mercury versus silt and clay

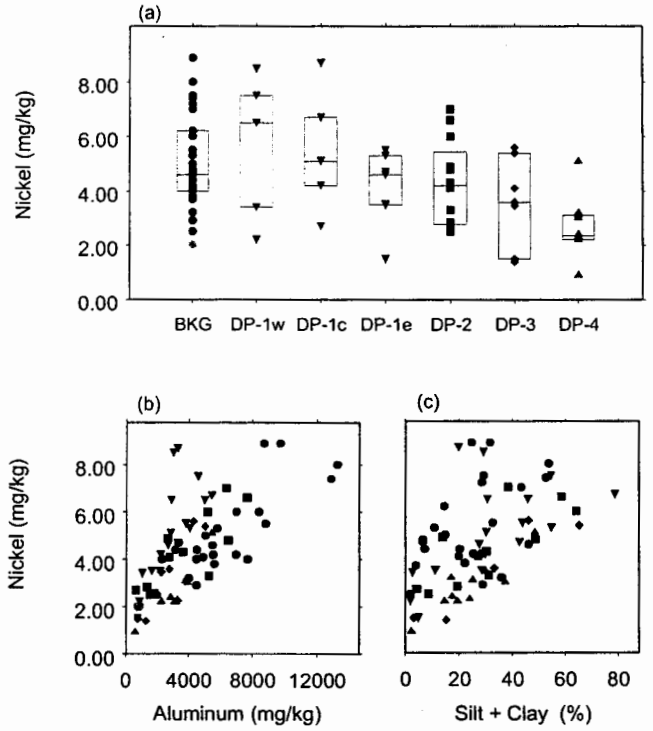


Figure E-1.2-16. (a) Box plot for nickel; (b) scatter plot for mercury versus nickel; (c) scatter plot for nickel versus silt and clay

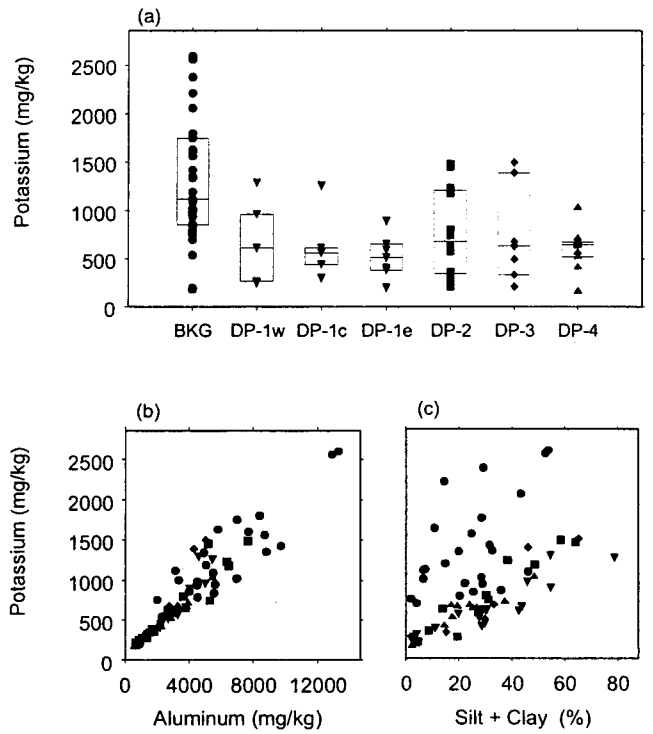


Figure E-1.2-17. (a) Box plot for potassium; (b) scatter plot for potassium versus aluminum; (c) scatter plot for potassium versus silt and clay

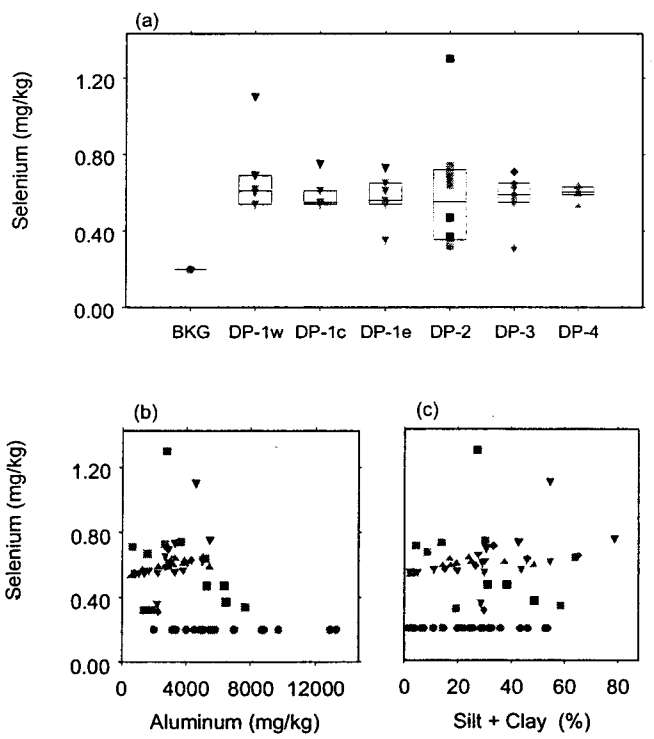


Figure E-1.2-18. (a) Box plot for selenium; (b) scatter plot for selenium versus aluminum; (c) scatter plot for selenium versus silt and clay

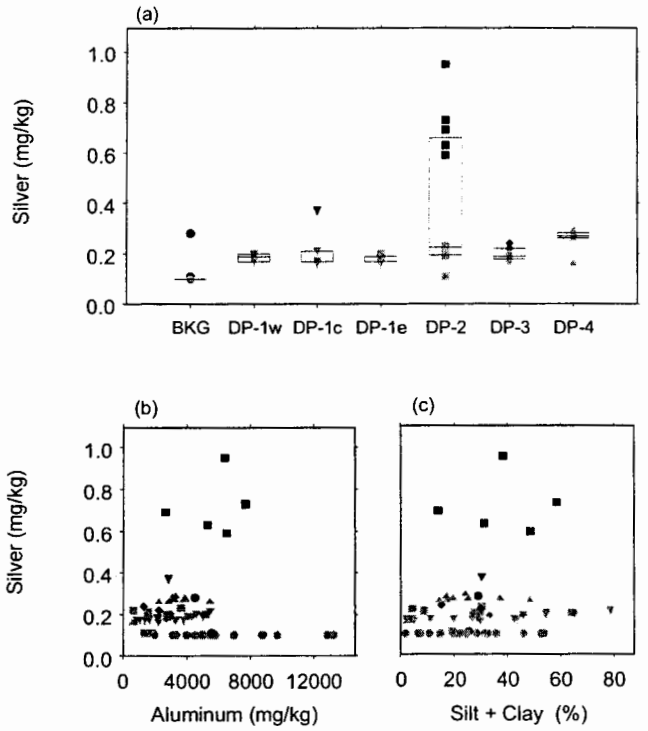


Figure E-1.2-19. (a) Box plot for silver; (b) scatter plot for silver versus aluminum; (c) scatter plot for silver versus silt and clay

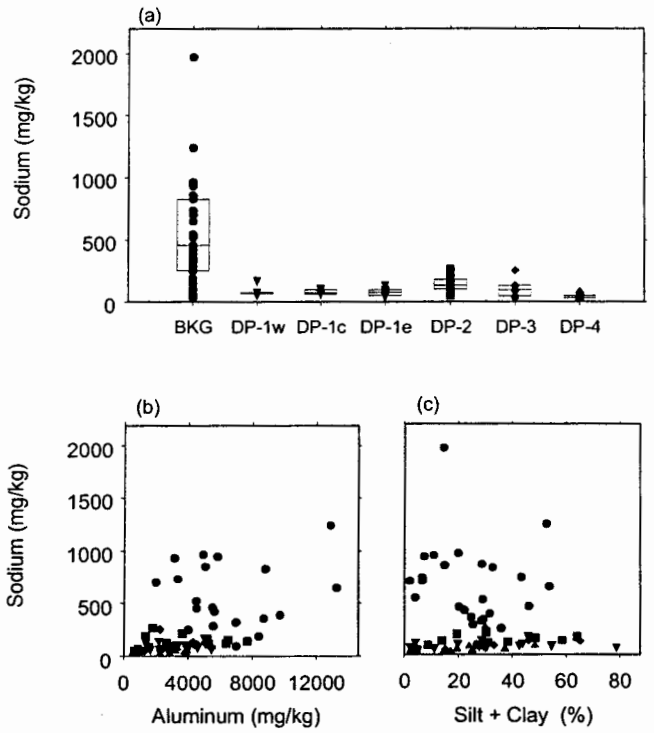


Figure E-1.2-20. (a) Box plot for sodium; (b) scatter plot for sodium versus aluminum; (c) scatter plot for sodium versus silt and clay

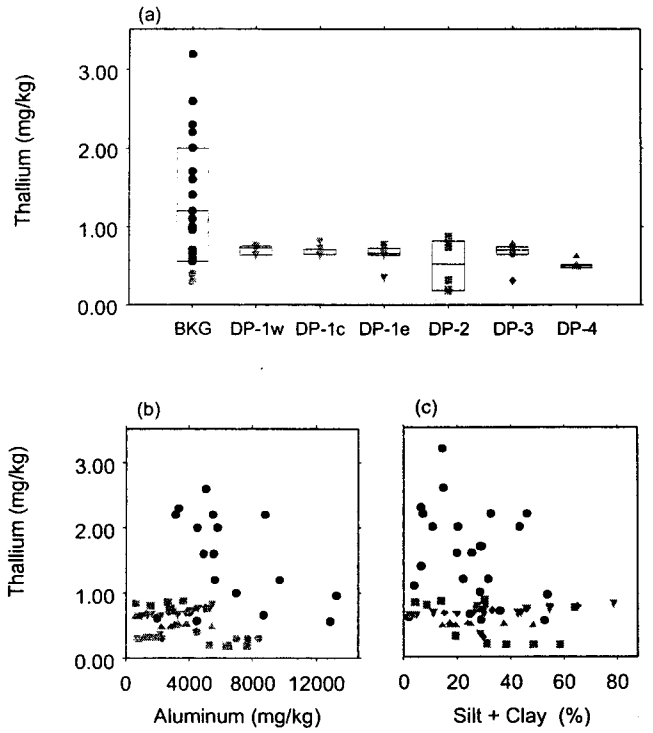


Figure E-1.2-21. (a) Box plot for thallium; (b) scatter plot for thallium versus aluminum; (c) scatter plot for thallium versus silt and clay

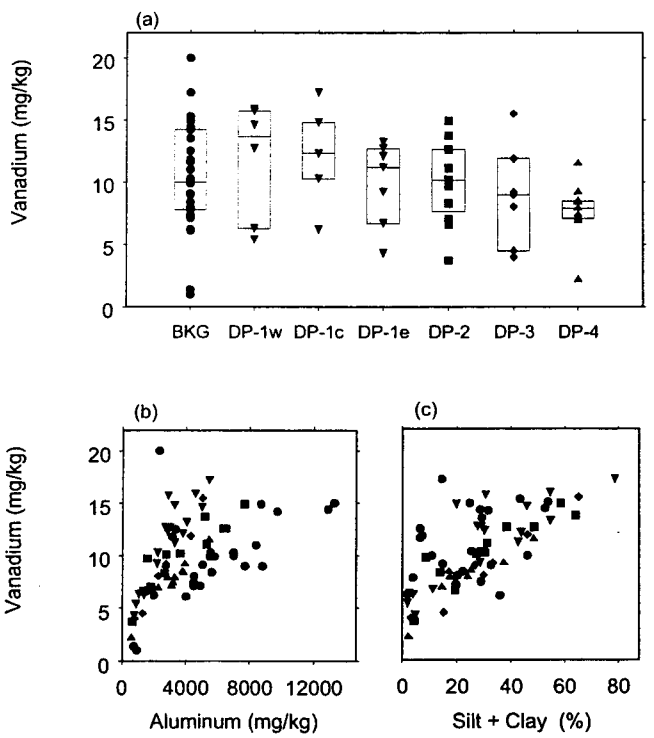


Figure E-1.2-22. (a) Box plot for vanadium; (b) scatter plot for vanadium versus aluminum; (c) scatter plot for vanadium versus silt and clay

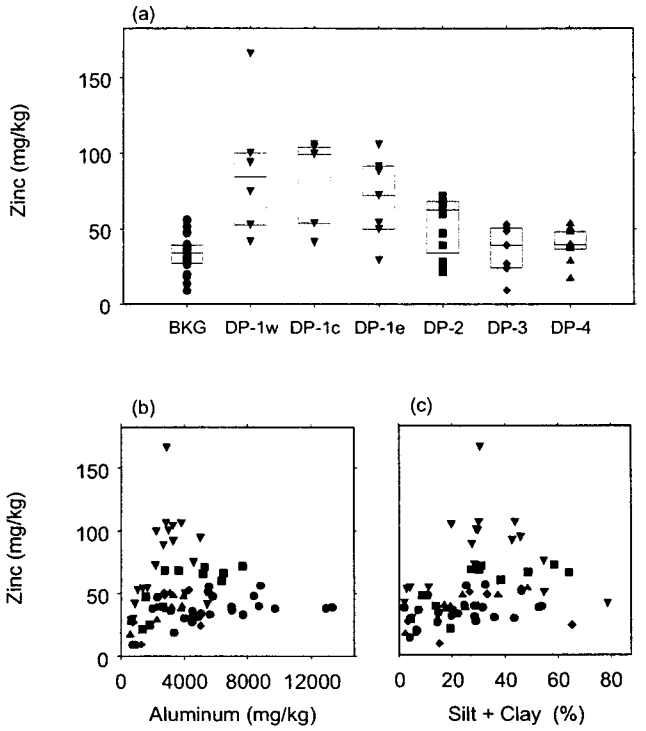


Figure E-1.2-23. (a) Box plot for zinc; (b) scatter plot for zinc versus aluminum; (c) scatter plot for zinc versus silt and clay

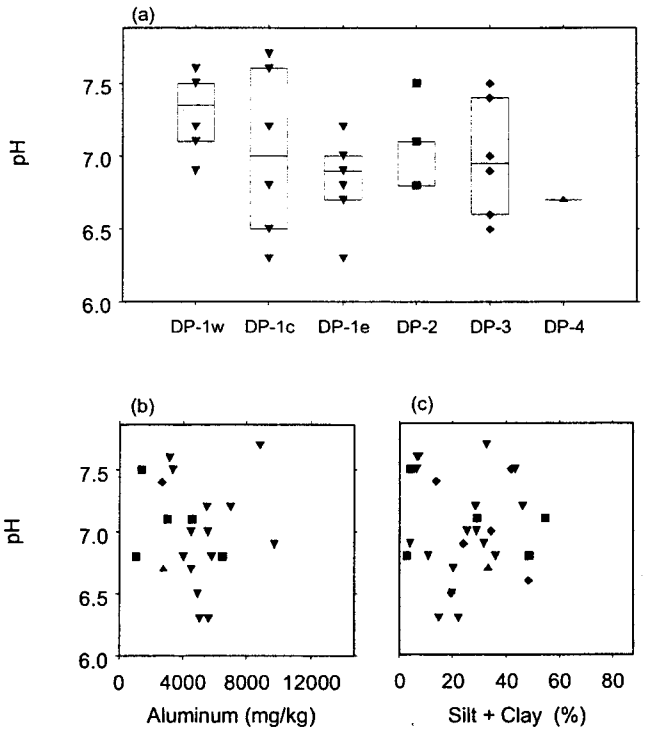


Figure E-1.2-24. (a) Box plot for pH; (b) scatter plot for pH versus aluminum; (c) scatter plot for pH versus silt and clay

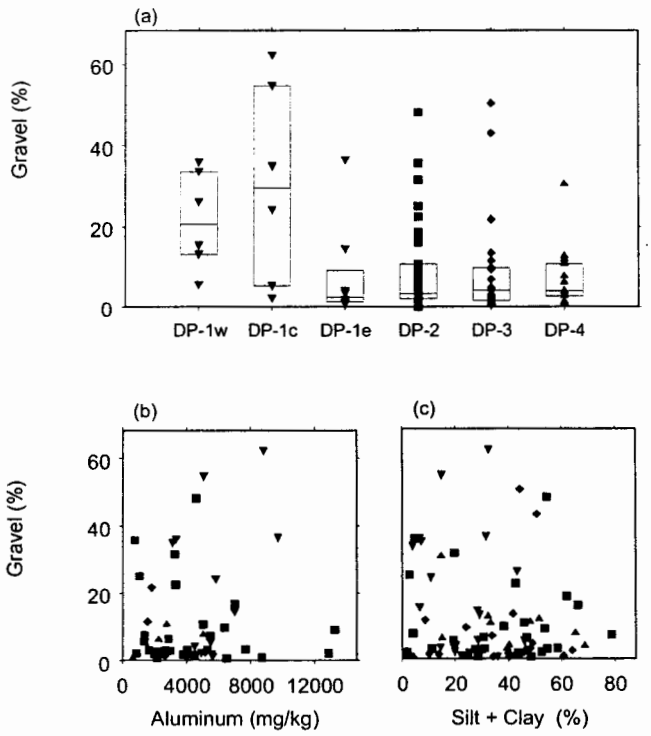


Figure E-1.2-25. (a) Box plot for gravel; (b) scatter plot for gravel versus aluminum; (c) scatter plot for gravel versus silt and clay

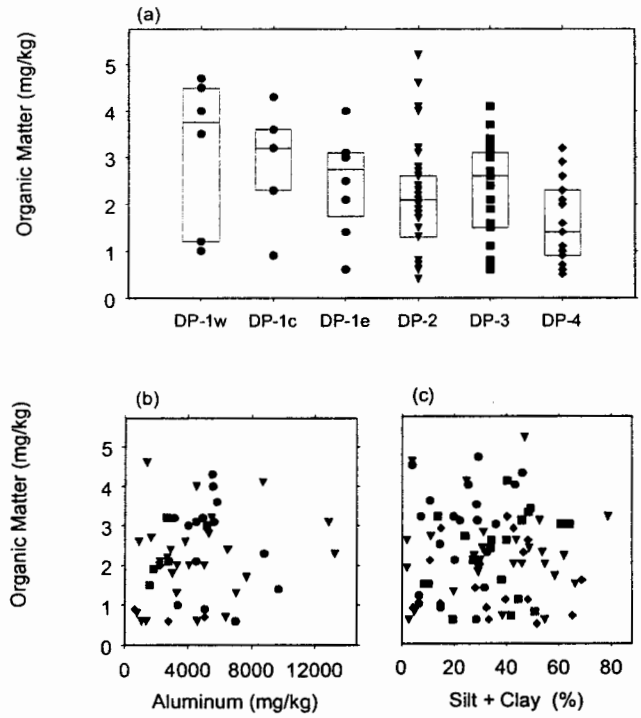


Figure E-1.2-26. (a) Box plot for organic matter; (b) scatter plot for organic matter versus aluminum; (c) scatter plot for organic matter versus silt and clay

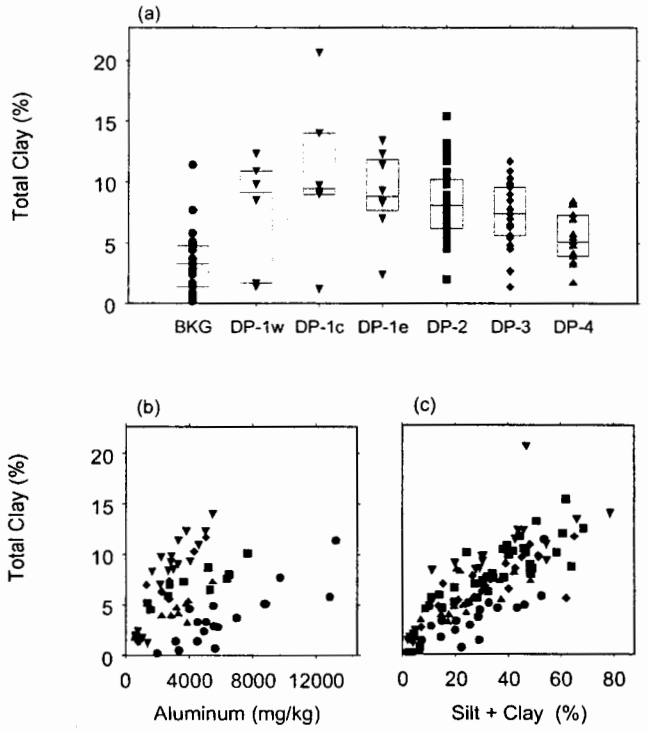


Figure E-1.2-27. (a) Box plot for total clay; (b) scatter plot for total clay versus aluminum; (c) scatter plot for total clay versus silt and clay

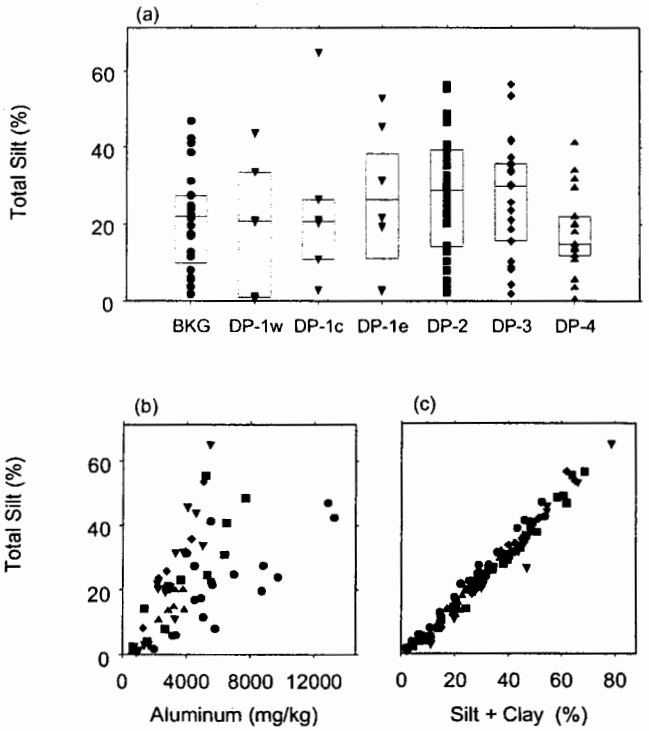


Figure E-1.2-28. (a) Box plot for total silt; (b) scatter plot for total silt versus aluminum; (c) scatter plot for total silt versus silt and clay

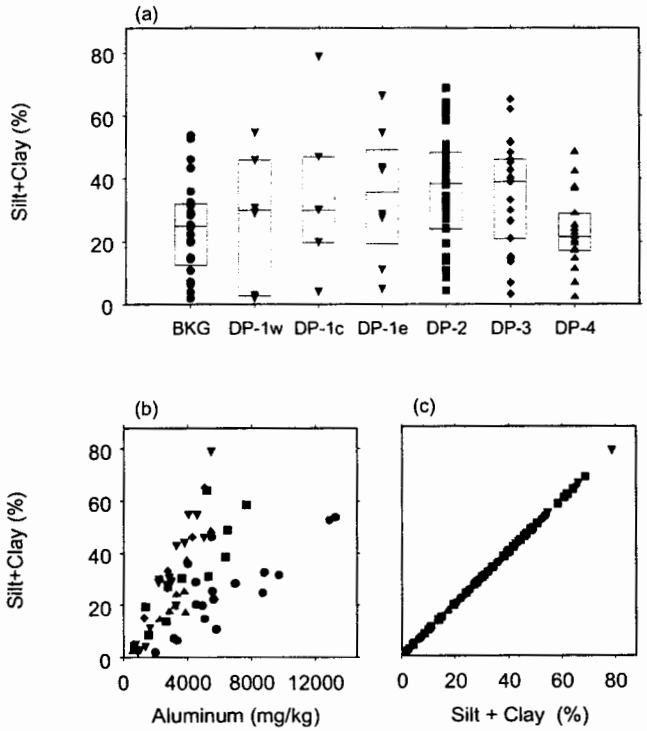


Figure E-1.2-29. (a) Box plot for silt and clay; (b) scatter plot for silt and clay versus aluminum; (c) scatter plot for silt and clay versus silt and clay

Table E-1.0-1
Summary of the P-Values from the Gehan Statistical Testing

Analyte	DP-1	DP-2	DP-3	DP-4
Aluminum	1.000	0.967	0.995	0.997
Antimony	ND[a]	ND	ND	ND
Arsenic	0.209	0.318	0.739	0.631
Barium	0.422	0.289	0.796	0.902
Beryllium	0.980	0.940	0.897	0.733
Cadmium	—[b]	—	—	—
Calcium	**<0.001**	0.165	0.433	0.753
Chromium, total	**0.003**	0.500	0.654	0.985
Cobalt	0.125	**0.010**	0.332	0.590
Copper	**<0.001**	**0.023**	0.477	**<0.001**
Iron	0.999	0.886	0.989	0.999
Lead	**<0.001**	**<0.001**	**0.008**	**<0.001**
Magnesium	0.753	0.914	0.975	0.994
Manganese	0.992	0.701	0.983	0.971
Mercury	—	—	—	—
Nickel	0.483	0.864	0.957	1.000
Potassium	1.000	0.992	0.986	1.000
Selenium	—	—	—	—
Silver	—	—	—	—
Sodium	1.000	1.000	0.999	1.000
Thallium	ND	ND	ND	ND
Vanadium	0.250	0.607	0.796	0.984
Zinc	**<0.001**	**0.004**	0.299	**0.045**

Note: Bolded values indicate that reach sample results are significantly greater than background values.

[a] ND = no background data.

[b] A dash in the table means "not applicable" (statistical tests are not appropriate because of the high frequency of nondetected values).

E-2.0 STATISTICAL EVALUATIONS OF SEDIMENT RADIONUCLIDE DATA

The objective of this section is to present graphical analyses that compare radionuclide data from DP Canyon sediment samples with Laboratory background sediment data. These analyses are used to determine whether the reach data show evidence of contaminant releases through a systematic increase in concentration of one or more analytes over concentrations observed in the background data. Statistical testing was also used to help determine which radionuclides should be retained as COPCs.

The figures and tables for this section are placed at the end of the section; the figures appear first, followed by the table.

E-2.1 Data Analysis Methods

Two types of data analyses were used to evaluate the concentrations of radionuclides in the reach samples as compared with background data. The first analysis is a graphical comparison of reach and background sample results. The second is the results of formal statistical testing. Each method is briefly discussed below.

E-2.1.1 Comparisons of Radionuclide Data by Reach

This comparison uses graphical displays called "box plots," which show sample results for each radionuclide. All of the DP Canyon radionuclide results are not censored, which means that nondetect results less than the minimum detectable activity are presented in all statistical plots and analyses. Some of the background data are censored (cesium-137 and isotopic uranium), and the plots and statistical analyses display the minimum detectable activity as the sample value. There is no impact of data censoring on the identification of COPCs. The ends of each box represent the "interquartile" range of the data distribution, which is specified by the 25th percentile and 75th percentile of the data distribution. The horizontal line within each box is the median (50th percentile) of the data distribution (if the number of samples is four or fewer, the line is not displayed). Thus, each box indicates concentration values for the central half of the data, and concentration shifts can be readily assessed by comparing the boxes. If most of the data are represented by a single concentration value (usually the detection limit), the box is reduced to a single line.

In these box plots a different symbol is used for the laboratory results for each reach and for the background data (BKG), and the symbols are used consistently in all statistical plots. Background data are represented by a circle, reach DP-1 data by an inverted triangle, reach DP-2 data by a square, reach DP-3 data by a diamond, and reach DP-4 data by a triangle. Note that the DP-1 data are presented in three groups to show the concentration trends between western (DP-1w), central (DP-1c) and eastern (DP-1e) subreaches of DP-1.

E-2.1.2 Statistical Testing

Because the data for these radionuclides do not appear to typically satisfy statistical assumptions of normality, nonparametric statistical tests are preferred for background comparisons. The Wilcoxon Rank Sum (WRS) test was used for statistical testing. The purpose of this test is to detect whether the reach data show evidence of contaminant releases through a systematic increase in concentration greater than that observed in the background sediment data. The WRS test pools reach and background data into one aggregate set and determines whether the average rank of reach data is greater than that of the background data. The WRS test is most sensitive to detecting cases where most of the reach data are

greater than the average or median value observed in the background data. Additional discussions of these tests are presented in Ryti et al. (1996, 53953).

The metrics used to determine if a statistically significant difference between reach data and site data exists are the calculated significance levels (p-values) for the tests. A low p-value (near zero) indicates that reach data are greater than background data, whereas a p-value of 1 indicates no difference between reach data and background data. If a p-value is less than some small probability (0.05), then there is some reason to suspect that site distribution may be elevated above the background distribution; otherwise, no difference is indicated.

E-2.2 Results

E-2.2.1 Americium-241

Americium-241 in the DP Canyon sample was determined by gamma spectroscopy. The sediment background data were determined by alpha spectroscopy. Alpha spectroscopy has lower detection limits and higher precision than gamma spectroscopy. Thus, the detection limit of the DP Canyon americium-241 data serves as the *de facto* background value. Although gamma spectroscopy does not have the same sensitivity as alpha spectroscopy, statistical tests were used to provide another qualitative measure of the similarity of the reach data to background. Results of the statistical testing (Table E-2.2-1) show there are significant differences between reaches DP-2, DP-3 and DP-4 and background data. There were no detected americium-241 sample results in reach DP-1. Process knowledge would also suggest that americium-241 was not released into reach DP-1. The box plot shows elevated values in reaches DP-2, DP-3 and DP-4 and confirms the results of the statistical test (Figure E-2.2-1). Thus, americium-241 is retained as a COPC.

E-2.2.2 Cesium-137

The box plot figure shows that cesium-137 is greater than background in reaches DP-2, DP-3, and DP-4 (Figure E-2.2-2). Results of the statistical testing (Table E-2.2-1) also show that there are significant differences between reaches DP-2, DP-3, and DP-4 and background. Thus, cesium-137 is retained as a COPC.

E-2.2.3 Plutonium-238

The box plot figure shows that plutonium-238 is greater than background in reaches DP-2, DP-3, and DP-4 (Figure E-2.2-3). Results of the statistical testing (Table E-2.2-1) also indicate there are significant differences between reaches DP-2, DP-3, and DP-4 and background, thus plutonium-238 is retained as a COPC.

E-2.2.4 Plutonium-239,240

The box plot figure shows that plutonium-239,240 is greater than background in reaches DP-2, DP-3, and DP-4 (Figure E-2.2-4). Results of the statistical testing (Table E-2.2-1) indicate there are significant differences between reaches DP-1, DP-2, DP-3, and DP-4 and background. The concentration shift in reach DP-1 is too small to detect on the box plot, but the shift is statistically significant nonetheless. Thus plutonium-239,240 is retained as a COPC.

E-2.2.5 Strontium-90

The box plot (Figure E-2.2-5) and results of the statistical testing (Table E-2.2-1) show that reaches DP-2, DP-3 and DP-4 are different from background. Thus, strontium-90 is retained as a COPC.

E-2.2.6 Tritium

The box plot (Figure E-2.2-6) and results of the statistical testing (Table E-2.2-1) suggest that reaches DP-1, DP-2, DP-3 and DP-4 are different from background. Although the differences from background are small for reaches DP-1, DP-3 and DP-4, at least one detected tritium sample result is above the background value in each reach. Effluent release records show that tritium was released at PRS 21-011(k), which is the main source of radionuclide contamination in reaches DP-2, DP-3 and DP-4. Thus, tritium is retained as a COPC.

E-2.2.7 Uranium-234

Only a single sample was analyzed for isotopic uranium in reach DP-3, and thus there are insufficient data in reach DP-3 for statistical testing. The box plot (Figure E-2.2-7) and results of the statistical testing (Table E-2.2-1) suggest that DP Canyon results are not greater than background. The values for uranium-234 and uranium-238 were compared to verify that the results supported secular equilibrium (or a natural ratio of these isotopes). This comparison showed that sample ID 0121-97-1432 had an elevated amount of uranium-234 compared with uranium-238 (1.71 pCi/g versus 0.441 pCi/g). Because of this single sample with uranium-234 consistent with enriched uranium, uranium-234 is retained as a COPC.

E-2.2.8 Uranium-235

Only a single sample was analyzed for isotopic uranium in reach DP-3, and thus there are insufficient data in reach DP-3 for statistical testing. The box plot (Figure E-2.2-8) and results of the statistical testing (Table E-2.2-1) suggest that DP Canyon results are not greater than background. Comparing the uranium-235 values to the uranium-238 results identified no suspect values. Thus, uranium-235 is not retained as a COPC.

E-2.2.9 Uranium-238

Only a single sample was analyzed for isotopic uranium in reach DP-3, and thus there are insufficient data in reach DP-3 for statistical testing. The box plot (Figure E-2.2-9) and results of the statistical testing (Table E-2.2-1) suggest that DP Canyon results are not greater than background. Thus, uranium-238 is not retained as a COPC.

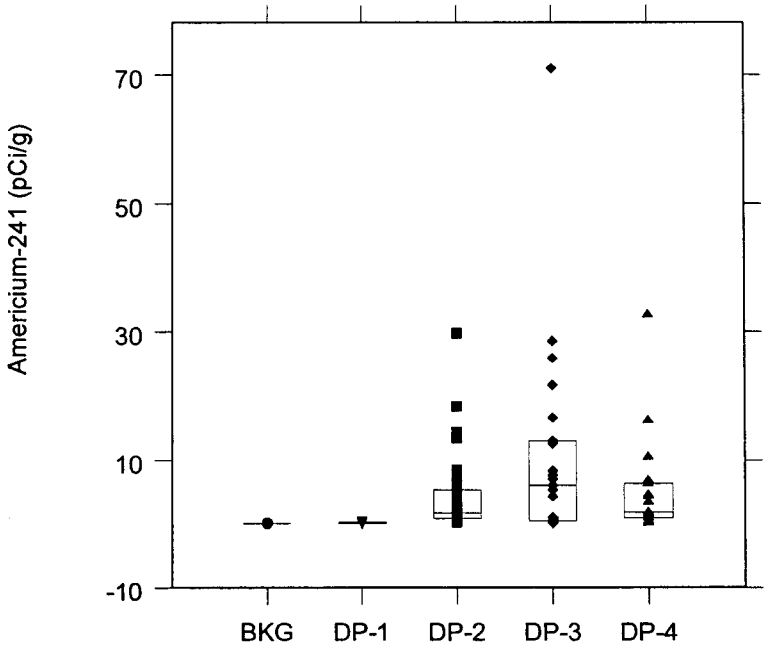


Figure E-2.2-1. Box plot for americium-241

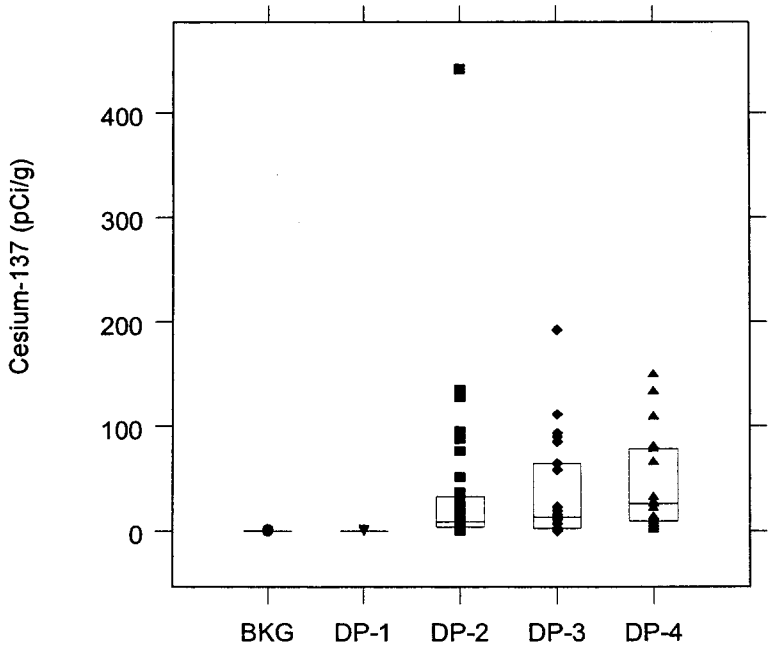


Figure E-2.2-2. Box plot for cesium-137

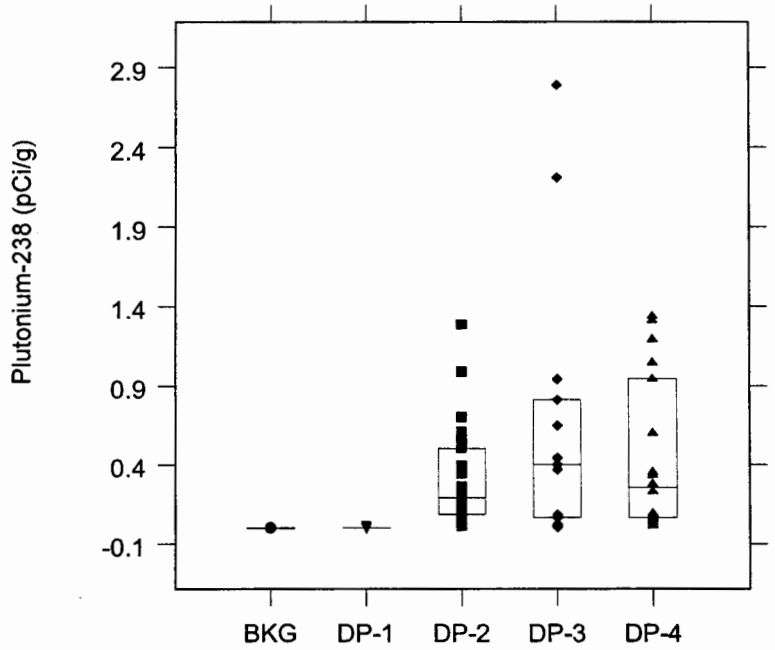


Figure E-2.2-3. Box plot for plutonium-238

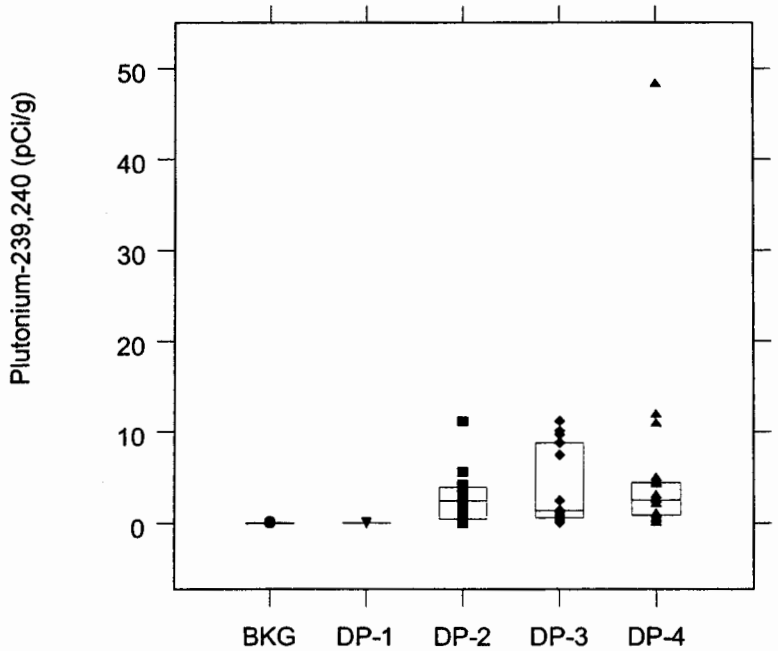


Figure E-2.2-4. Box plot for plutonium-239,240

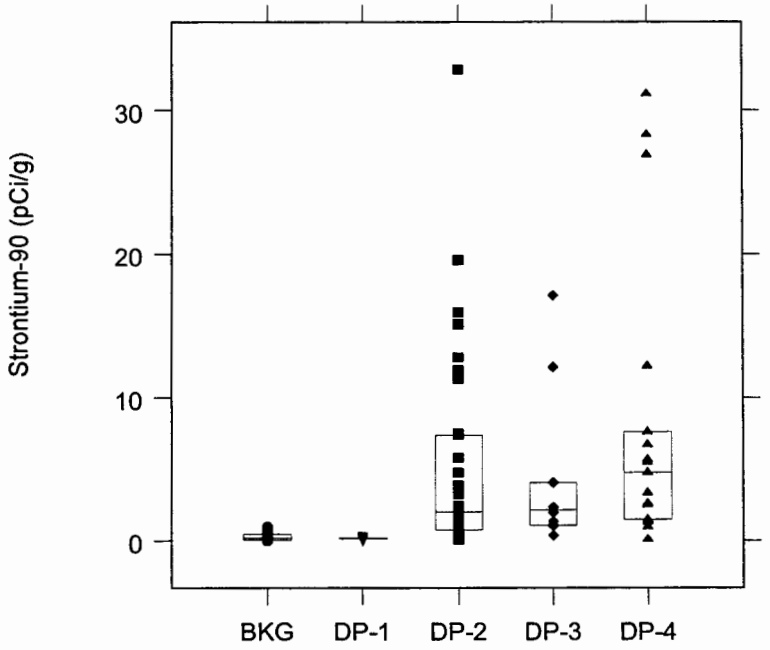


Figure E-2.2-5. Box plot for strontium-90

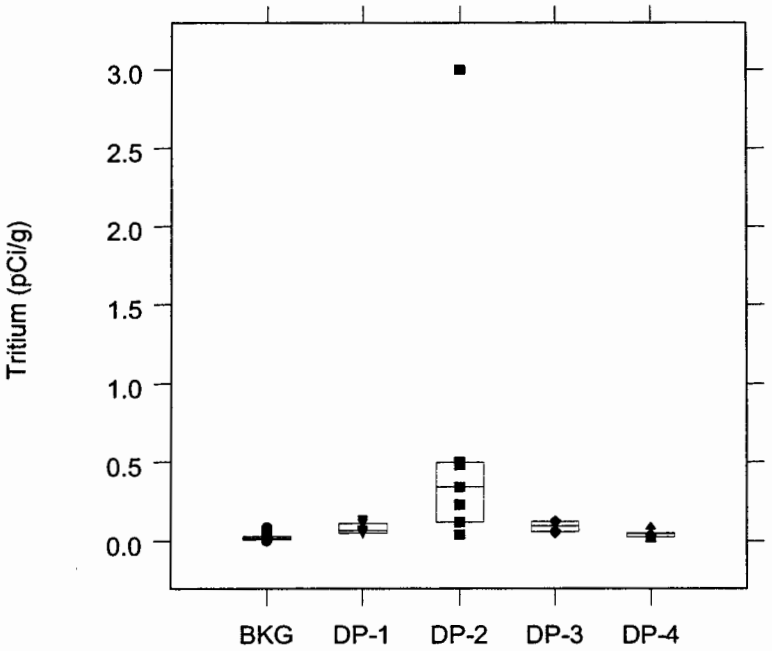


Figure E-2.2-6. Box plot for tritium

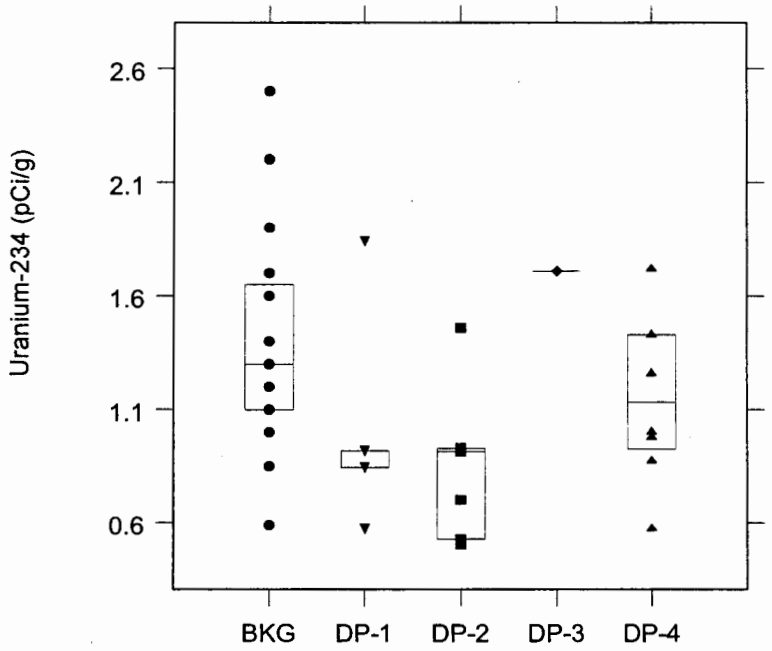


Figure E-2.2-7. Box plot for uranium-234

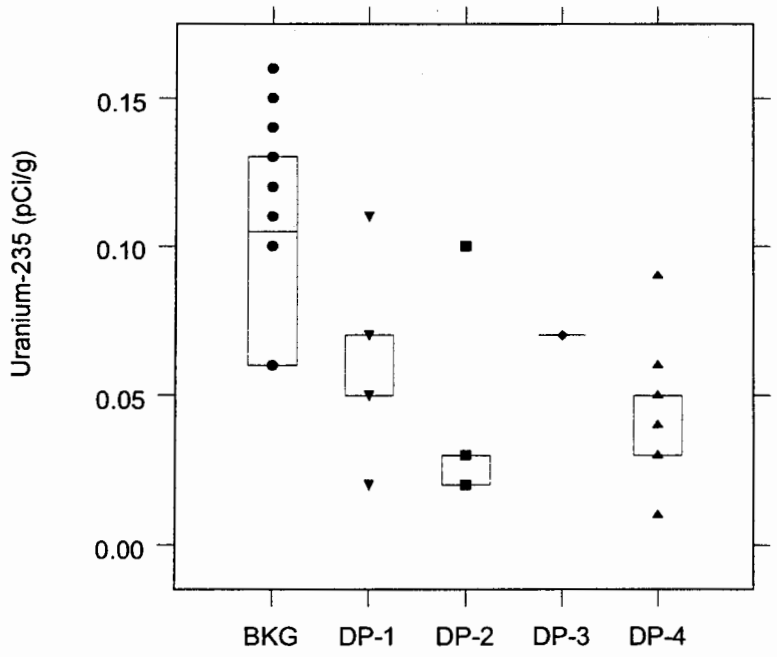


Figure E-2.2-8. Box plot for uranium-235

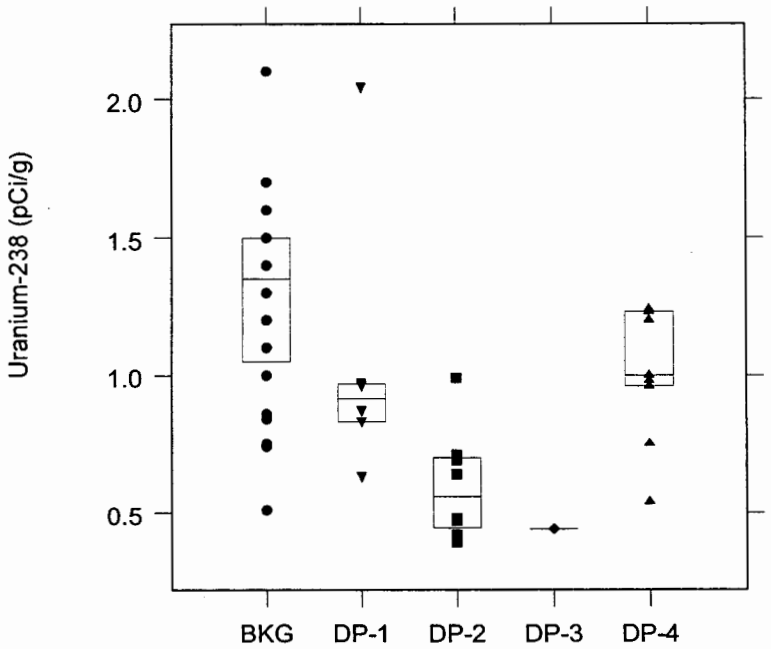


Figure E-2.2-9. Box plot for uranium-238

Table E-2.2-1
Summary of P-Values from Wilcoxan Rank Sum Statistical Tests

Analyte	DP-1	DP-2	DP-3	DP-4
Americium-241	0.995	**<0.001**	**<0.001**	**<0.001**
Cesium-137	0.194	**<0.001**	**<0.001**	**<0.001**
Plutonium-238	0.686	**<0.001**	**<0.001**	**<0.001**
Plutonium-239,240	**<0.001**	**<0.001**	**<0.001**	**<0.001**
Strontium-90	**0.001**	**<0.001**	**0.002**	**0.008**
Tritium	0.618	**<0.001**	**0.002**	**0.008**
Uranium-234	0.990	0.999	*	0.872
Uranium-235 (alpha spectroscopy)	0.996	1.000	*	1.000
Uranium-238	0.944	1.000	*	0.980

Note: Bolded values indicate reach sample results that are significantly greater than background.

*Only a single sample result for isotopic uranium in this reach, thus insufficient data for statistical testing.

E-3.0 COLLOCATION OF SEDIMENT COPCs

The collocation, or correlation of concentrations, of COPCs was evaluated through a series of figures and statistical analyses. One radionuclide (cesium-137) was selected as an indicator COPC because of its abundance in DP Canyon sediments downstream of the PRS 21-011(k) outfall. Zinc was selected as the other indicator COPC based on its distribution in DP Canyon sediments. Zinc seems to represent contaminant releases associated with the Los Alamos townsite.

The figures and tables for this section are placed at the end of the section; the figures appear first, followed by the table.

E-3.1 Methods

To evaluate the collocation of COPCs, scatter plots were developed for each COPC versus cesium-137 and zinc. These plots contain the same symbols used in the plots for Sections E-1 and E-2 of this appendix. Background data are represented by a circle, reach DP-1 data by an inverted triangle, reach DP-2 data by a square, reach DP-3 data by a diamond, and reach DP-4 data by a triangle. The x-axis of these plots is the rank value of cesium-137 and zinc. Some form of data transformation was needed for the x-axis variables to visualize concentration trends over the full range of x-axis values. A rank transformation was selected to be consistent with the nonparametric correlation analysis discussed below. The rank transformation also has the advantage that negative values can be depicted, where a logarithmic transform cannot convert negative values. Also note that nondetected sample results are plotted as the detection limit value and the symbol is shaded in a light gray pattern. The rank, or order statistic, is assigned in decreasing order. Thus, the largest cesium-137 result has a rank of 1, the second largest has a rank of 2, and so forth until the smallest cesium-137 value is assigned a rank of 102 (because there are 102 sample results for cesium-137 in DP Canyon sediments or background). The ranks for zinc are assigned in the same way, except that the smallest zinc value is assigned a rank of 75 (because there are 75 sample results for zinc in DP Canyon sediments or background). The field duplicate sample results were excluded in preparing the data for this analysis, which means that the maximum value for some COPCs does not appear in this analysis.

To support the graphical analysis provided by the scatter plots, nonparametric correlations were calculated. These correlations are calculated from the detected sample results, or in the case of nondetects, the detection limit is used. The Spearman rank correlation analysis provides a nonparametric correlation coefficient and an associated measure of statistical significance (or p-value). The correlation coefficients can potentially range between –1 and +1. A correlation coefficient of zero suggests no correlation between the two measurements. A correlation coefficient of +1 suggests a perfect positive relationship between the measurements. A correlation coefficient of –1 suggests a perfect negative relationship between the measurements.

E-3.2 Results

Table E-3.2-1 provides the results of the correlation analysis between ranked cesium-137 and zinc with the other COPCs. The basic pattern is that cesium-137 has significant correlations with the other radionuclides, and that zinc is correlated with the other metals, diesel range organics, and polychlorinated biphenyls (PCBs)/pesticides. The semivolatile and volatile organic COPCs are typically correlated with neither cesium-137 nor zinc.

Figures E-3.2-1 through E-3.2-10 show the relationships of ranked cesium-137 and zinc with the inorganic chemicals identified as COPCs. Recall that the light gray shaded symbols represent

nondetected sample results. All of the inorganic COPCs, with the exception of antimony and total chromium have stronger correlations with zinc than cesium-137. The antimony correlation coefficient is strongly influenced by nondetect values, and therefore has little practical meaning. Nondetect sample results also interfere with the evaluation of the selenium correlation coefficient. The largest correlation coefficient is between lead and zinc, and suggests that these metals are collocated. Lead and zinc also show differences from background over most of the sampled reaches in DP Canyon, which also supports the collocation argument. Many of the other inorganic chemicals are sporadically measured above background outside of reach DP-1, which places a practical limit on the apparent collocation with zinc. Thus, most inorganic COPCs are collocated with zinc, which suggest a Los Alamos townsite source for the contaminants.

Figures E-3.2-11 through E-3.2-17 show the relationships of ranked cesium-137 and zinc with the radionuclides identified as COPCs. Some of the radionuclide sample results are not censored (e.g., isotopic plutonium, isotopic uranium), and thus there are no light gray shaded symbols that represent nondetected sample results on these plots. Cesium-137 has positive, statistically significant correlations with all radionuclide COPCs except for uranium-234. Only tritium has a modest correlation coefficient among these COPCs, and the remainder of the correlation coefficients are greater than 0.8. Although these rank correlations are impressive, a review of the plots will show that the ratios of radionuclides is by no means constant and likely is the result of variations in contaminant release history and differences in transport following release. Thus, the correlation analysis supports process knowledge that suggests that the radionuclides have a common release site, which is PRS 21-011(k).

Figures E-3.2-18 through E-3.2-23 show the relationships of ranked cesium-137 and zinc with the PCBs/pesticides identified as COPCs. Recall that the light gray shaded symbols represent nondetected sample results. All of the PCBs/pesticides COPCs have stronger correlations with zinc than cesium-137. Some of these correlations include elevated detection limits, which are associated with higher-rank zinc values (Aroclor-1260, 4,4'-DDE, Heptachlor Epoxide). Thus, PCB/pesticide COPCs are collocated with zinc, which suggests a Los Alamos townsite source for the contaminants.

Figure E-3.2-24 shows the relationship of ranked cesium-137 and zinc with diesel range organics. These plots show that zinc has a strong correlation with diesel range organics. Figures E-3.2-25 through E-3.2-48 show the relationships of cesium-137 and zinc with the semivolatile organic COPCs. Interpretation of these plots is hampered by the elevated detection limits for all of these COPCs. Even with the confounding factor of the detection limits, some of these COPCs show a correlation with zinc, and one shows a correlation with cesium-137. If detected results are reviewed, then a strong correlation with zinc is evident. Thus, the detected results for semivolatile organic COPCs and diesel range organics correlate with zinc. This correlation with zinc suggests that there is a Los Alamos townsite source for these COPCs.

Figures E-3.2-49 and E-3.2-50 show the relationships of cesium-137 and zinc with the volatile organic COPCs. There are only six sample results for these volatile organics, and the detected sample results are less than the detection limits of other samples. No correlation is evident with either cesium-137 or zinc, and thus there is no evidence for collocation of volatile organic COPCs.

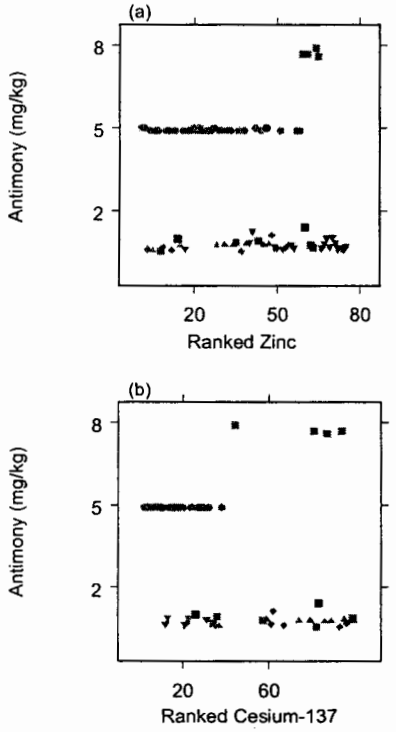


Figure E-3.2-1. (a) Scatter plot for antimony by ranked zinc; (b) scatter plot for antimony by ranked cesium-137

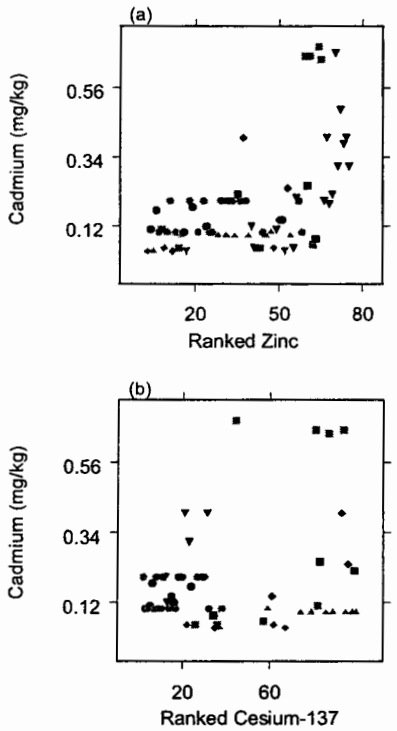


Figure E-3.2-2. (a) Scatter plot for cadmium by ranked zinc; (b) scatter plot for cadmium by ranked cesium-137

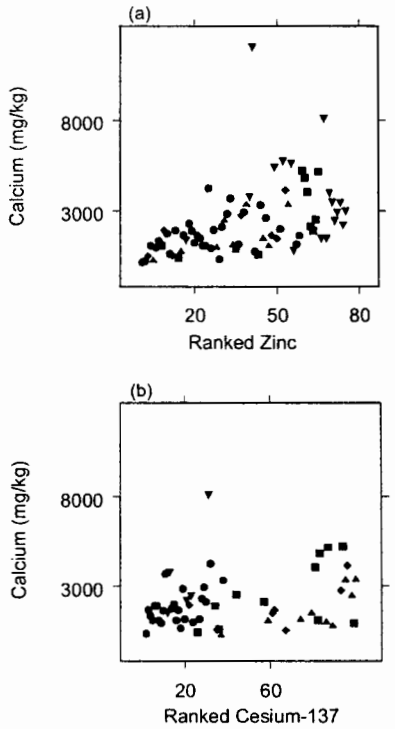


Figure E-3.2-3. (a) Scatter plot for calcium by ranked zinc; (b) scatter plot for calcium by ranked cesium-137

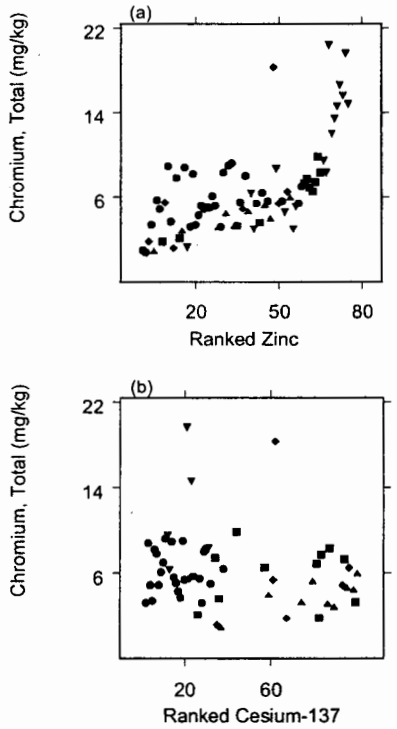


Figure E-3.2-4. (a) Scatter plot for chromium by ranked zinc; (b) scatter plot for chromium by ranked cesium-137

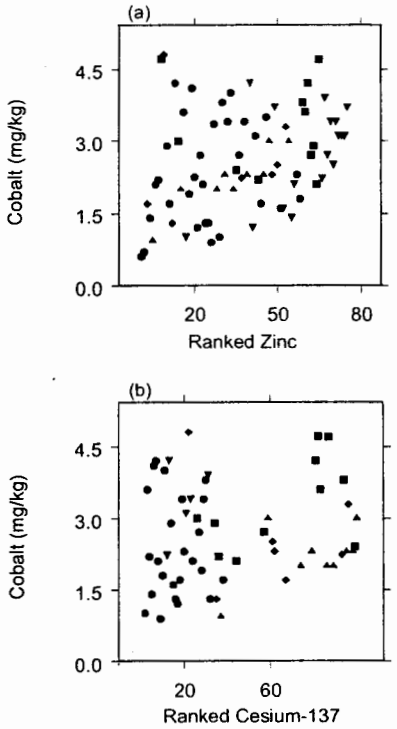


Figure E-3.2-5. (a) Scatter plot for cobalt by ranked zinc; (b) scatter plot for cobalt by ranked cesium-137

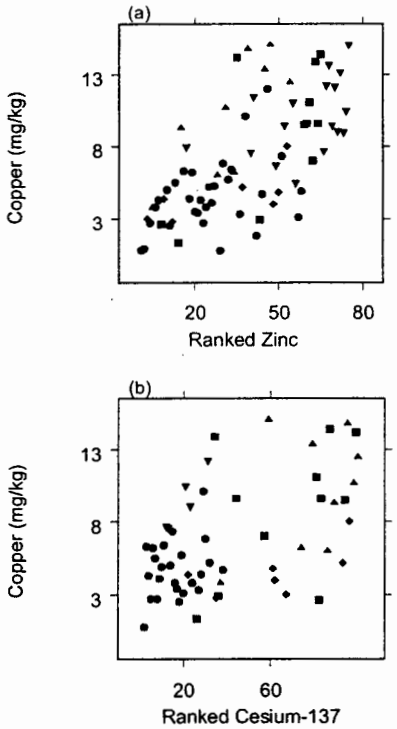


Figure E-3.2-6. (a) Scatter plot for copper by ranked zinc; (b) scatter plot for copper by ranked cesium-137

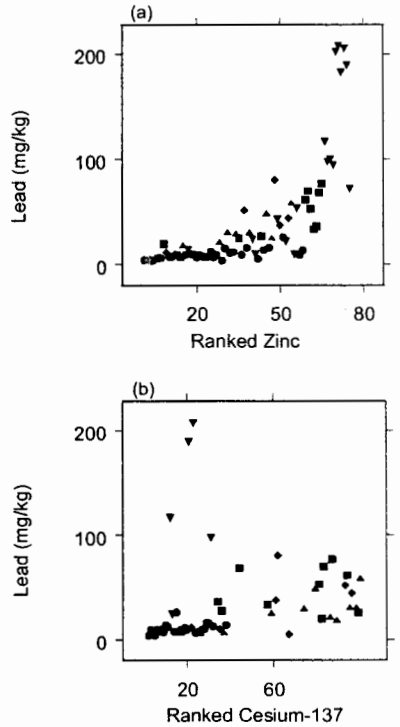


Figure E-3.2-7. (a) Scatter plot for lead by ranked zinc; (b) scatter plot for lead by ranked cesium-137

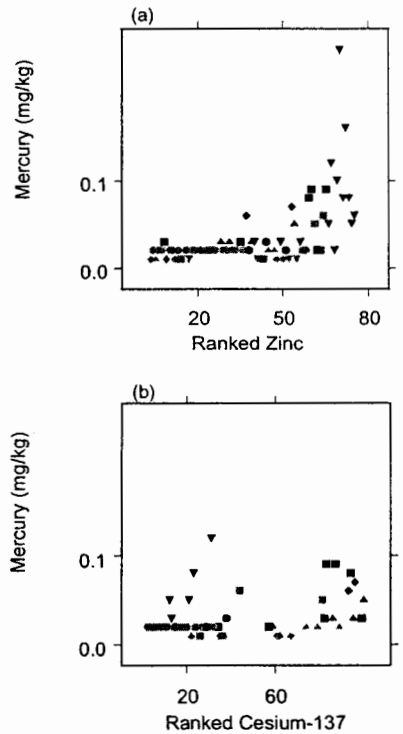


Figure E-3.2-8. (a) Scatter plot for mercury by ranked zinc; (b) scatter plot for mercury by ranked cesium-137

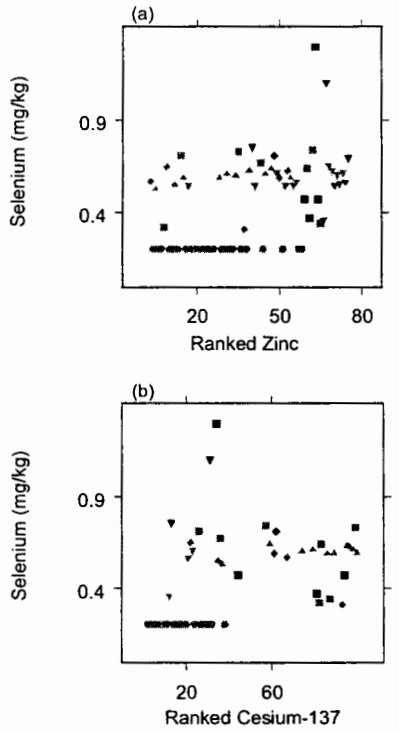


Figure E-3.2-9. (a) Scatter plot for selenium by ranked zinc; (b) scatter plot for selenium by ranked cesium-137

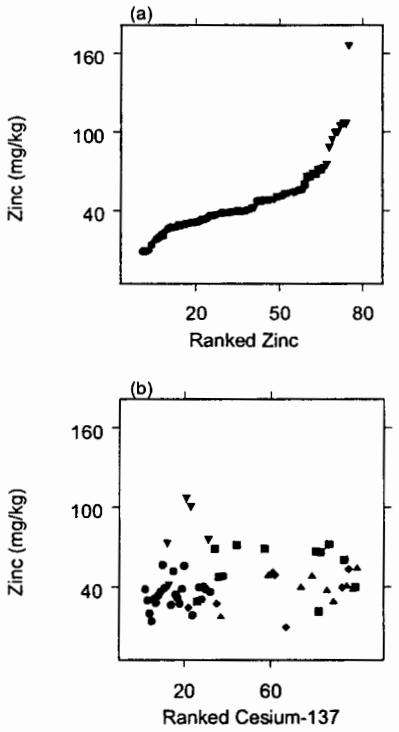


Figure E-3.2-10. (a) Scatter plot for zinc by ranked zinc; (b) scatter plot for zinc by ranked cesium-137

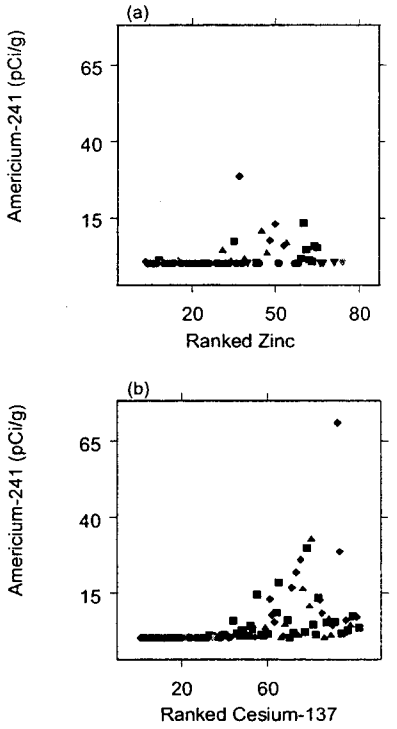


Figure E-3.2-11. (a) Scatter plot for americium-241 by ranked zinc; (b) scatter plot for americium-241 by ranked cesium-137

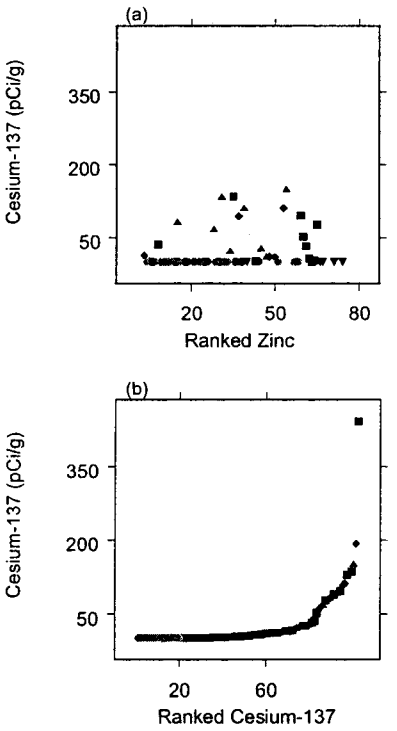


Figure E-3.2-12. (a) Scatter plot for cesium-137 by ranked zinc; (b) scatter plot for cesium-137 by ranked cesium-137

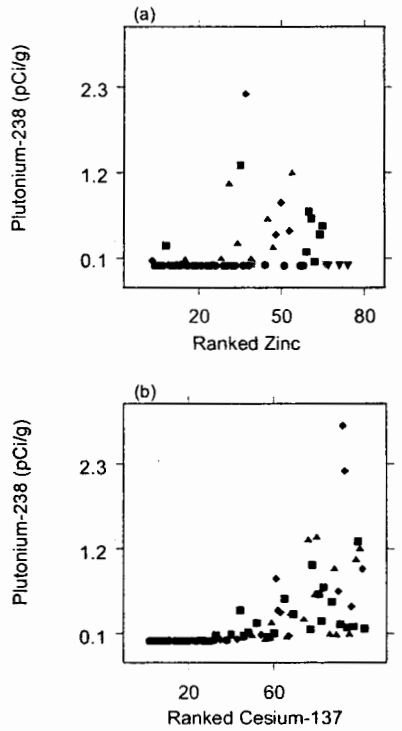


Figure E-3.2-13. (a) Scatter plot for plutonium-238 by ranked zinc; (b) scatter plot for plutonium-238 by ranked cesium-137

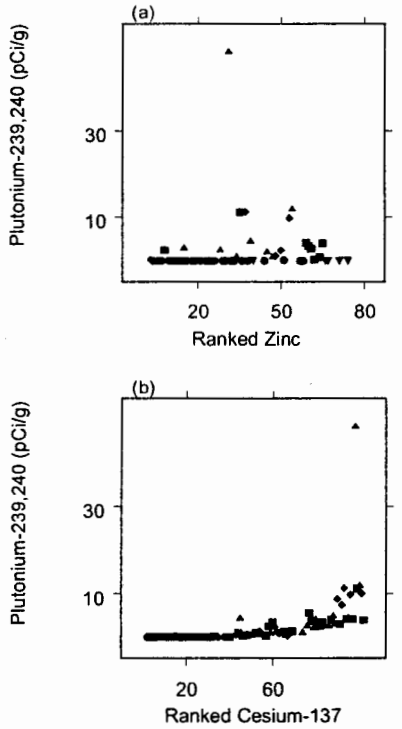


Figure E-3.2-14. (a) Scatter plot for plutonium-239,240 by ranked zinc; (b) scatter plot for plutonium-239,240 by ranked cesium-137

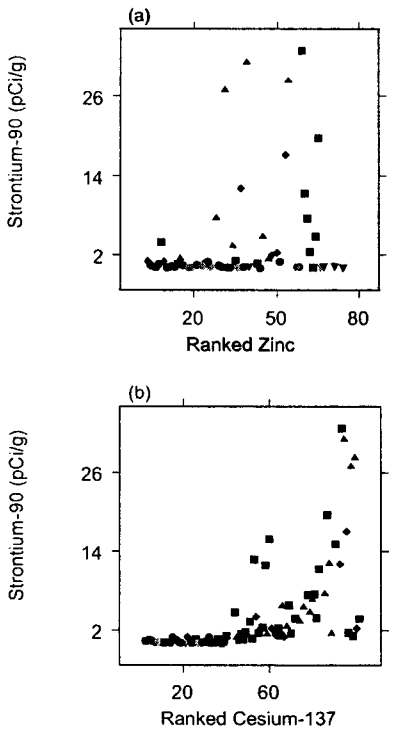


Figure E-3.2-15. (a) Scatter plot for strontium-90 by ranked zinc; (b) scatter plot for strontium-90 by ranked cesium-137

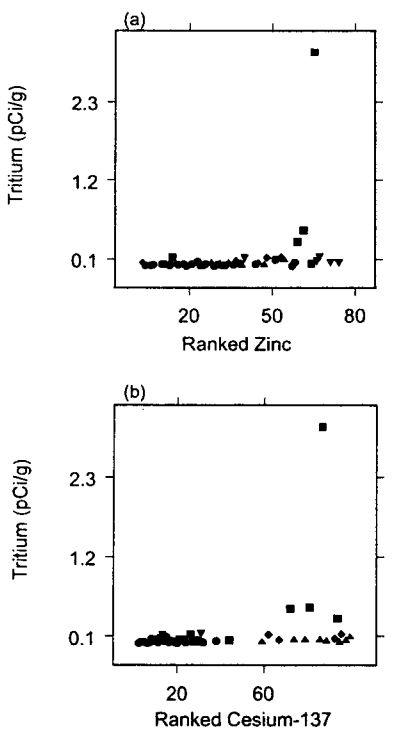


Figure E-3.2-16. (a) Scatter plot for tritium by ranked zinc; (b) scatter plot for tritium by ranked cesium-137

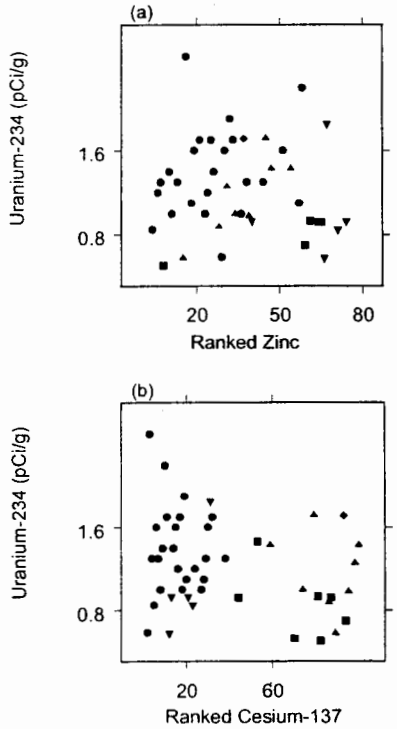


Figure E-3.2-17. (a) Scatter plot for uranium-234 by ranked zinc; (b) scatter plot for uranium-234 by ranked cesium-137

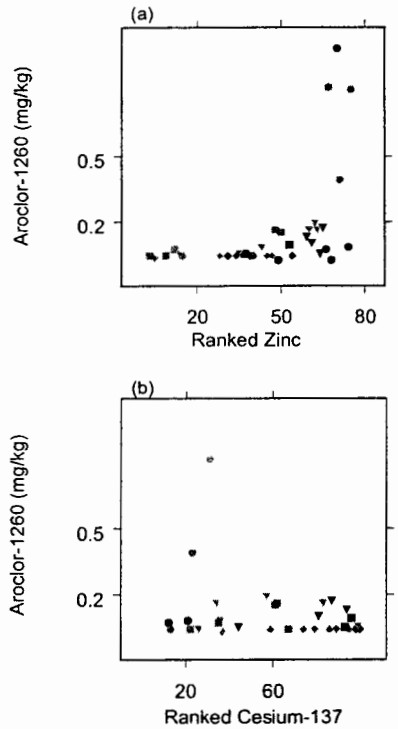


Figure E-3.2-18. (a) Scatter plot for Aroclor-1260 by ranked zinc; (b) scatter plot for Aroclor-1260 by ranked cesium-137

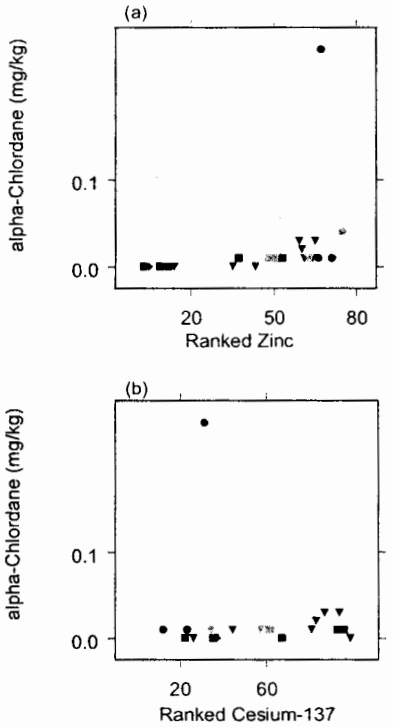


Figure E-3.2-19. (a) Scatter plot for alpha-chlordane by ranked zinc; (b) scatter plot for alpha-chlordane by ranked cesium-137

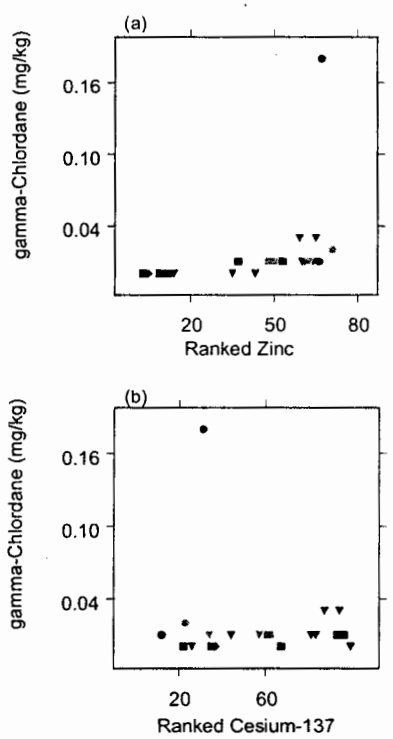


Figure E-3.2-20. (a) Scatter plot for gamma-chlordane by ranked zinc; (b) scatter plot for gamma-chlordane by ranked cesium-137

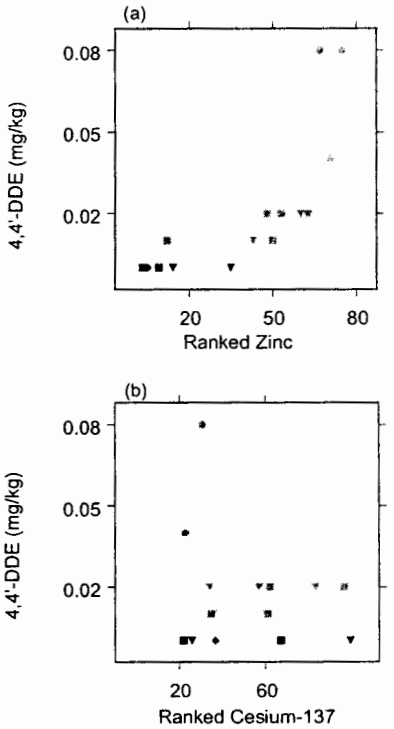


Figure E-3.2-21. (a) Scatter plot for 4,4'-DDE by ranked zinc; (b) scatter plot for 4,4'-DDE by ranked cesium-137

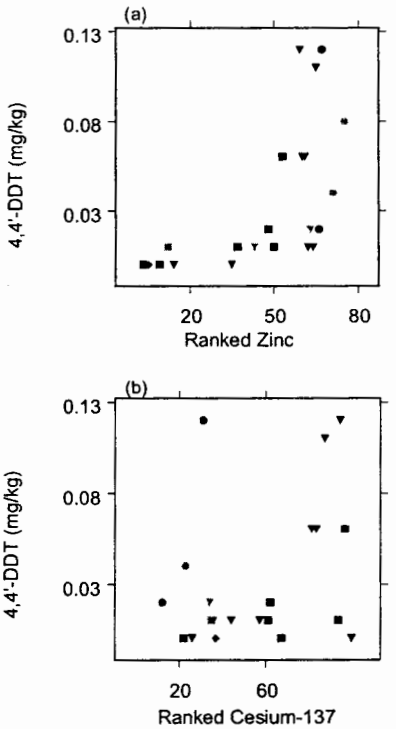


Figure E-3.2-22. (a) Scatter plot for 4,4'-DDT by ranked zinc; (b) scatter plot for 4,4'-DDT by ranked cesium-137

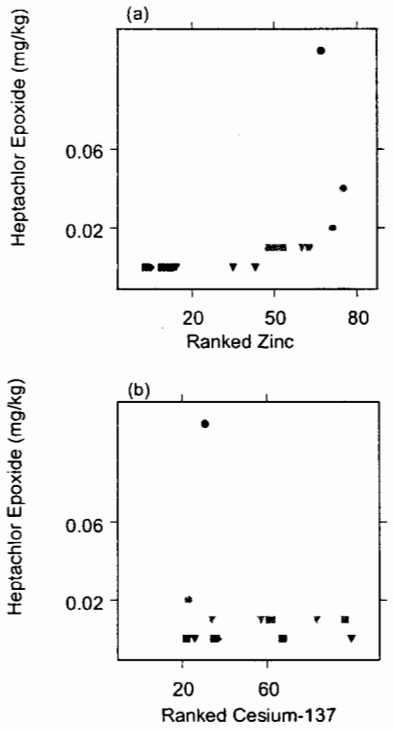


Figure E-3.2-23. (a) Scatter plot for Heptachlor Epoxide by ranked zinc; (b) scatter plot for Heptachlor Epoxide by ranked cesium-137

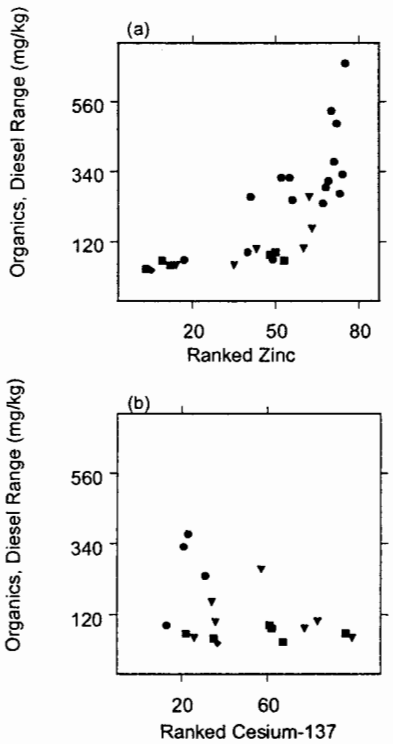


Figure E-3.2-24. (a) Scatter plot for diesel range organics by ranked zinc; (b) scatter plot for diesel range organics by ranked cesium-137

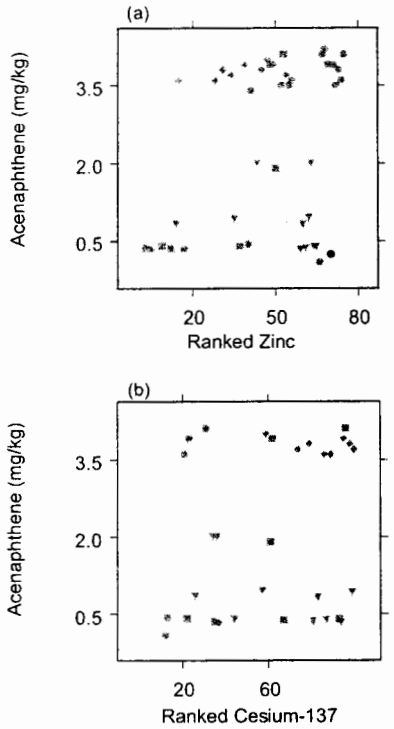


Figure E-3.2-25. (a) Scatter plot for acenaphthene by ranked zinc; (b) scatter plot for acenaphthene by ranked cesium-137

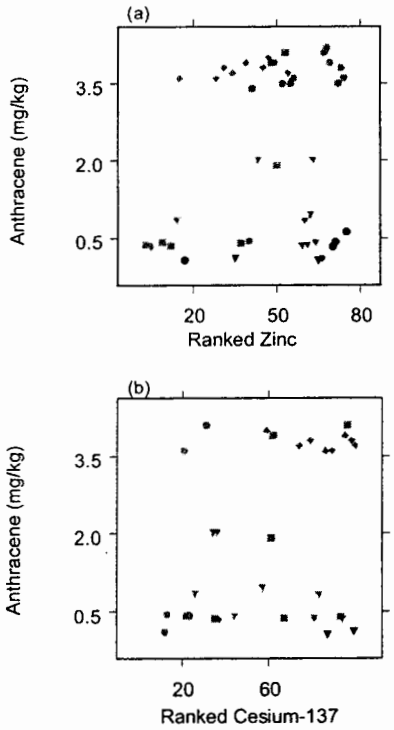


Figure E-3.2-26. (a) Scatter plot for anthracene by ranked zinc; (b) scatter plot for anthracene by ranked cesium-137

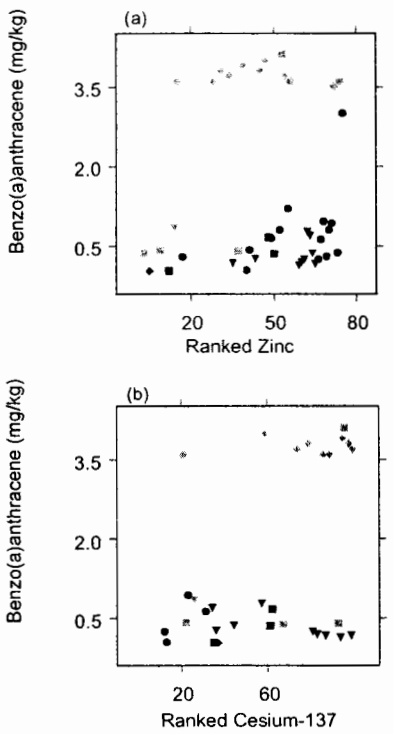


Figure E-3.2-27. (a) Scatter plot for benz(a)anthracene by ranked zinc; (b) scatter plot for benz(a)anthracene by ranked cesium-137

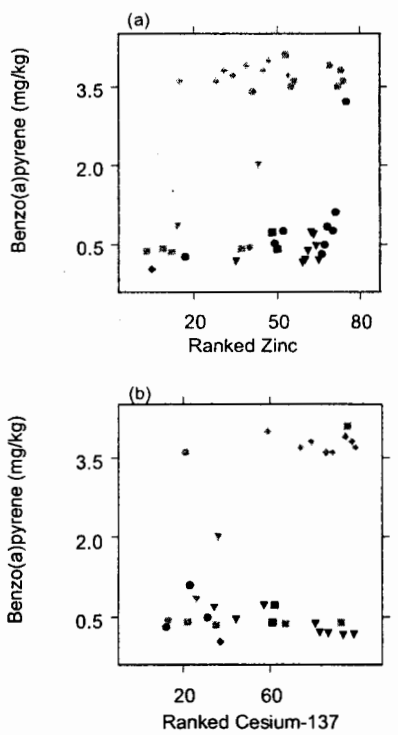


Figure E-3.2-28. (a) Scatter plot for benzo(a)pyrene by ranked zinc; (b) scatter plot for benzo(a)pyrene by ranked cesium-137.

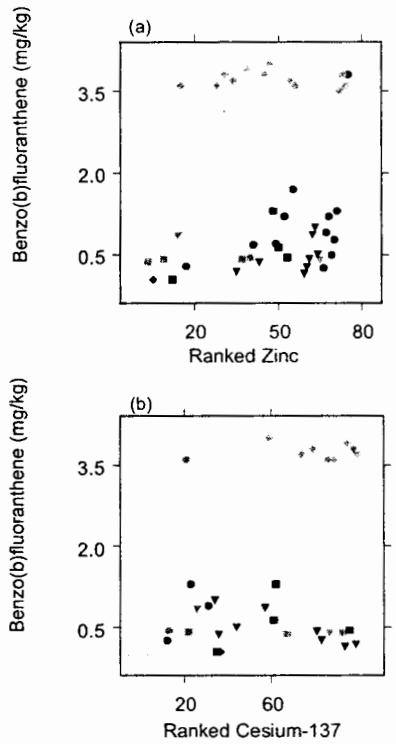


Figure E-3.2-29. (a) Scatter plot for benzo(b)fluoranthene by ranked zinc; (b) scatter plot for benzo(a) fluoranthene by ranked cesium-137

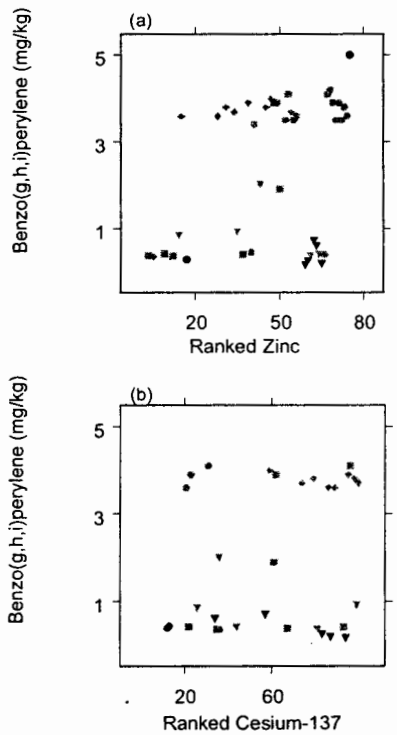


Figure E-3.2-30. (a) Scatter plot for benzo(g,h,i)perylene by ranked zinc; (b) scatter plot for benzo(g,h,i)perylene by ranked cesium-137

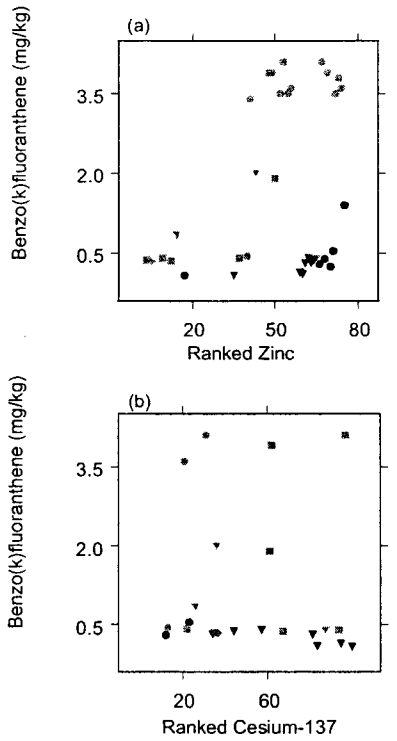


Figure E-3.2-31. (a) Scatter plot for benzo(k)fluoranthene by ranked zinc; (b) scatter plot for benzo(k)fluoranthene by ranked cesium-137

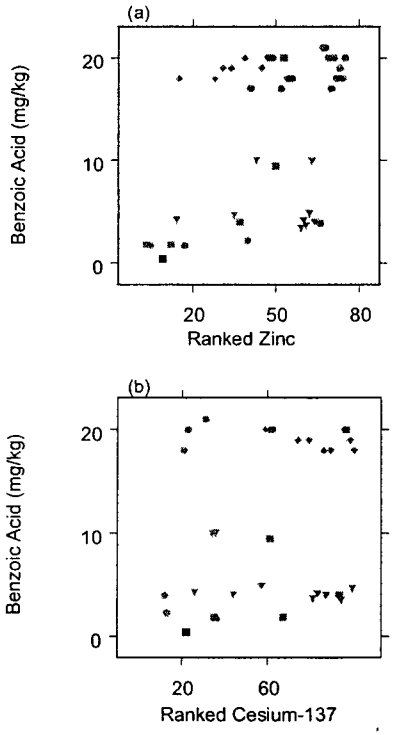


Figure E-3.2-32. (a) Scatter plot for benzoic acid by ranked zinc; (b) scatter plot for benzoic acid by ranked cesium-137

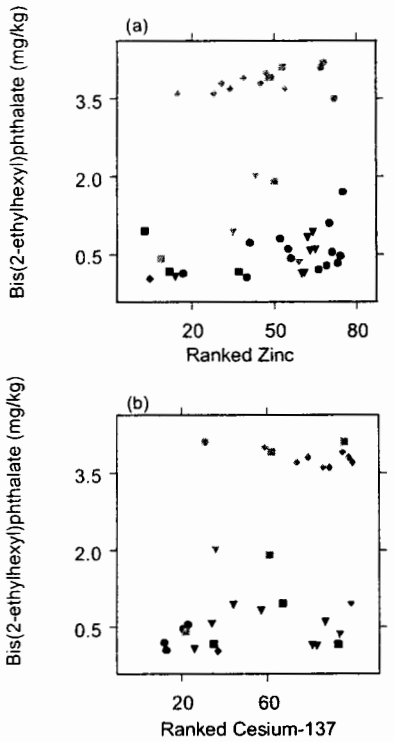


Figure E-3.2-33. (a) Scatter plot for bis(2-ethylhexyl)phthalate by ranked zinc; (b) scatter plot for bis(2-ethylhexyl)phthalate by ranked cesium-137

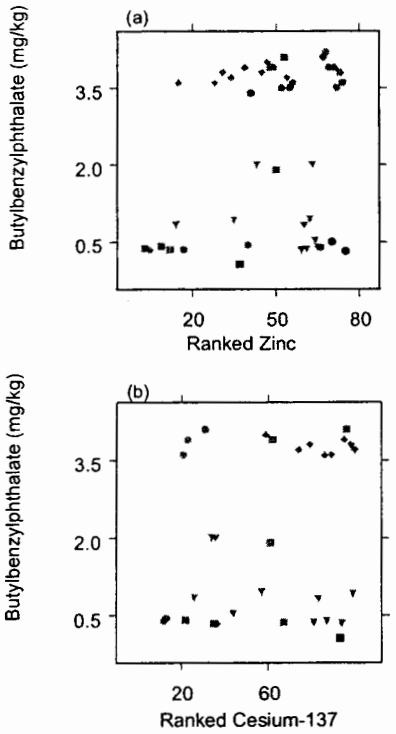


Figure E-3.2-34. (a) Scatter plot for butylbenzylphthalate by ranked zinc; (b) scatter plot for butylbenzylphthalate by ranked cesium-137

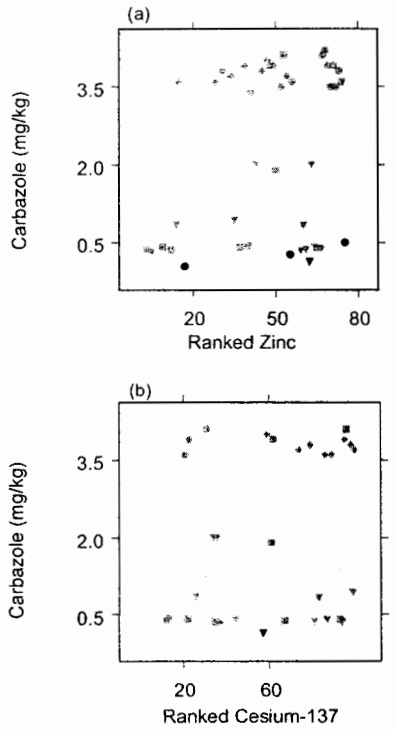


Figure E-3.2-35. (a) Scatter plot for carbazole by ranked zinc; (b) scatter plot for carbazole by ranked cesium-137

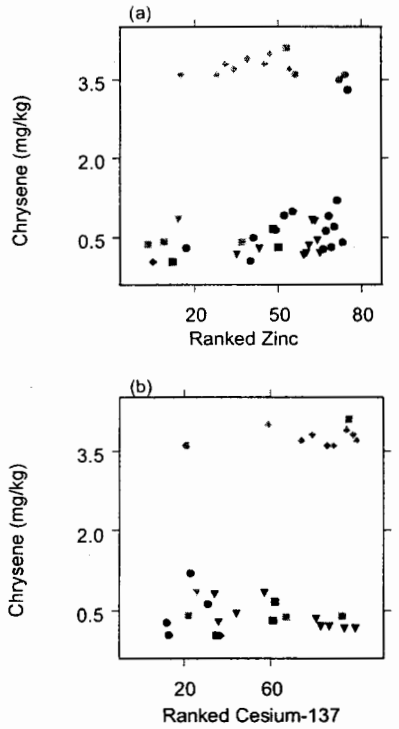


Figure E-3.2-36. (a) Scatter plot for chrysene by ranked zinc; (b) scatter plot for chrysene by ranked cesium-137

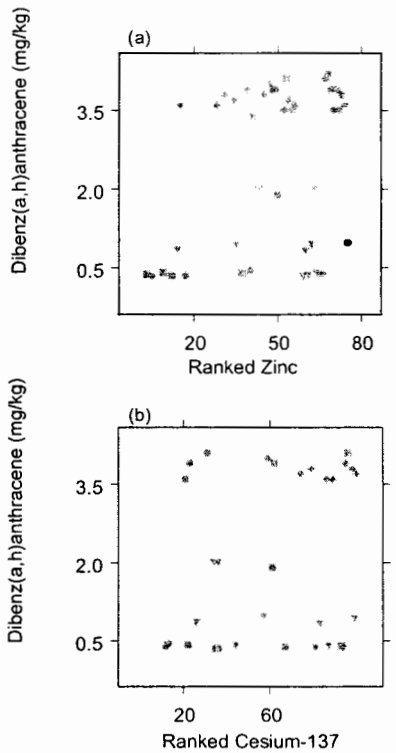


Figure E-3.2-37. (a) Scatter plot for dibenz(a,h)anthracene by ranked zinc; (b) scatter plot for dibenz(a,h)anthracene by ranked cesium-137

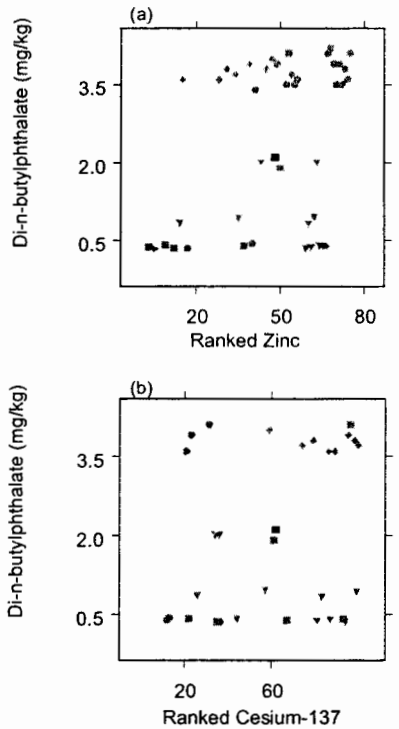


Figure E-3.2-38. (a) Scatter plot for di-n-butylphthalate by ranked zinc; (b) scatter plot for di-n-butylphthalate by ranked cesium-137

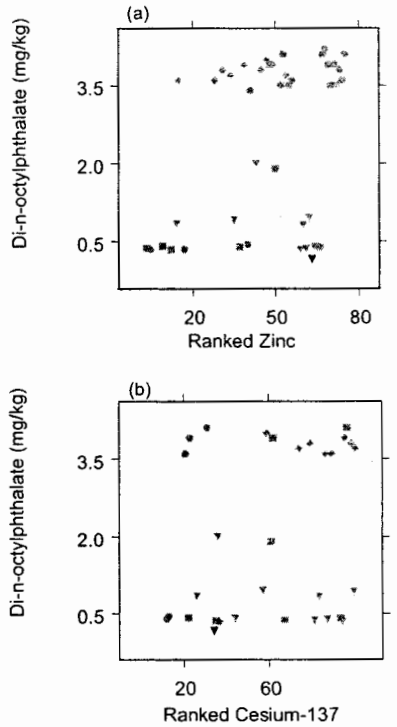


Figure E-3.2-39. (a) Scatter plot for di-n-octylphthalate by ranked zinc; (b) scatter plot for di-n-octylphthalate by ranked cesium-137

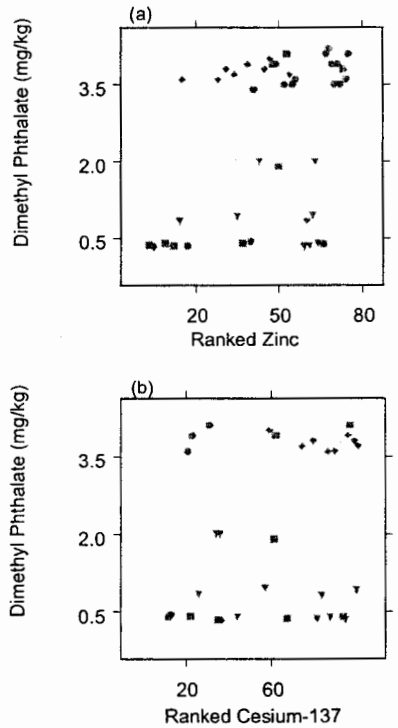


Figure E-3.2-40. (a) Scatter plot for dimethyl phthalate by ranked zinc; (b) scatter plot dimethyl phthalate by ranked cesium-137

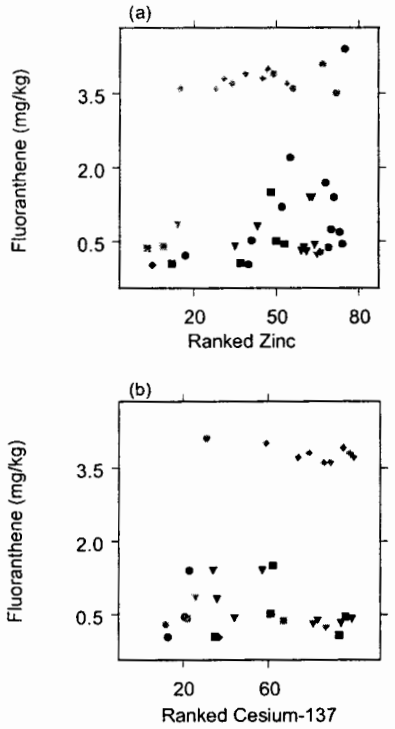


Figure E-3.2-41. (a) Scatter plot for fluoranthene by ranked zinc; (b) scatter plot for fluoranthene by ranked cesium-137

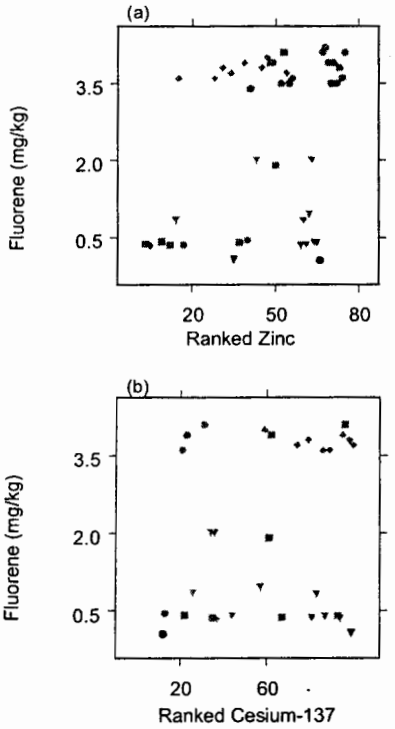


Figure E-3.2-42. (a) Scatter plot for fluorene by ranked zinc; (b) scatter plot for fluorene by ranked cesium-137

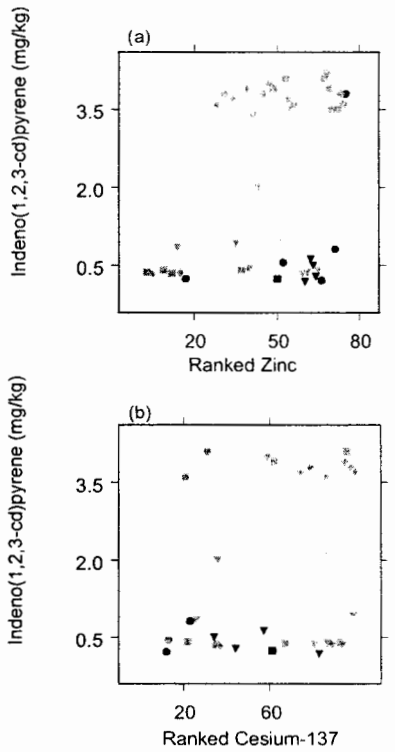


Figure E-3.2-43. (a) Scatter plot for indeno(1,2,3-cd)pyrene by ranked zinc; (b) scatter plot for indeno(1,2,3-cd)pyrene by ranked cesium-137

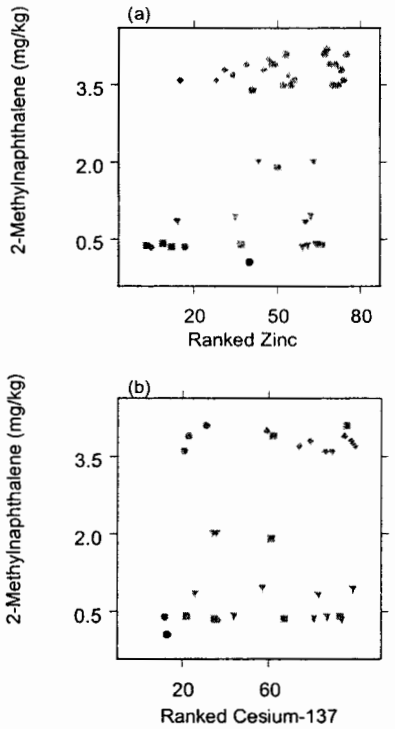


Figure E-3.2-44. (a) Scatter plot for 2-methylnaphthalene by ranked zinc; (b) scatter plot for 2-methylnaphthalene by ranked cesium-137

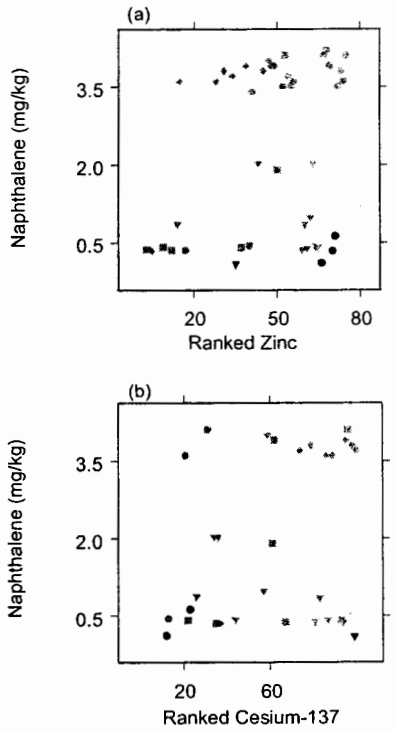


Figure E-3.2-45. (a) Scatter plot for naphthalene by ranked zinc; (b) scatter plot for naphthalene by ranked cesium-137

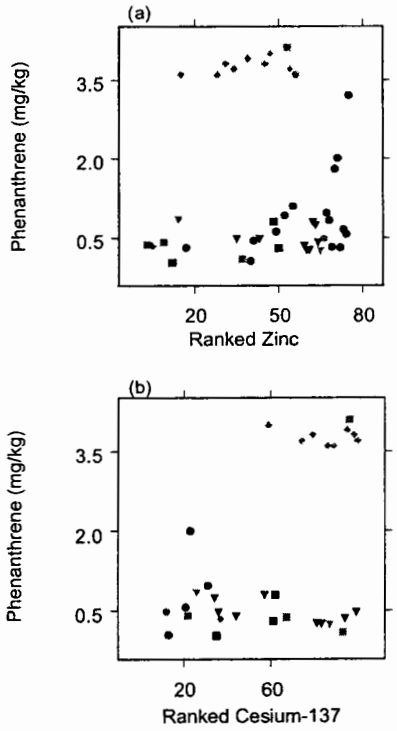


Figure E-3.2-46. (a) Scatter plot for phenanthrene by ranked zinc; (b) scatter plot for phenanthrene by ranked cesium-137

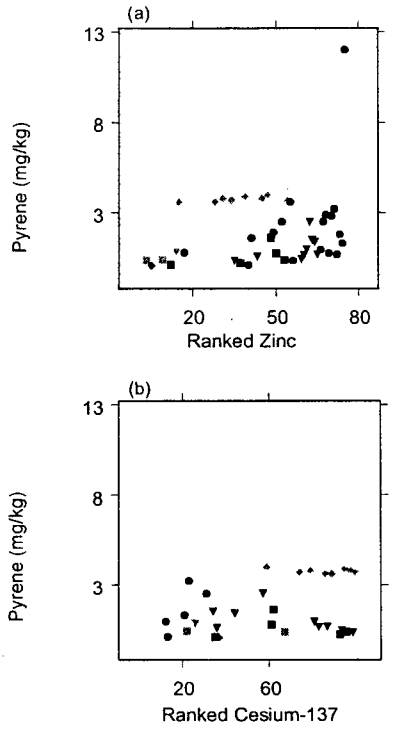


Figure E-3.2-47. (a) Scatter plot for pyrene by ranked zinc; (b) scatter plot for pyrene by ranked cesium-137

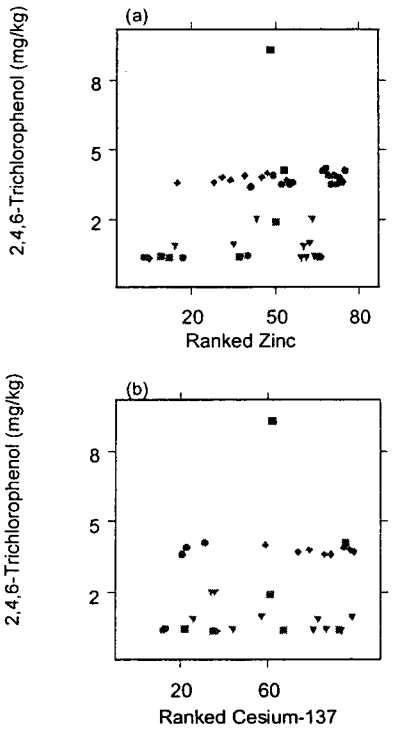


Figure E-3.2-48. (a) Scatter plot for 2,4,6-trichlorophenol by ranked zinc; (b) scatter plot for 2,4,6-trichlorophenol by ranked cesium-137

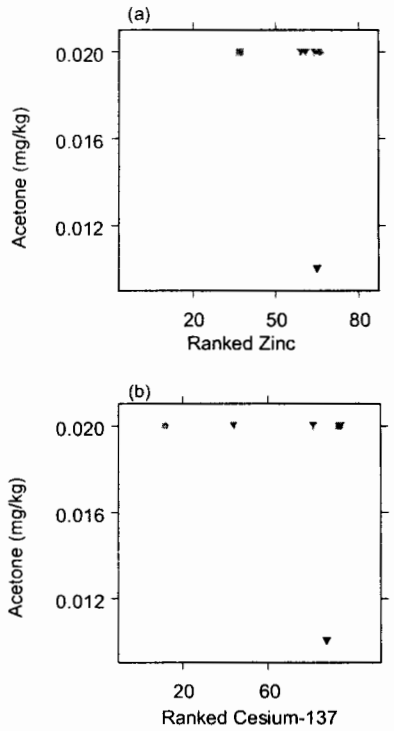


Figure E-3.2-49. (a) Scatter plot for acetone by ranked zinc; (b) scatter plot for acetone by ranked cesium-137

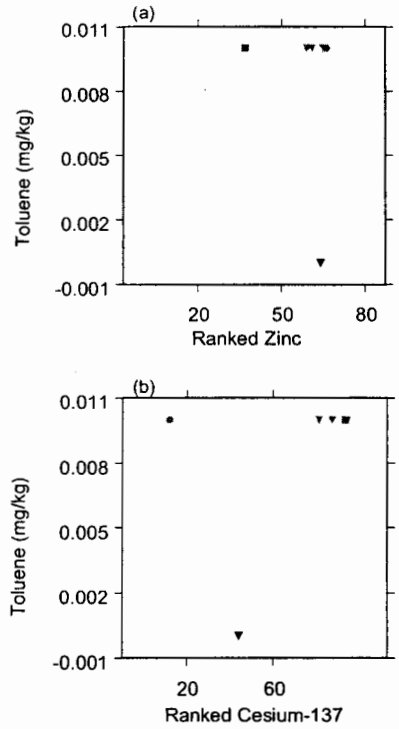


Figure E-3.2-50. (a) Scatter plot for toluene by ranked zinc; (b) scatter plot for toluene by ranked cesium-137.

Table E-3.2-1
Spearman Rank Correlation Values

COPC	Cesium-137			Zinc		
	Count	r_s[a]	p[b]	Count	r_s	p
Antimony	56	-0.410	0.002	75	-0.206	0.077
Cadmium	56	-0.056	0.684	68	**0.502**	**<0.001**
Calcium	56	0.230	0.088	75	**0.581**	**<0.001**
Chromium, total	56	-0.638	<0.001	75	-0.083	0.478
Cobalt	56	0.142	0.298	75	**0.348**	**0.002**
Copper	56	0.468	<0.001	75	**0.675**	**<0.001**
Lead	56	0.580	<0.001	75	**0.835**	**<0.001**
Mercury	56	0.345	0.009	68	**0.585**	**<0.001**
Selenium	56	0.604	<0.001	68	**0.422**	**<0.001**
Zinc	56	0.305	0.022	—[c]	—	—
Organics, diesel range	18	-0.336	0.173	29	**0.875**	**<0.001**
Aroclor-1260	31	-0.223	0.228	35	**0.637**	**<0.001**
α-Chlordane	21	0.217	0.344	22	**0.833**	**<0.001**
γ-Chlordane	21	0.155	0.503	21	**0.835**	**<0.001**
4,4'-DDE	15	-0.060	0.833	16	**0.957**	**<0.001**
4,4'-DDT	21	0.161	0.487	22	**0.804**	**<0.001**
Heptachlor Epoxide	15	-0.036	0.899	16	**0.957**	**<0.001**
Americium-241	101	**0.800**	**<0.001**	54	0.508	<0.001
Cesium-137	—	—	—	56	0.305	0.022
Plutonium-238	81	**0.875**	**<0.001**	53	0.380	0.005
Plutonium-239,240	82	**0.925**	**<0.001**	54	0.413	0.002
Strontium-90	90	**0.827**	**<0.001**	56	0.223	0.099
Tritium	47	**0.498**	**<0.001**	46	0.538	0.000
Uranium-234	45	-0.183	0.230	43	-0.057	0.719
Acenaphthene	31	0.186	0.316	43	0.263	0.088
Anthracene	31	0.161	0.389	43	0.129	0.410
Benz(a)anthracene	31	0.255	0.166	43	0.069	0.662
Benzo(a)pyrene	31	0.158	0.396	43	0.151	0.335
Benzo(b)fluoranthene	31	0.146	0.434	43	0.230	0.138
Benzo(g,h,i)perylene	31	0.110	0.554	43	0.290	0.059
Benzo(k)fluoranthene	23	-0.276	0.203	35	0.215	0.216
Benzoic acid	31	0.219	0.236	43	**0.396**	**0.009**
Bis(2-ethylhexyl)phthalate	31	**0.401**	**0.025**	43	0.060	0.700
Butylbenzylphthalate	31	0.127	0.495	43	0.207	0.183
Carbazole	31	0.160	0.389	43	0.222	0.153
Chrysene	31	0.258	0.161	43	0.094	0.547
Dibenz(a,h)anthracene	31	0.150	0.420	43	0.276	0.073

Table E-3.2-1 (continued)

COPC	Cesium-137			Zinc		
	Count	r_s	p	Count	r_s	p
Dimethyl phthalate	31	0.150	0.420	43	**0.347**	**0.023**
Di-n-butylphthalate	31	0.164	0.378	43	**0.358**	**0.019**
Di-n-octylphthalate	31	0.194	0.296	43	**0.310**	**0.043**
Fluoranthene	31	0.200	0.281	43	0.155	0.320
Fluorene	31	0.112	0.549	43	**0.335**	**0.028**
Indeno(1,2,3-cd)pyrene	31	0.195	0.293	43	0.232	0.135
2-Methylnaphthalene	31	0.202	0.276	43	**0.351**	**0.021**
Naphthalene	31	0.169	0.364	43	0.229	0.139
Phenanthrene	31	0.248	0.179	43	0.026	0.867
Pyrene	31	0.184	0.322	43	0.228	0.142
2,4,6-Trichlorophenol	31	0.150	0.421	43	**0.335**	**0.028**
Acetone	6	-0.516	0.295	6	-0.030	0.955
Toluene	6	0.638	0.173	6	-0.213	0.686

Note: Bolded values indicate the most significant positive correlations for a COPC (between Cs-137 and zinc).

[a] r_s = Spearman rank correlation coefficient.

[b] p = Statistical significance probability for the Spearman rank correlation coefficient.

[c] A dash in the table means "not applicable" (correlation analysis is not appropriate to the same analyte).

E-4.0 ANALYSIS OF RADIONUCLIDES IN SEDIMENT FIELD QA SAMPLES

An important aspect of the uncertainty associated with determining either the inventory or risk resulting from contaminants in DP Canyon sediments is the repeatability of collocated or replicated field samples. Because of the number of samples analyzed for the key radionuclides and their importance in human-health risk calculations, this analysis of field quality assurance (QA) samples will be based on data only for the key radionuclides. Table E-4.0-1 provides the field QA sample results for two types of samples: field duplicates and resamples (nondetect sample results are excluded from this analysis as they do not provide a meaningful estimate of variability in detected sample results). Field duplicates (FDs) are basically field splits of single field samples. Resamples are collocated field samples that are collected at key geomorphic sampling locations in later sampling events, such as layers with exceptionally high sample results. Because of lateral variability in the thickness and particle size distribution of sediment layers, these resamples cannot replicate the original sampled sediment as well as the field QA samples, although they still provide useful information on radionuclide variability within geomorphic units. Because only a single location was resampled for tritium, the graphical comparison includes only FD samples and is provided in Figure E-4.0-1. This figure shows the first sample result for these QA samples plotted as the x-axis variable and the second result plotted as the y-axis variable. The line of equality ($y = x$) is also plotted as a point of reference. In general, the FD samples showed little variation from the original sample result (variability of FD values was ±22% [based on standard deviation of relative difference values]), with few exceptions. Most of the FD results with high relative difference values were at the lower concentration range, except that the highest relative difference value was for the plutonium-239,240 sample results for samples CA21-98-0134 and CA21-98-0153 (collected at location 21-05491). The only resample in the DP Canyon sediment samples also shows a high relative difference value. Although tritium was detected above the background value in both samples 0121-97-1362 and CA21-98-0083, the resample value was roughly an order of magnitude less than the original sample result. The resample value is more consistent with the remainder of the tritium sample results, which suggests that the maximum tritium sample result likely represents a reasonably conservative estimate of the highest concentrations of tritium in DP Canyon sediments.

Table E-4.0-1
Summary of Key Radionuclide Field QA Results

Original Sample ID	Related Sample ID	Sample Type	Analyte	Result	QA Sample Result	Relative Difference[a]
0121-97-1350	0121-97-1351	FD[b]	Americium-241	3.41	2.22	30%
0121-97-1441	0121-97-1442	FD	Americium-241	1.23	1.22	1%
CA21-98-0126	CA21-98-0152	FD	Americium-241	1.55	1.45	5%
0121-97-1350	0121-97-1351	FD	Cesium-137	9.18	8.22	8%
0121-97-1441	0121-97-1442	FD	Cesium-137	36.3	34.6	3%
CA21-98-0065	CA21-98-0069	FD	Cesium-137	0.159	0.101	32%
CA21-98-0126	CA21-98-0152	FD	Cesium-137	3.32	3.61	-6%
0121-97-1350	0121-97-1351	FD	Plutonium-238	0.233	0.317	-22%
0121-97-1441	0121-97-1442	FD	Plutonium-238	0.263	0.187	24%
CA21-98-0134	CA21-98-0153	FD	Plutonium-238	0.335	0.225	28%
0121-97-1350	0121-97-1351	FD	Plutonium-239,240	0.879	0.495	40%
0121-97-1441	0121-97-1442	FD	Plutonium-239,240	2.45	2.1	11%
CA21-98-0065	CA21-98-0069	FD	Plutonium-239,240	0.075	0.061	15%
CA21-98-0126	CA21-98-0152	FD	Plutonium-239,240	4.3	4.5	-3%
CA21-98-0134	CA21-98-0153	FD	Plutonium-239,240	10.87	4	65%
0121-97-1350	0121-97-1351	FD	Strontium-90	1.41	1	24%
0121-97-1441	0121-97-1442	FD	Strontium-90	3.88	5.22	-21%
CA21-98-0126	CA21-98-0152	FD	Strontium-90	0.99	0.54	42%
0121-97-1350	0121-97-1351	FD	Uranium-234	1.43	1.32	6%
0121-97-1441	0121-97-1442	FD	Uranium-234	0.505	0.577	-9%
CA21-98-0065	CA21-98-0069	FD	Uranium-234	0.919	0.899	2%
0121-97-1362	CA21-98-0083	Resample	Tritium	3	0.23	121%

[a] Relative difference = relative percent difference between the two results.

[b] FD = field duplicate.

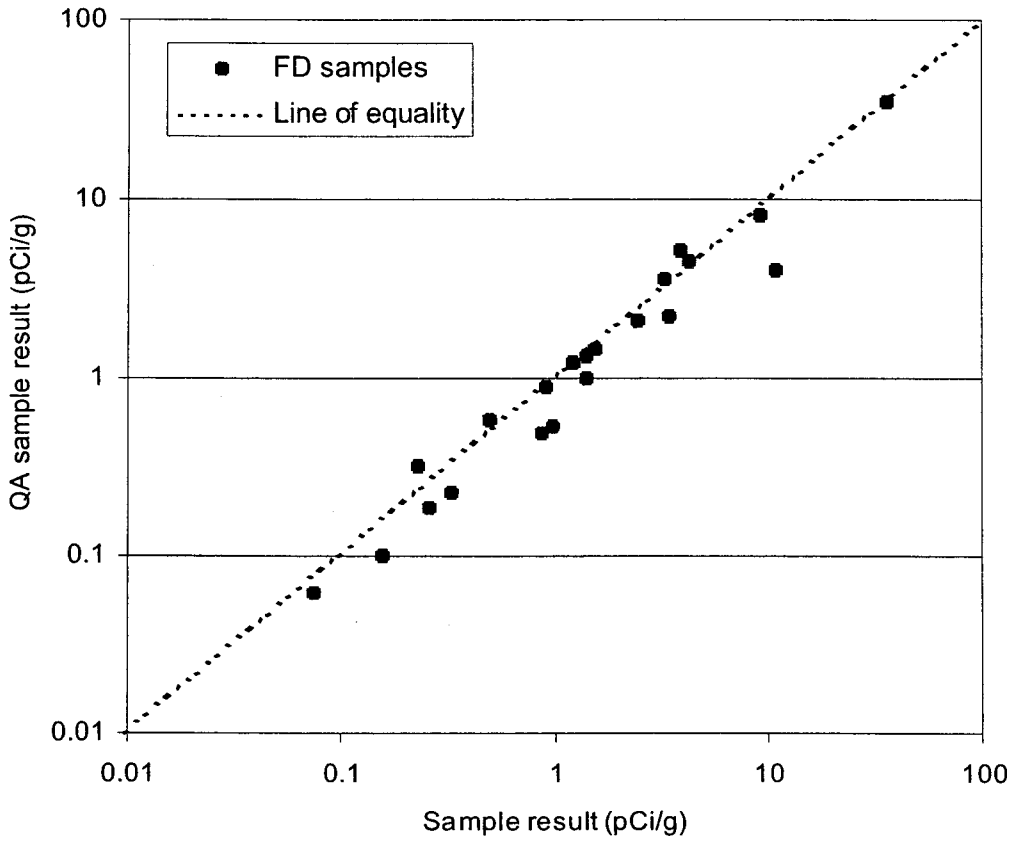


Figure E-4.0-1. Evaluation of field duplicate samples collected in DP Canyon

E-5.0 STATISTICAL EVALUATIONS OF INORGANIC CHEMICAL DATA FROM WATER SAMPLES

The objective of this section is to present graphical analyses that compare inorganic chemical data from DP Canyon water samples with Laboratory background water data. These analyses are used to determine whether the water data show evidence of contaminant releases through a systematic increase in concentration of one or more analytes greater than concentrations observed in the background data. This section also presents information for water quality parameters, which are measured to evaluate fate and transport of contaminants. Thus, water quality parameters are excluded from the COPC list.

The figures for this section are placed at the end of the section.

E-5.1 Methods

Because the background data for water are currently being defined, formal statistical tests were not used to determine which analytes should be retained as COPCs. Instead, a more qualitative approach was used to focus the analyte list to an initial list of COPCs. This approach relied on graphical displays called "box plots," which show the actual values for each inorganic chemical. The ends of each box represent the "interquartile" range of the data distribution, which is specified by the 25th percentile and 75th percentile of the data distribution. The horizontal line within each box is the median (50th percentile) of the data distribution (if the number of samples is four or fewer, the line is not displayed). Thus, each box indicates concentration values for the central half of the data, and concentration shifts can be readily assessed by comparing the boxes. If most of the data are represented by a single concentration value (usually the detection limit), the box is reduced to a single line.

A trio of box plots is presented for each analyte. First the data are presented by sampling location, where the two surface water (SW) sampling locations are presented as one data group. The DP Canyon alluvial groundwater is represented by samples collected in two wells (LAUZ-1 and LAUZ-2). The location plot also shows sample data for DP Spring (DP Spr). Lastly, the preliminary background (BKG) is historical sample data from well LAO-B in Los Alamos Canyon, which is the only background alluvial well for the Laboratory. The BKG (LAO-B) data are presented in Appendix D. A second box plot shows the difference between filtered and unfiltered sample results (note that both filtered and unfiltered are presented in the location box plot). Lastly, the temporal variation is shown in a box plot that displays the data by the month collected (BKG [LAO-B] sample results are not included in the time series plot). The main evidence used to assess whether an analyte should be retained as a COPC is the pattern of sample results noted by location. Analytes with higher concentrations in the alluvial wells or DP Spring are retained as COPCs, and analytes with higher concentrations in surface water or BKG (LAO-B) are eliminated as COPCs.

In these box plots a different symbol is used for the laboratory results for each sampling location, and the symbols are used consistently in each box plot in this section. BKG (LAO-B) data are represented by a circle, DP Spring data by an inverted triangle, LAUZ-1 data by a square, LAUZ-2 data by a diamond, and surface water data by a triangle. Also note that nondetected sample results are plotted as the detection limit value and the symbol is shaded in a light gray pattern.

E-5.2 Results

The results of the statistical evaluation are presented for each inorganic chemical.

E-5.2.1 Aluminum

Figure E-5.2-1a shows the variation in concentration by sample location; the plot shows that concentrations of aluminum are greatest in surface water and are similar for all other locations. Figure E-5.2-1b shows that the unfiltered concentrations are greater than the filtered concentrations. Although Figure E-5.2-1b is influenced by the large difference in filtered and unfiltered concentrations for surface water, the difference is also noted for other sampling locations. Lastly, Figure E-5.2-1c shows the date of surface water sample collection, and no other temporal trends are evident. Aluminum is not retained as a COPC in water because concentrations in alluvial groundwater are similar to BKG (LAO-B) results.

E-5.2.2 Antimony

Figure E-5.2-2a shows the variation in concentration by sample locations that there is a single detect of antimony in surface water. Figure E-5.2-2b shows that the detected antimony sample result was from an unfiltered sample. Lastly, Figure E-5.2-2c shows that the detected antimony sample result was from the October 1998 sampling event. Antimony is not retained as a COPC because it was not detected in alluvial groundwater or DP Spring samples.

E-5.2.3 Arsenic

Figure E-5.2-3a shows the variation in concentration by sample location; the plot shows that there were detects of arsenic in surface water, alluvial groundwater, and BKG (LAO-B). The concentration range of detected sample results is similar to the range of detection limits. Figure E-5.2-3b shows that the arsenic detects were from unfiltered and filtered samples. Lastly, Figure E-5.2-3c shows that the detected arsenic sample results were from three sampling events. Arsenic is not retained as a COPC because the concentration range of detected sample results is similar to the range of detection limits.

E-5.2.4 Barium

Figure E-5.2-4a shows the variation in concentration by sample location; the plot shows that concentrations of barium are greatest in LAUZ-1 and surface water and are less for other sampling locations. Concentrations of barium decrease going from LAUZ-1 to LAUZ-2 to DP Spring, which is suggestive of a spatial trend for a contaminant associated with releases from PRS 21-011(k). Figure E-5.2-4b shows that the unfiltered concentrations are similar to the filtered concentrations. Lastly, Figure E-5.2-4c shows some evidence for an annual trend in barium concentration, although the time series is of insufficient length for a meaningful temporal assessment. Barium is retained as a COPC in water based on the apparently elevated concentrations in alluvial groundwater and DP Spring in comparison to BKG (LAO-B) results.

E-5.2.5 Beryllium

Figure E-5.2-5a shows the variation in concentration by sample location; the plot shows that there are three detects of beryllium in surface water, two of which are at the same concentration. Figure E-5.2-5b shows that the detected beryllium sample results were from unfiltered samples. Lastly, Figure E-5.2-5c shows that the detected beryllium sample results were from the August 1997 and October 1998 sampling events. Beryllium is not retained as a COPC because it was not detected in alluvial groundwater or DP Spring samples.

E-5.2.6 Boron

Figure E-5.2-6a shows the variation in concentration by sample location; the plot shows that there are boron detects in samples collected from all locations. However, there are only five sample results for boron from DP Canyon sampling locations. Figure E-5.2-6b shows that the filtered boron sample results are greater than the unfiltered sample results, but a careful review of the symbols shows that the filtered and unfiltered data are from different sampling locations. Lastly, Figure E-5.2-6c shows that the boron sample results were obtained from the last two sampling events, which makes a time series analysis meaningless. Boron is retained as a COPC based on the apparently elevated concentrations for samples collected from alluvial groundwater or DP Spring and based on limited number of samples collected from DP Canyon locations.

E-5.2.7 Cadmium

Figure E-5.2-7a shows the variation in concentration by sample location; the plot shows that there is a single detect of cadmium in surface water at a concentration less than the detected BKG (LAO-B) sample result. Figure E-5.2-7b shows that the detected cadmium sample results were from unfiltered samples. Lastly, Figure E-5.2-7c shows that the detected cadmium sample result was from the October 1998 sampling event. Cadmium is not retained as a COPC because it was not detected in alluvial groundwater or DP Spring samples.

E-5.2.8 Calcium

Figure E-5.2-8a shows the variation in concentration by sample location; the plot shows that concentrations of calcium are greatest in LAUZ-1 and are less for other sampling locations. Concentrations of calcium decrease going from LAUZ-1 to LAUZ-2 to DP Spring, which is suggestive of a spatial trend for a contaminant associated with releases from PRS 21-011(k). Figure E-5.2-8b shows that the unfiltered concentrations are similar to the filtered concentrations. Lastly, Figure E-5.2-8c shows some evidence for an annual trend in calcium concentration, although the time series is of insufficient length for a meaningful temporal assessment. Calcium is retained as a COPC in water based on the apparently elevated concentrations in alluvial groundwater and DP Spring in comparison to BKG (LAO-B) results.

E-5.2.9 Chromium, Total

Figure E-5.2-9a shows the variation in concentration by sample location; the plot shows that total chromium is not detected in alluvial groundwater or DP Spring samples. There is a single elevated detected sample result for BKG (LAO-B), and other detected total chromium sample results in surface water. Figure E-5.2-9b shows that the detected total chromium sample results were from unfiltered and unfiltered samples, and the detected concentrations are higher in unfiltered samples. Lastly, Figure E-5.2-9c shows that the detected total chromium sample results were from the August 1997 and October 1998 sampling events. Total chromium is not retained as a COPC because it was not detected in alluvial groundwater or DP Spring samples.

E-5.2.10 Cobalt

Figure E-5.2-10a shows the variation in concentration by sample location; the plot shows that there were detects of cobalt in surface water and alluvial groundwater. The concentration range of detected sample results is similar to the range of detection limits. Figure E-5.2-10b shows that the cobalt detects were from unfiltered and filtered samples. Lastly, Figure E-5.2-10c shows that the detected cobalt sample results

were from multiple sampling events. Cobalt is not retained as a COPC because the concentration range of detected sample results is similar to the range of detection limits.

E-5.2.11 Copper

Figure E-5.2-11a shows the variation in concentration by sample location; the plot shows that there were detects of copper in surface water, alluvial groundwater, and BKG (LAO-B). The concentration range of detected sample results is similar to the range of detection limits. Figure E-5.2-11b shows that the copper detects were from unfiltered and filtered samples, and the detected concentrations are higher in unfiltered samples. Lastly, Figure E-5.2-11c shows that the detected copper sample results were from three sampling events. Copper is not retained as a COPC because the concentration range of detected sample results is similar to the range of detection limits and because the detected results in alluvial groundwater and DP Spring are less than the detected values in BKG (LAO-B).

E-5.2.12 Iron

Figure E-5.2-12a shows the variation in concentration by sample location; the plot shows that concentrations of iron are greatest in LAUZ-2 and surface water. Concentrations of iron are similar in wells BKG (LAO-B) and LAUZ-1 to DP Spring, which tends to make the elevated values in LAUZ-2 more difficult to explain and perhaps indicative of a localized iron anomaly. Figure E-5.2-12b shows that the unfiltered concentrations are greater than the filtered concentrations. Lastly, Figure E-5.2-12c shows some evidence for a temporal trend in iron concentration, but this apparent trend is highly influenced by the timing of surface water collection. In any case, the time series is of insufficient length for a meaningful temporal assessment. Iron is retained as a COPC in water based on the apparently elevated concentrations in alluvial groundwater in comparison to BKG (LAO-B) results.

E-5.2.13 Lead

Figure E-5.2-13a shows the variation in concentration by sample location; the plot shows that there are detects of lead at all sampling locations. The detected concentrations in alluvial groundwater and DP Spring are a small fraction of the maximum detected result for BKG (LAO-B). Figure E-5.2-13b shows that greater concentrations of lead were measured in unfiltered samples than in filtered samples. Lastly, Figure E-5.2-13c shows that the detected lead sample results are from three of the five sampling events. Lead is not retained as a COPC because the range of detected concentrations is similar to detected sample results from BKG (LAO-B) (and are much less than one high value reported from BKG (LAO-B)).

E-5.2.14 Lithium

Figure E-5.2-14a shows the variation in concentration by sample location; the plot shows that there are lithium detects in samples collected from all locations. However, there are only five sample results for lithium from DP Canyon sampling locations. Figure E-5.2-14b shows that the filtered lithium sample results are similar to the unfiltered sample results, but a careful review of the symbols shows that the filtered and unfiltered data are from different sampling locations. Lastly, Figure E-5.2-14c shows that the lithium sample results were obtained from the last two sampling events, which makes a time series analysis meaningless. Lithium is retained as a COPC based on the apparently elevated concentrations for samples collected from alluvial groundwater and DP Spring and based on limited number of samples collected from DP Canyon locations.

E-5.2.15 Magnesium

Figure E-5.2-15a shows the variation in concentration by sample location; the plot shows that concentrations of magnesium are greatest in LAUZ-1. Concentrations of magnesium decrease going from LAUZ-1 to LAUZ-2 to DP Spring, which is suggestive of a spatial trend for a contaminant associated with releases from PRS 21-011(k). Figure E-5.2-15b shows that the unfiltered concentrations are similar to the filtered concentrations. Lastly, Figure E-5.2-15c shows some evidence for a temporal trend in magnesium concentration, although the time series is of insufficient length for a meaningful temporal assessment. Magnesium is retained as a COPC in water based on the apparently elevated concentrations in alluvial groundwater and DP Spring in comparison with BKG (LAO-B) results.

E-5.2.16 Manganese

Figure E-5.2-16a shows the variation in concentration by sample location; the plot shows that concentrations of manganese are greatest in LAUZ-2. Concentrations of manganese are similar in BKG (LAO-B), well LAUZ-1, and DP Spring, which tends to make the elevated values in LAUZ-2 more difficult to explain and perhaps indicative of a localized manganese anomaly. Figure E-5.2-16b shows that the unfiltered concentrations are similar to filtered concentrations. Lastly, Figure E-5.2-16c shows no evidence for a temporal trend in manganese concentration. In any case, the time series is of insufficient length for a meaningful temporal assessment. Manganese is retained as a COPC in water based on the apparently elevated concentrations in alluvial groundwater in comparison to BKG (LAO-B) results.

E-5.2.17 Mercury

Figure E-5.2-17a shows the variation in concentration by sample location. The two detected mercury sample results (less than 10 μg/L) are not evident on Figure E-5.2-17a, because the detected results are within the same concentration range as nondetects. Figure E-5.2-17b shows that the detection limits in unfiltered samples are greater than the detection limits in filtered samples. Lastly, Figure E-5.2-17c shows no evidence for temporal variation in mercury detection limits. Mercury is not retained as a COPC because it was not detected in alluvial groundwater or DP Spring.

E-5.2.18 Molybdenum

Figure E-5.2-18a shows the variation in concentration by sample location; the plot shows that molybdenum was detected in LAUZ-1 and DP Spring. The two detected molybdenum sample results are within the same concentration range of nondetects for BKG (LAO-B). Figure E-5.2-18b shows that the detected sample results were from filtered and unfiltered samples. Lastly, Figure E-5.2-18c shows no evidence for temporal variation in molybdenum concentrations because molybdenum was sampled in the last two sampling events. Molybdenum is not retained as a COPC because the detected sample results are within the range of detection limits for BKG (LAO-B) data.

E-5.2.19 Nickel

Figure E-5.2-19a shows the variation in concentration by sample location; the plot shows that nickel was detected in all locations except BKG (LAO-B). The two detected nickel sample results are at the lower range of nondetect sample results for BKG (LAO-B). Figure E-5.2-19b shows that the detected sample results were from filtered samples and unfiltered samples. Lastly, Figure E-5.2-19c shows no evidence for temporal variation in nickel sample results. Nickel is not retained as a COPC because the detected sample results are within the range of detection limits for BKG (LAO-B) data.

E-5.2.20 Potassium

Figure E-5.2-20a shows the variation in concentration by sample location; the plot shows that concentrations of potassium are greatest in LAUZ-2. Concentrations of potassium are also elevated in DP Spring and LAUZ-1, which suggests that the alluvial aquifer in DP Canyon has elevated concentrations of potassium. Figure E-5.2-20b shows that the filtered concentrations are greater than the unfiltered concentrations, but this plot is distorted by the low unfiltered sample results in unfiltered surface water. Lastly, Figure E-5.2-20c shows little evidence for a temporal trend in potassium concentration, but the time series is of insufficient length for a meaningful temporal assessment. Potassium is retained as a COPC in water based on the apparently elevated concentrations in alluvial groundwater in comparison with BKG (LAO-B) results.

E-5.2.21 Selenium

Figure E-5.2-21a shows the variation in concentration by sample location; the plot shows that there is a single detect of selenium in surface water. Figure E-5.2-21b shows that the detected selenium sample result was from an unfiltered sample. Lastly, Figure E-5.2-21c shows that the detected selenium sample result was from the October 1998 sampling event. Selenium is not retained as a COPC because it was not detected in alluvial groundwater or DP Spring samples.

E-5.2.22 Sodium

Figure E-5.2-22a shows the variation in concentration by sample location; the plot shows that concentrations of sodium are greatest in LAUZ-1. Concentrations of sodium decrease going from LAUZ-1 to LAUZ-2 to DP Spring, which is suggestive of a spatial trend for a contaminant associated with releases from PRS 21-011(k). Figure E-5.2-22b shows that the unfiltered concentrations are similar to the filtered concentrations. Lastly, Figure E-5.2-22c shows some evidence for a temporal trend in sodium concentration, although the time series is of insufficient length for a meaningful temporal assessment. Sodium is retained as a COPC in water based on the apparently elevated concentrations in alluvial groundwater and DP Spring in comparison with BKG (LAO-B) results.

E-5.2.23 Strontium

Figure E-5.2-23a shows the variation in concentration by sample location; the plot shows that there are detects of strontium at all sampling locations. The detected concentrations in alluvial groundwater and DP Spring are a small fraction of the maximum detected result for BKG (LAO-B). Figure E-5.2-23b shows that greater concentrations of strontium were measured in unfiltered samples than in filtered samples. Lastly, Figure E-5.2-23c shows that the strontium results were obtained from the last two sampling events. Strontium is not retained as a COPC because the range of detected concentrations is similar to detected sample results from BKG (LAO-B) (and are much less than the two highest values reported from BKG [LAO-B]).

E-5.2.24 Thallium

Figure E-5.2-24a shows the variation in concentration by sample location; the plot shows that thallium was detected in surface water and the alluvial groundwater. The detected thallium sample results in alluvial groundwater are greater than the upper range of nondetect sample results for BKG (LAO-B), and the detected thallium results are similar across DP Canyon water sampling locations. What is not evident from the figure is that thallium was detected in less than half of the samples. Figure E-5.2-24b shows that the detected sample results were from filtered and unfiltered samples. Lastly, Figure E-5.2-24c shows no

evidence for temporal variation in thallium sample results. Thallium is not retained as a COPC because the detected sample results are similar between all DP Canyon sampling locations and are only shifted by 5 ug/L above the maximum detection limits for the BKG (LAO-B) data.

E-5.2.25 Vanadium

Figure E-5.2-25a shows the variation in concentration by sample location; the plot shows that vanadium was detected in all locations. The detected vanadium sample results in samples from the alluvial groundwater or DP Spring are less than detected sample results for BKG (LAO-B). Figure E-5.2-25b shows that the detected sample results were from filtered and unfiltered samples, and that unfiltered samples had greater concentrations than filtered samples. Lastly, Figure E-5.2-25c shows no evidence for temporal variation in vanadium sample results. Vanadium is not retained as a COPC because the detected sample results are within the range of detected values reported for BKG (LAO-B).

E-5.2.26 Zinc

Figure E-5.2-26a shows the variation in concentration by sample location; the plot shows that zinc was detected in all locations except BKG (LAO-B). There is a single elevated zinc result from LAUZ-1, which is greater than range of detection limits for BKG (LAO-B). The concentration range of other zinc sample results for alluvial groundwater or DP Spring are similar to concentrations in BKG (LAO-B). Figure E-5.2-26b shows that the detected sample results were from filtered and unfiltered samples, and that unfiltered samples had greater concentrations than filtered samples. Lastly, Figure E-5.2-26c shows no evidence for temporal variation in zinc sample results. Zinc is not retained as a COPC because most detected sample results are within the range of detected values reported for BKG (LAO-B).

E-5.2.27 Water Quality Parameters

Water quality parameters (e.g., major anions and cations) were measured on some of the DP Canyon water samples. This information is provided to assist in interpreting contaminant fate and transport. Statistical plots are provided to evaluate spatial and temporal variation in these parameters, and not to evaluate these parameters as COPCs.

Plots are provided for bicarbonate (Figure E-5.2-27a, b, c), chloride (Figure E-5.2-28a, b, c), fluoride (Figure E-5.2-29a, b, c), nitrate (Figure E-5.2-30a, b, c), nitrate and nitrites (Figure E-5.2-31a, b, c), sulfate (Figure E-5.2-32a, b, c), total organic carbon (Figure E-5.2-33a, b, c), total phosphorous (Figure E-5.2-34a, b, c), and total silica (Figure E-5.2-35a, b, c). Bicarbonate shows an interesting pattern between sampling locations, and the highest bicarbonate concentrations are in the alluvial groundwater. Chloride and fluoride are also highest in alluvial water, and the maximum value is from LAUZ-2. Concentrations of sulfate are variable within the alluvial water. There are insufficient data to draw any conclusions regarding variability for nitrates, nitrate and nitrites, total organic carbon, total phosphorous, and total silica.

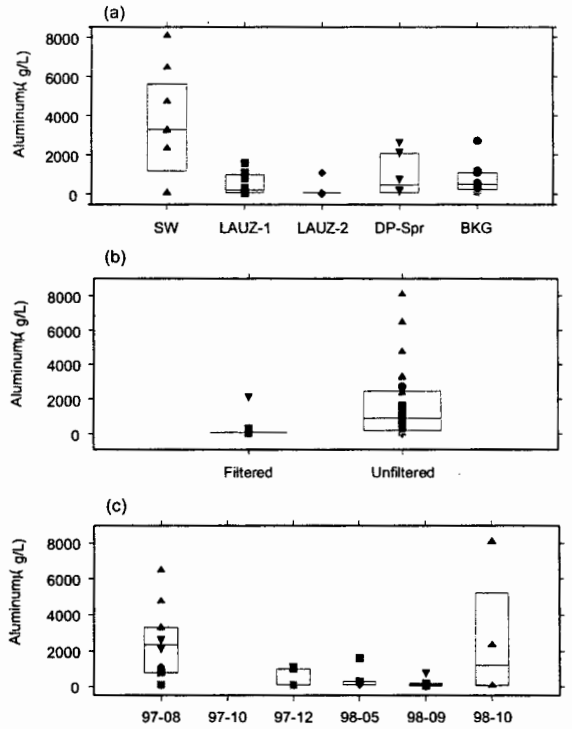


Figure E-5.2-1. Aluminum concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

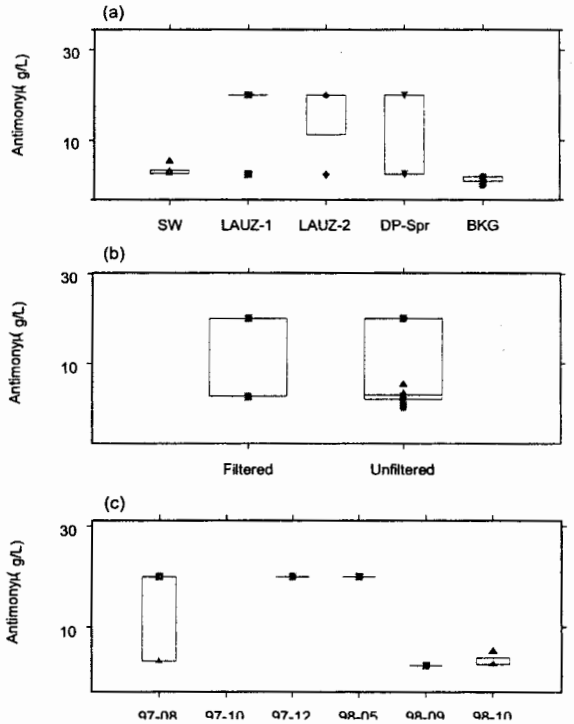


Figure E-5.2-2. Antimony concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

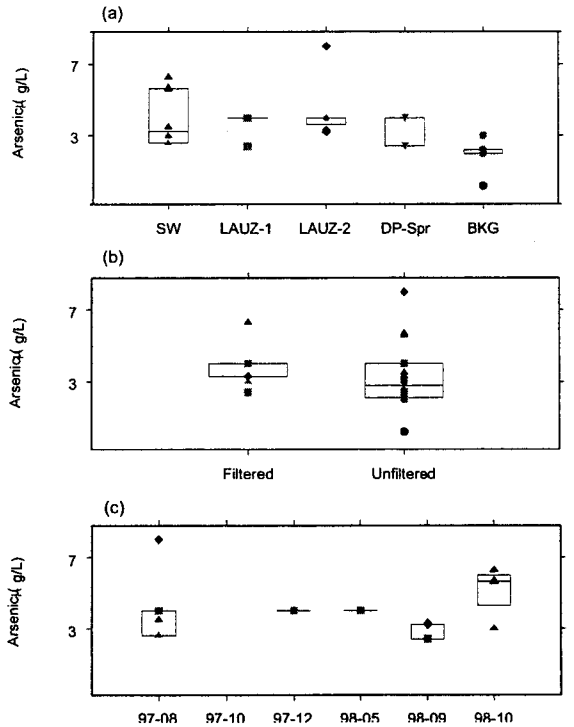


Figure E-5.2-3. Arsenic concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

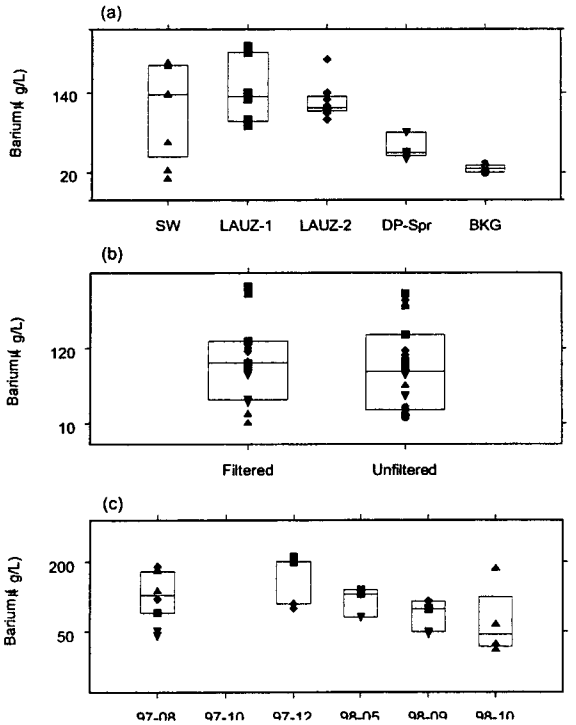


Figure E-5.2-4. Barium concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

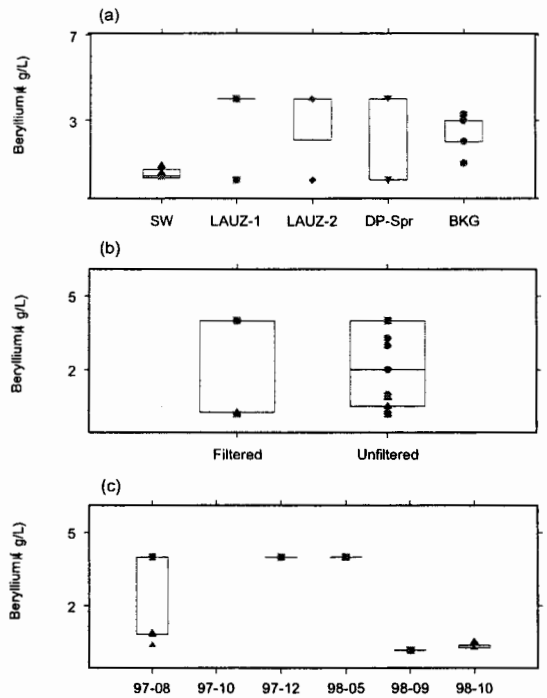


Figure E-5.2-5. Beryllium concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

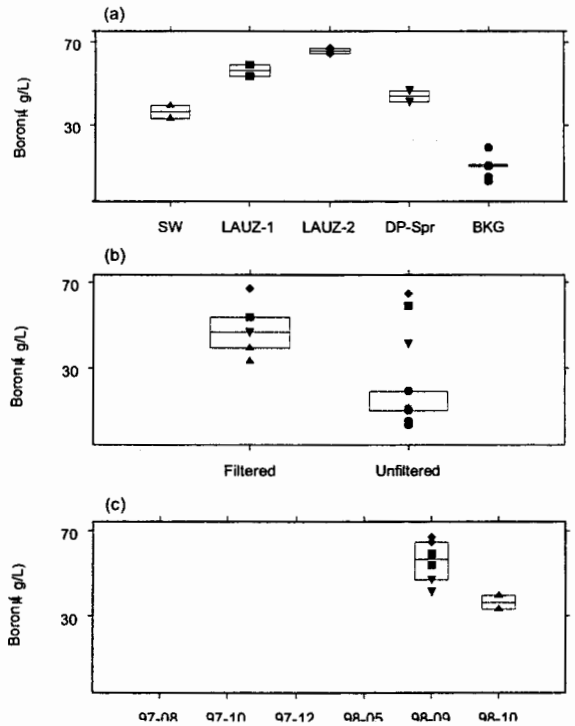


Figure E-5.2-6. Boron concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

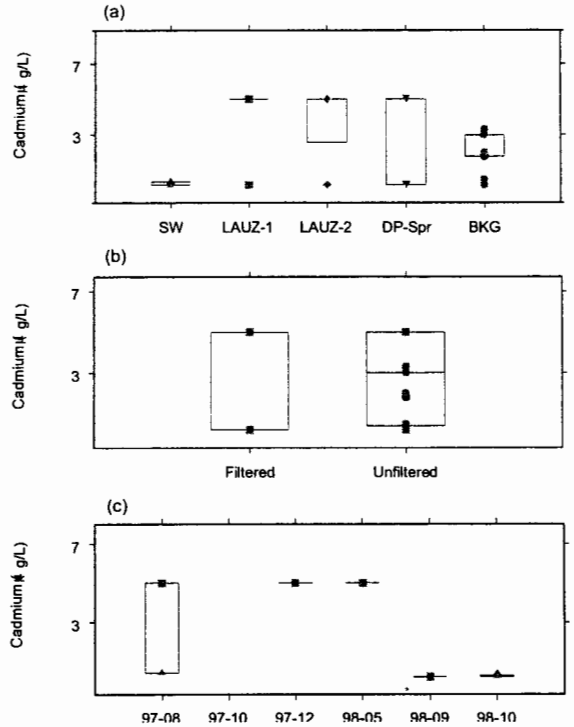


Figure E-5.2-7. Cadmium concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

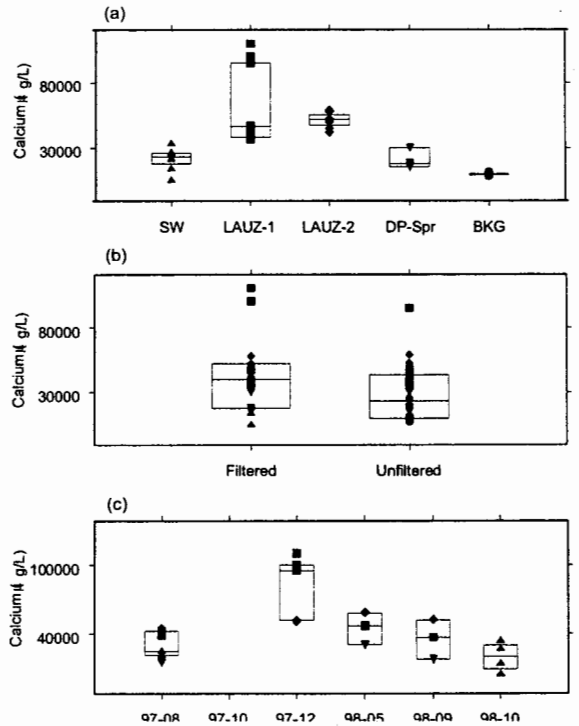


Figure E-5.2-8. Calcium concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

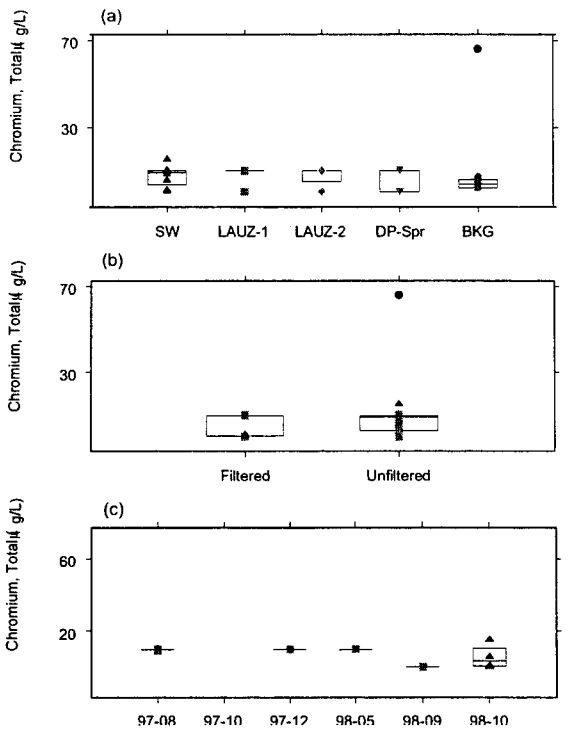


Figure E-5.2-9. Chromium concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

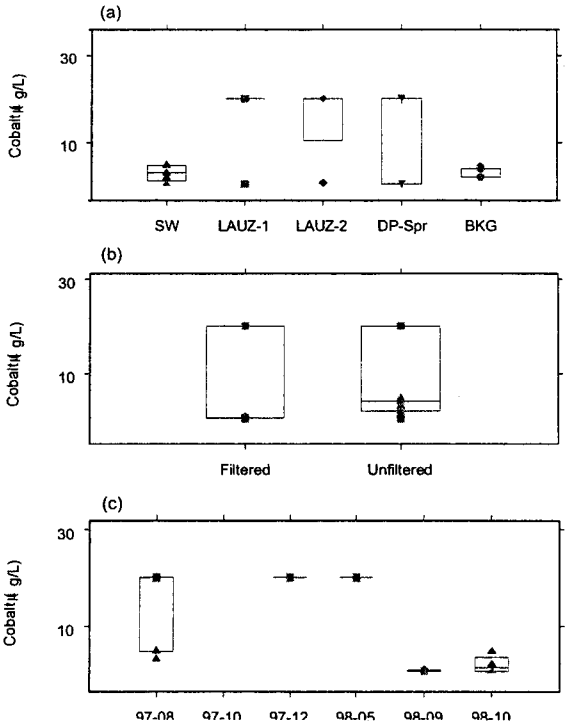


Figure E-5.2-10. Cobalt concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

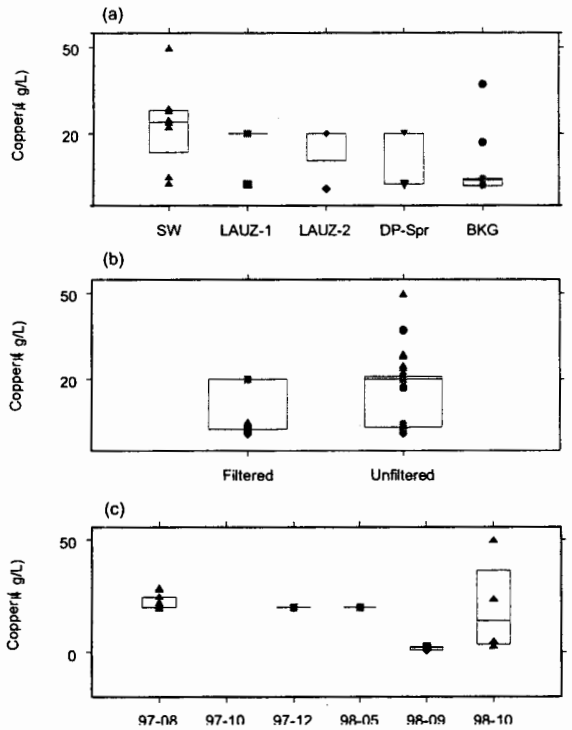


Figure E-5.2-11. Copper concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

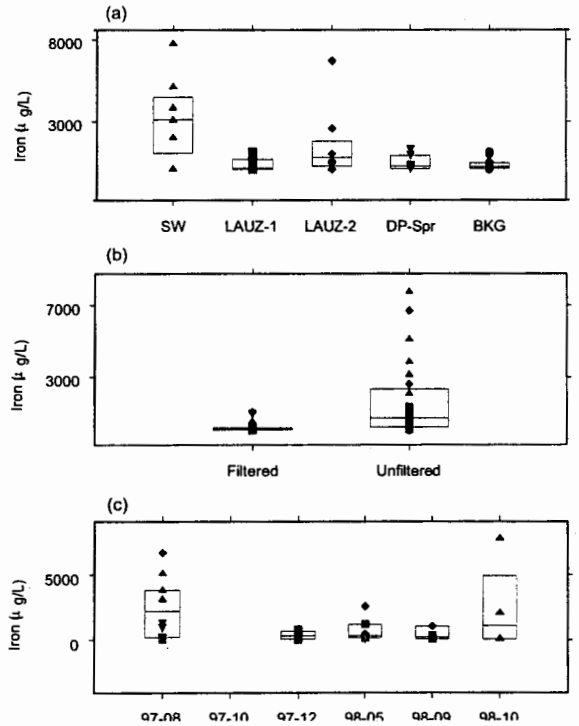


Figure E-5.2-12. Iron concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

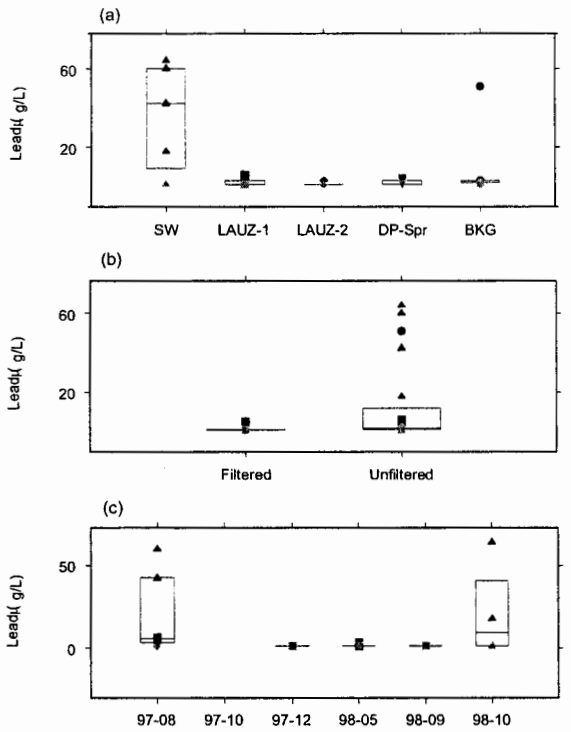


Figure E-5.2-13. Lead concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

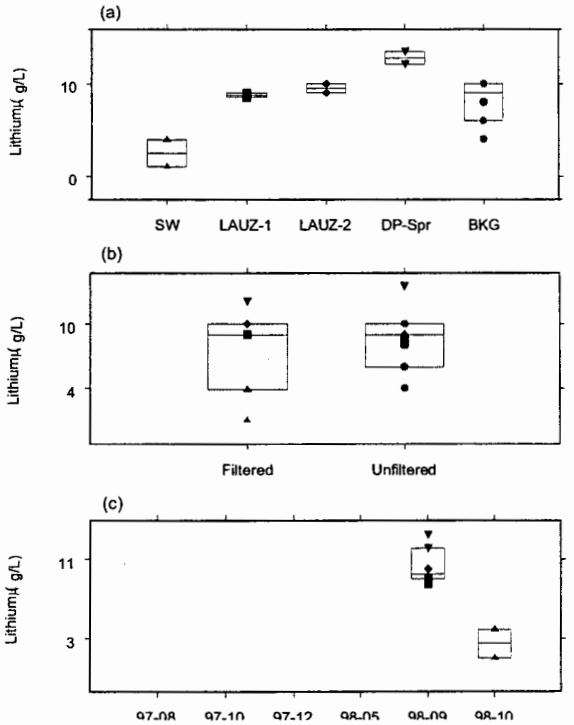


Figure E-5.2-14. Lithium concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

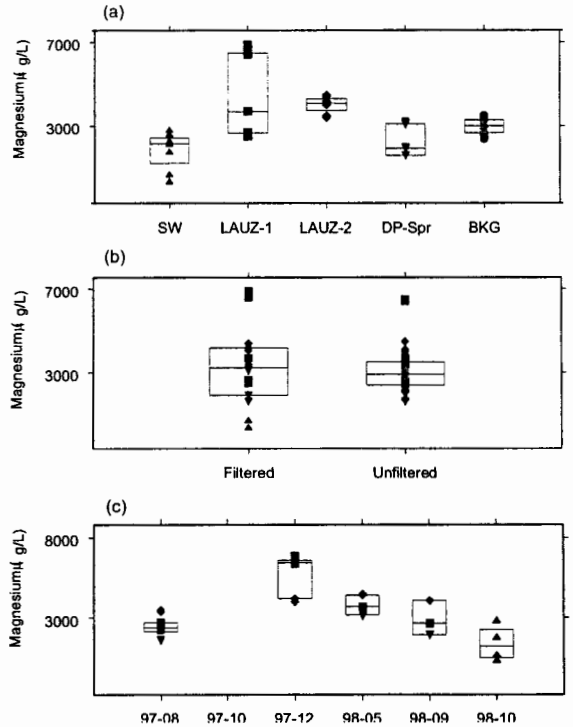


Figure E-5.2-15. Magnesium concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

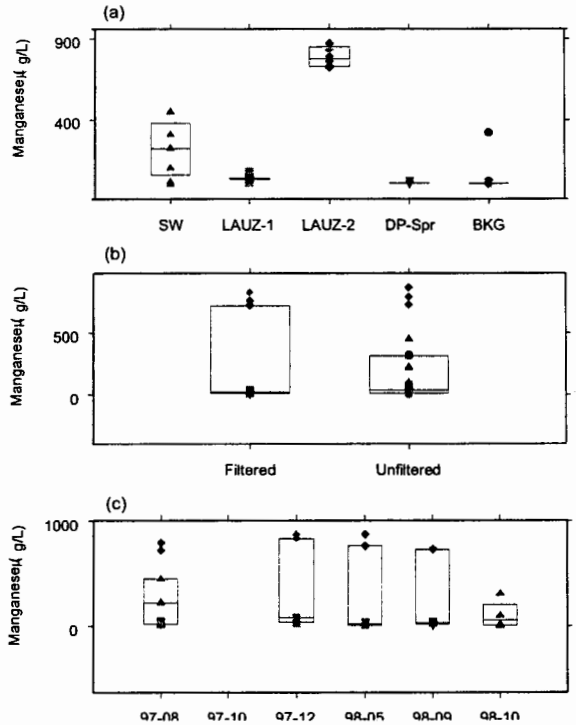


Figure E-5.2-16. Manganese concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

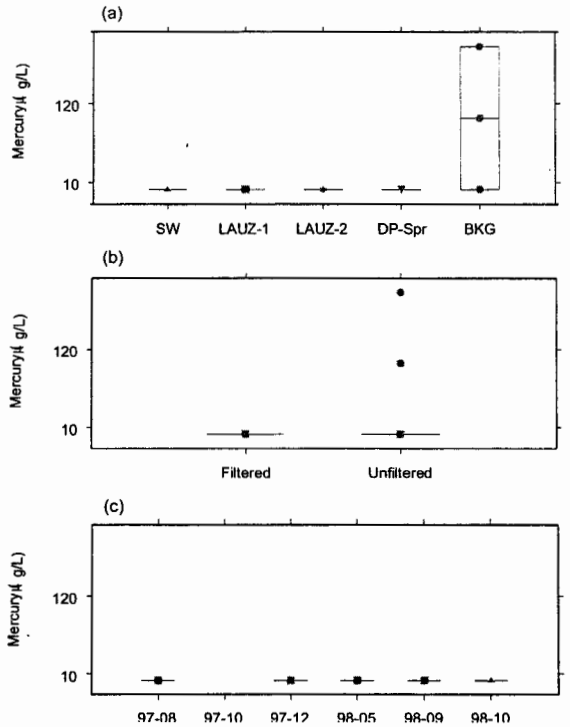


Figure E-5.2-17. Mercury concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

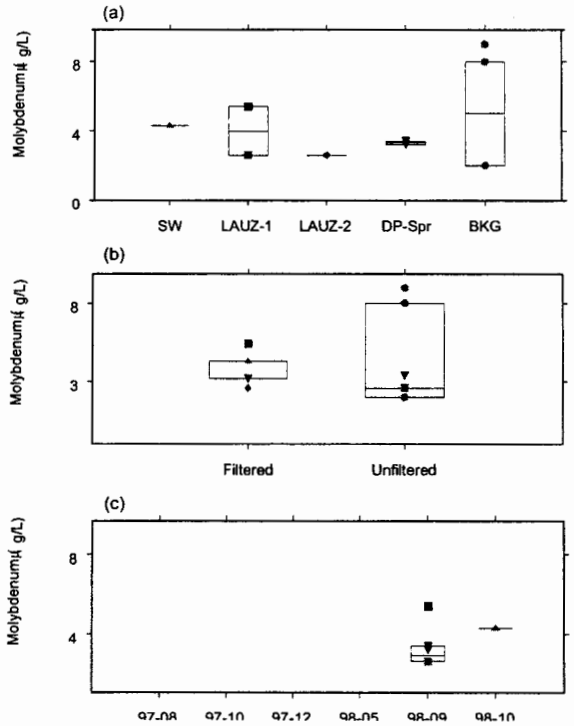


Figure E-5.2-18. Molybdenum concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

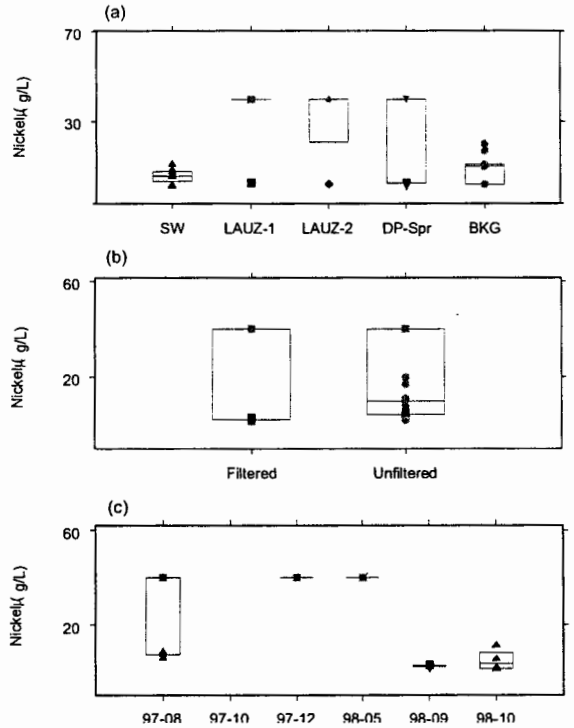


Figure E-5.2-19. Nickel concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

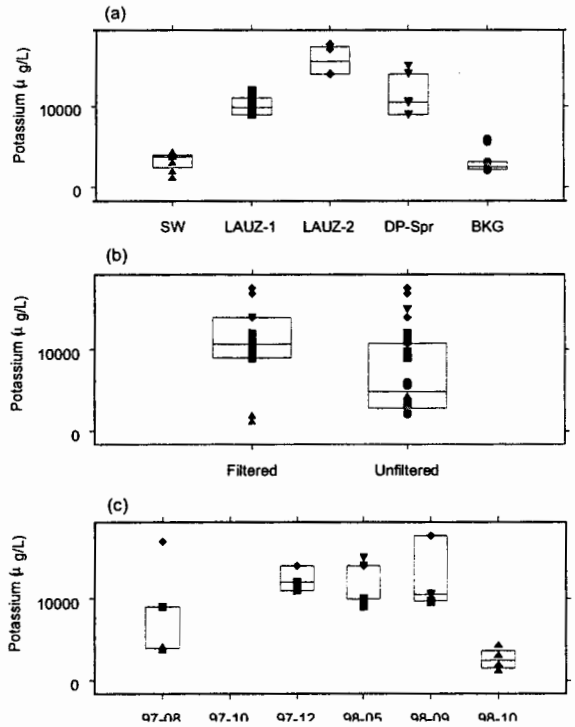


Figure E-5.2-20. Potassium concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

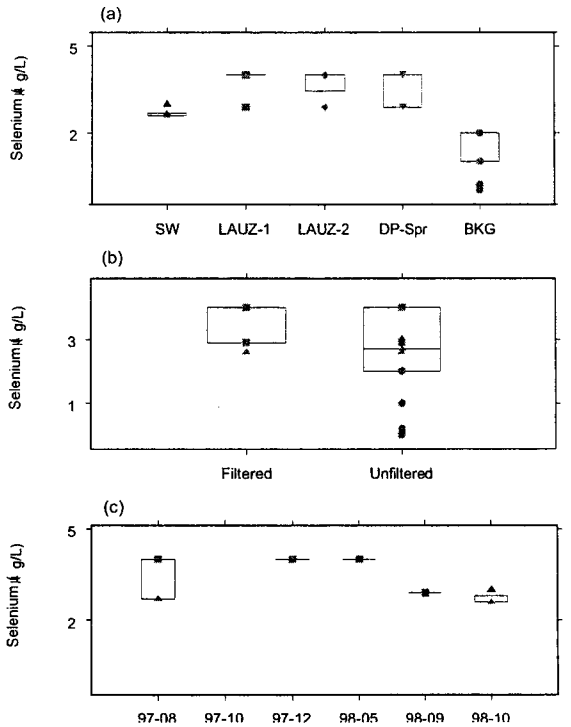


Figure E-5.2-21. Selenium concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

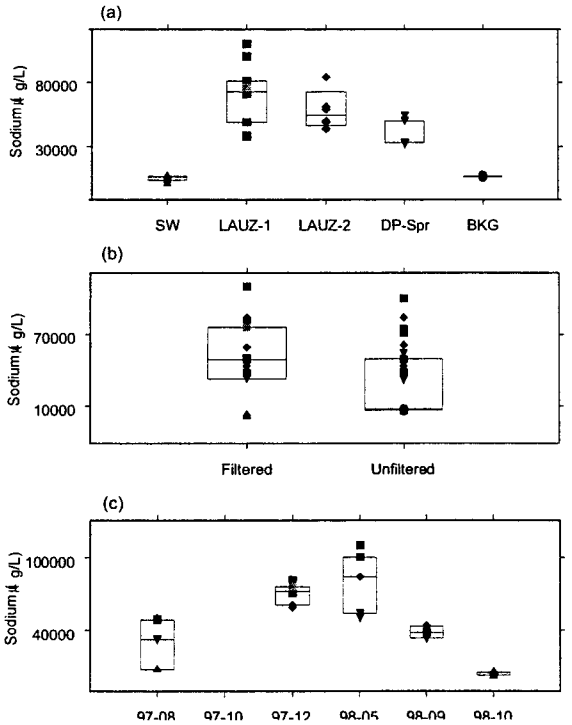


Figure E-5.2-22. Sodium concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

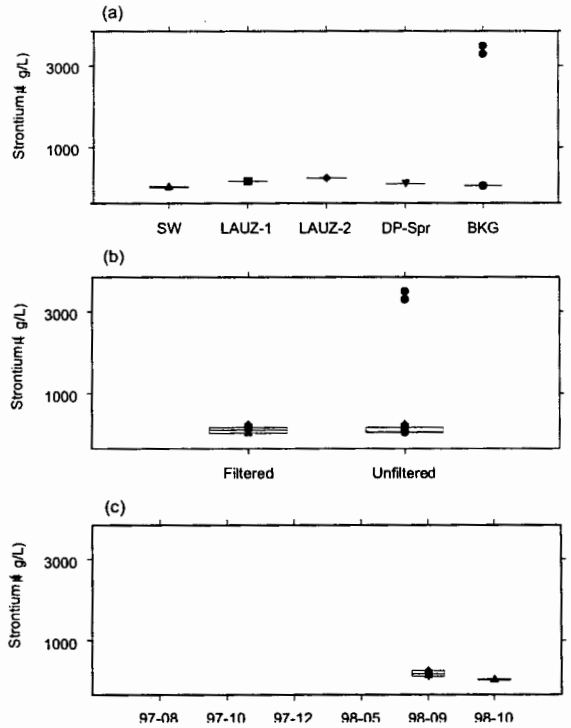


Figure E-5.2-23. Strontium concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

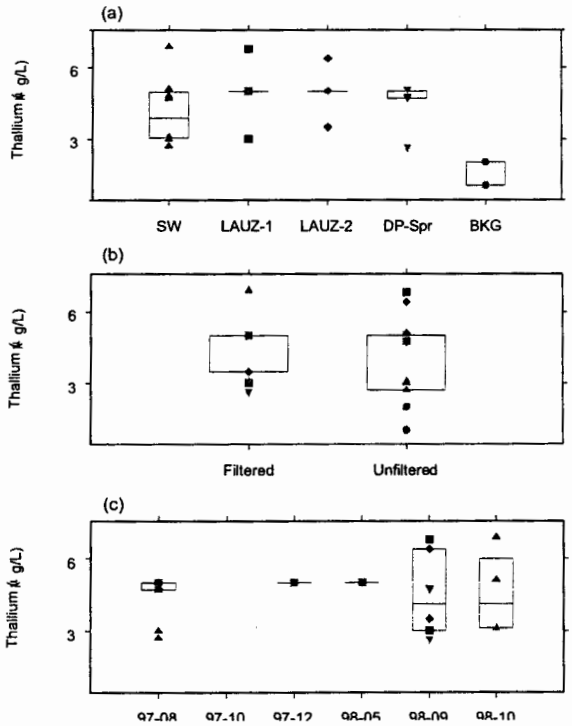


Figure E-5.2-24. Thallium concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

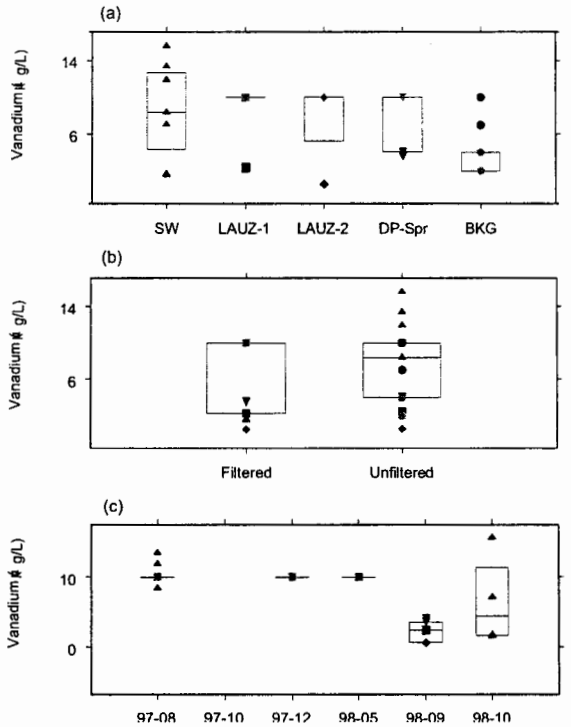


Figure E-5.2-25. Vanadium concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

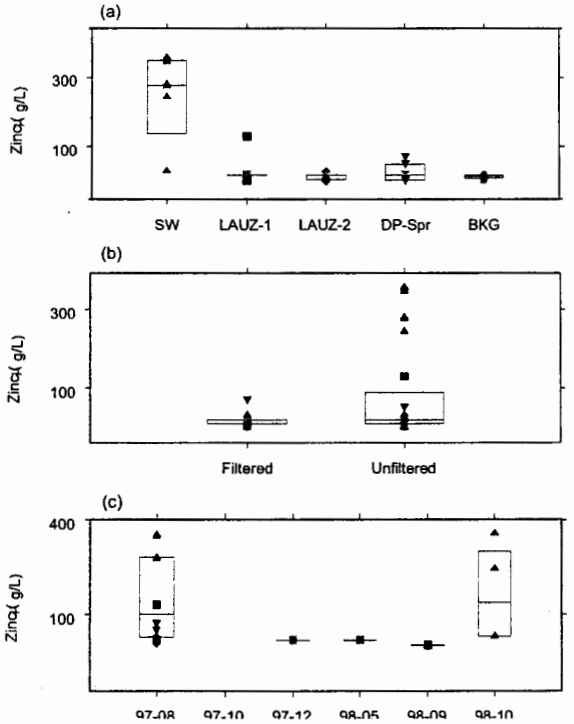


Figure E-5.2-26. Zinc concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

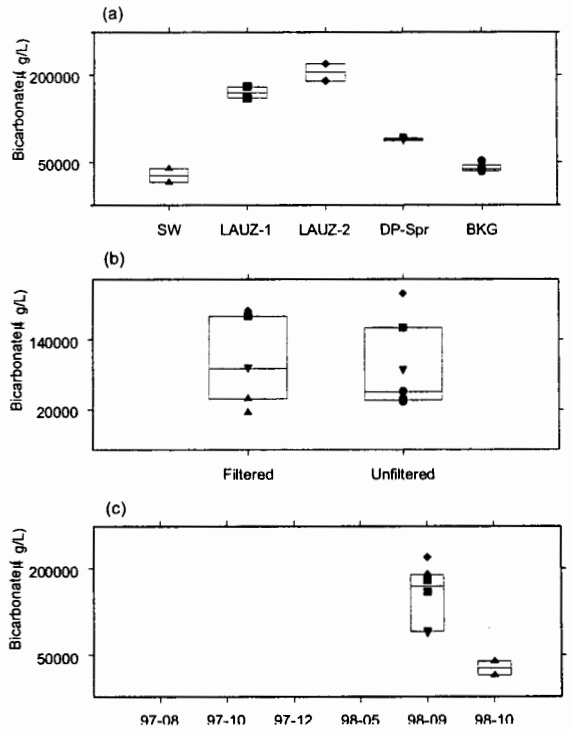


Figure E-5.2-27. Bicarbonate concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

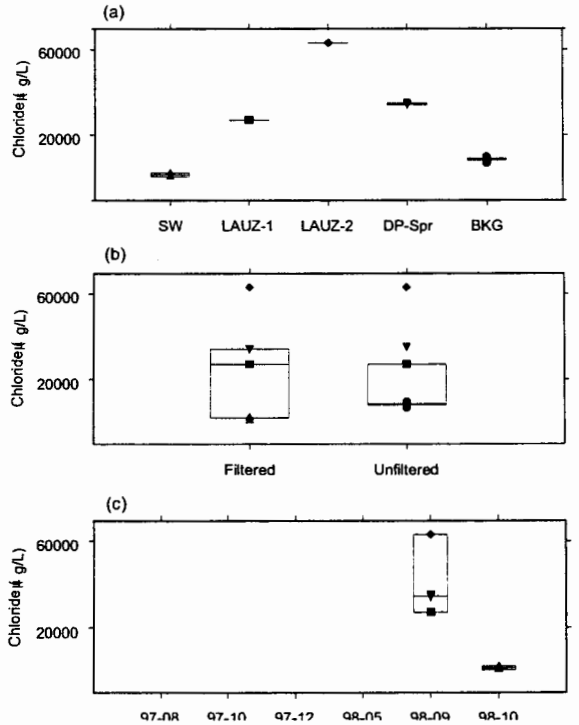


Figure E-5.2-28. Chloride concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

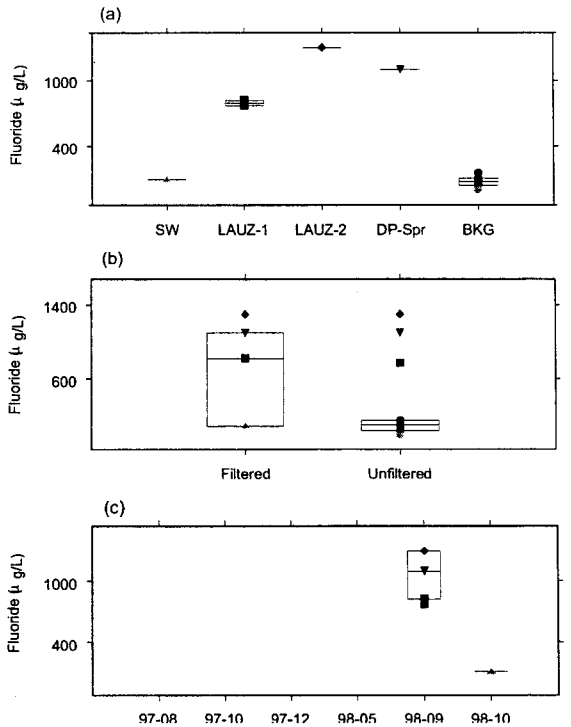


Figure E-5.2-29. Fluoride concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

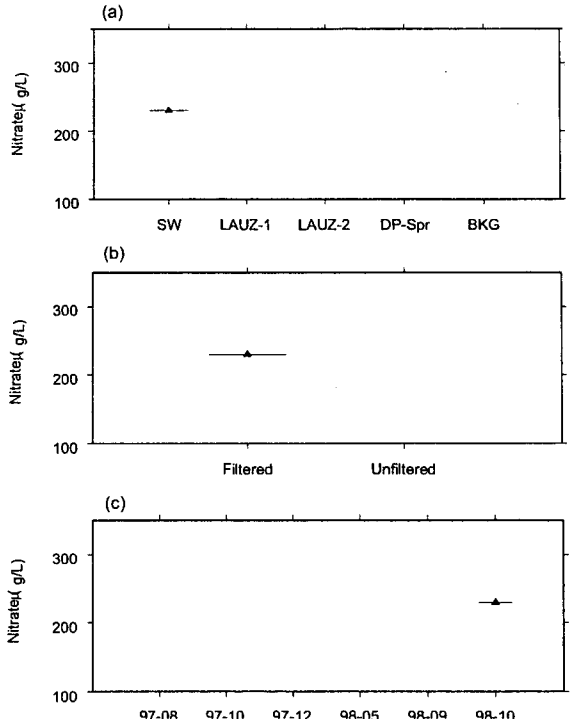


Figure E-5.2-30. Nitrate concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

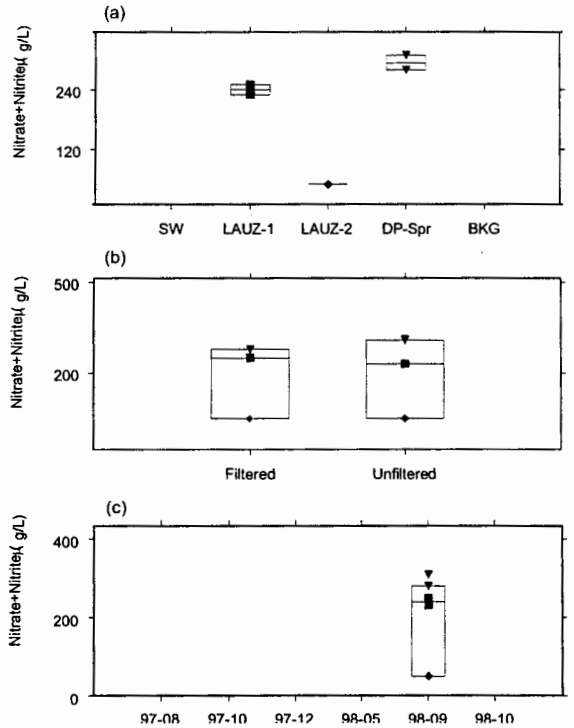


Figure E-5.2-31. Nitrate and nitrite concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

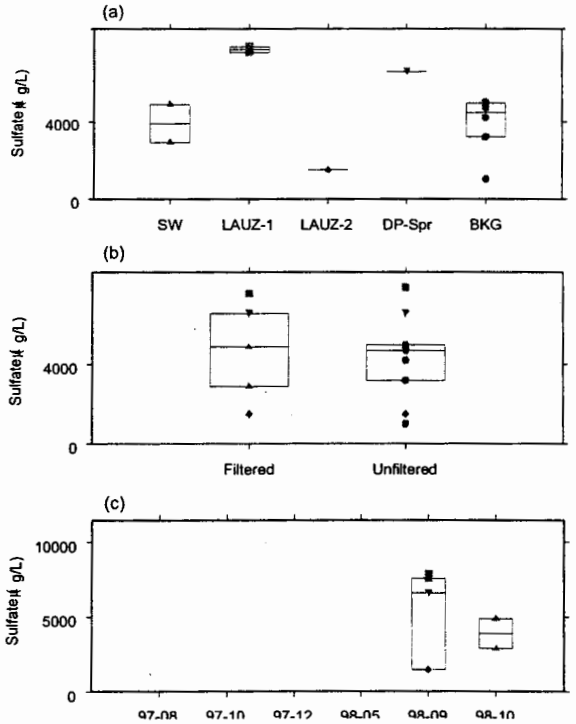


Figure E-5.2-32. Sulfate concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

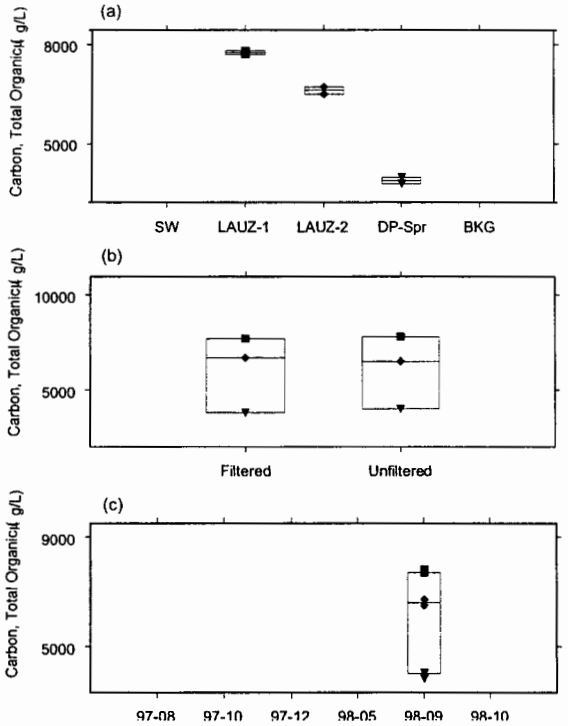


Figure E-5.2-33. Total organic carbon concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

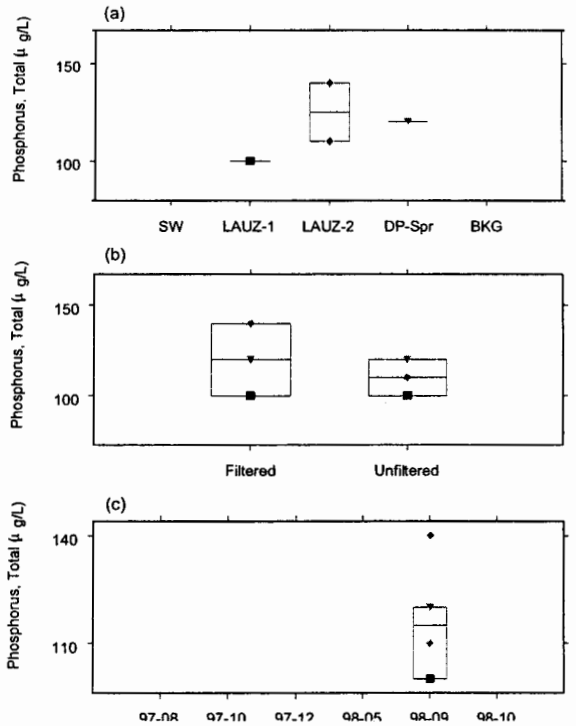


Figure E-5.2-34. Phosphorous concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

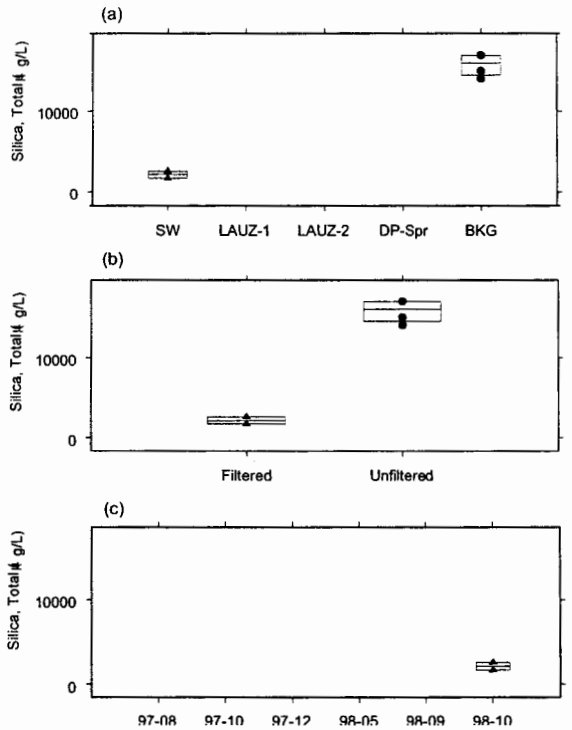


Figure E-5.2-35. Total silica concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

E-6.0 STATISTICAL EVALUATIONS OF RADIONUCLIDE DATA FROM WATER SAMPLES

The objective of this section is to present graphical analyses of radionuclide data from DP Canyon water samples. These analyses are used to determine whether the water data show evidence of contaminant releases through a qualitative evaluation of concentration trends by sampling location.

The figures for this section are placed at the end of the section.

E-6.1 Methods

Because the background data for water are currently being defined and there are no historical background water data for radionuclides, formal statistical tests were not used to determine which analytes should be retained as COPCs. Instead, a more qualitative approach was used to focus the analyte list to an initial list of COPCs. This approach relied on graphical displays called "box plots," which show the actual values for each radionuclide. The ends of each box represent the "interquartile" range of the data distribution, which is specified by the 25th percentile and 75th percentile of the data distribution. The horizontal line within the box is the median (50th percentile) of the data distribution (if the number of samples is four or fewer, the line is not displayed). Thus, each box indicates concentration values for the central half of the data, and concentration shifts can be readily assessed by comparing the boxes. If most of the data are represented by a single concentration value (usually the detection limit), the box is reduced to a single line.

A trio of box plots is presented for each radionuclide. First the data are presented by sampling location. The DP Canyon alluvial groundwater is represented by samples collected in two wells (LAUZ-1 and LAUZ-2). The location plot also shows sample data for DP Spring (DP Spr). A second box plot shows the difference between filtered and unfiltered sample results (note that both filtered and unfiltered are presented in the location box plot). Lastly, the temporal variation is shown in a box plot that displays the data by the month collected. The main evidence used to assess whether a radionuclide should be retained as a COPC is the pattern of sample results noted by location. Radionuclide releases in DP Canyon are assumed to be associated mainly with the releases from PRS 21-011(k). Thus, it is expected that the highest concentrations would be measured in well LAUZ-1, lower values in well LAUZ-2, and the lowest values in DP Spring. Radionuclides with concentration trends following this pattern are retained as COPCs.

In these box plots, a different symbol is used for the laboratory results for each sampling location, and the symbols are used consistently in each box plot in this section: DP Spring data by an inverted triangle, LAUZ-1 data by a square, and LAUZ-2 data by a diamond. Also note that nondetected sample results are plotted as the detection limit value and the symbol is shaded in a light gray pattern.

E-6.2 Results

The results of the statistical evaluation are presented for each radionuclide.

E-6.2.1 Plutonium-239,240

Figure E-6.2-1a shows the variation in concentration by sample location; the plot shows the pattern expected for radionuclides associated with releases from PRS 21-011(k). Figure E-6.2-1b shows that detected concentrations of plutonium-239,240 are associated with filtered and unfiltered water samples. Lastly, Figure E-6.2-1c shows little evidence for temporal variation in plutonium-239,240 concentrations. Plutonium-239,240 is retained as a COPC in water based on its documented presence in the

PRS 21-011(k) effluent, its detection in alluvial groundwater, and the decreasing concentration trend from LAUZ-1 to LAUZ-2 to DP Spring.

E-6.2.2 Strontium-90

Figure E-6.2-2a shows the variation in concentration by sample location; the plot shows the pattern expected for radionuclides associated with releases from PRS 21-011(k). Figure E-6.2-2b shows that filtered and unfiltered concentrations of strontium-90 are basically identical. Lastly, Figure E-6.2-2c shows some evidence for temporal variation in strontium-90 concentrations, but the time series is insufficient to draw any conclusions. Strontium-90 is retained as a COPC in water based on its documented presence in the PRS 21-011(k) effluent, its detection in alluvial groundwater, and the decreasing concentration trend from LAUZ-1 to LAUZ-2 to DP Spring.

E-6.2.3 Tritium

Figure E-6.2-3a shows the variation in concentration by sample location; the plot does not show the pattern expected for radionuclides associated with releases from PRS 21-011(k). Interpretation of the tritium data is hampered by the relatively high detection limits of these data, which resulted in only a single detected tritium sample result. Only unfiltered water samples are analyzed for tritium, which means that Figure E-6.2-3b contains only a single data group. Lastly, Figure E-6.2-3c shows that little interpretation of temporal variation in tritium concentrations can be made with a single detected tritium sample result. Tritium is retained as a COPC in water based on its documented presence in the PRS 21-011(k) effluent, its detection in alluvial groundwater, and the historical data showing detectable quantities of tritium in DP Spring.

E-6.2.4 Uranium-234

Figure E-6.2-4a shows the variation in concentration by sample location; the plot shows the pattern expected for radionuclides associated with releases from PRS 21-011(k). Figure E-6.2-4b shows that concentrations of uranium-234 in filtered samples are basically similar to unfiltered sample results. Lastly, Figure E-6.2-4c shows some evidence for temporal variation in uranium-234 concentrations, but the time series is not long enough to draw definitive conclusions. Ratios of uranium isotopes were also calculated to help determine the type of uranium detected in water. This analysis suggests that enriched uranium is present, which helps to support the conclusion that uranium detected in water is associated with PRS 21-011(k) effluent. Uranium-234 is retained as a COPC in water based on its documented presence in the PRS 21-011(k) effluent, its detection in alluvial groundwater, the isotopic ratio that suggest enriched uranium, and the decreasing concentration trend from LAUZ-1 to LAUZ-2 to DP Spring.

E-6.2.5 Uranium-235

Figure E-6.2-5a shows the variation in concentration by sample location; the plot shows the pattern expected for radionuclides associated with releases from PRS 21-011(k). It is important to note that only one uranium-235 sample result is a detect, and thus the apparent trend is for sample results less than the minimum detectable activity that have high analytical uncertainty. Figure E-6.2-5b shows that concentrations of uranium-235 in filtered samples are basically similar to unfiltered sample results. Lastly, Figure E-6.2-5c shows no evidence for temporal variation in uranium-235 concentrations, but the time series is not long enough to draw definitive conclusions. As discussed for uranium-234, the isotopic ratios of uranium-235 are suggestive of enriched uranium. Uranium-235 is retained as a COPC in water based

on its documented presence in the PRS 21-011(k) effluent, a single detection in alluvial groundwater, and the decreasing concentration trend from LAUZ-1 to LAUZ-2 to DP Spring.

E-6.2.6 Uranium-238

Figure E-6.2-6a shows the variation in concentration by sample location; the plot shows the pattern expected for radionuclides associated with releases from PRS 21-011(k). Although there is a concentration trend in uranium-238, preliminary radionuclide background information suggests that uranium-238 concentrations are within the background range for uranium-238 in alluvial water. The median value of the uranium-238 Laboratory background groundwater data is 0.15 pCi/L and the 75th percentile is 0.29 pCi/L (Longmire et al., report in progress).

Figure E-6.2-6b shows that detected concentrations of uranium-238 in filtered samples are basically similar to unfiltered water sample results. It is important to note that the maximum filtered sample result (0.42 pCi/L in sample 0121-97-1430) had a field duplicate sample result with much lower concentration (0.2 pCi/L in sample 0121-97-1428). If the maximum filtered sample result were excluded, then unfiltered concentrations would appear to be greater than filtered sample results. Lastly, Figure E-6.2-6c shows little evidence for temporal variation in uranium-238 concentrations, except that most of the detected values are from the August 1997 sampling event. Uranium-238 is not retained as a COPC in water based on similarity of uranium-238 concentrations to preliminary radionuclide background data, the isotopic ratio of uranium-238 to uranium-234, and the limited number of detections of uranium-238 in DP Canyon alluvial groundwater.

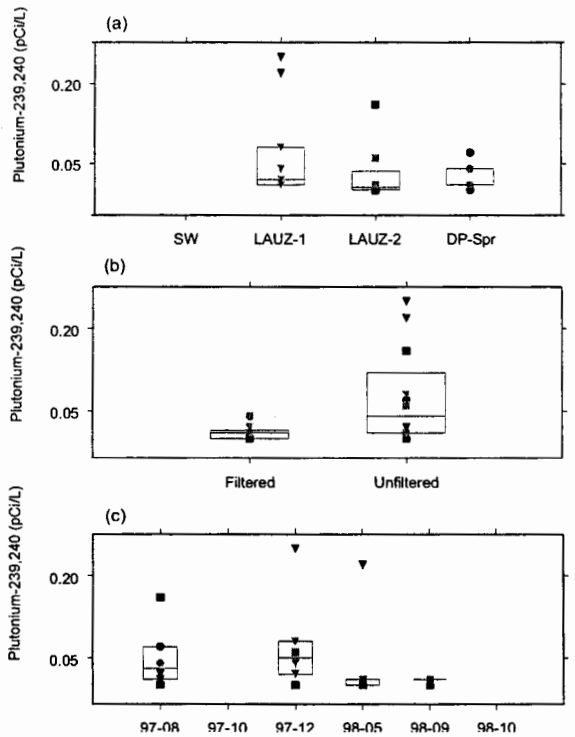


Figure E-6.2-1. Plutonium-239,240 concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

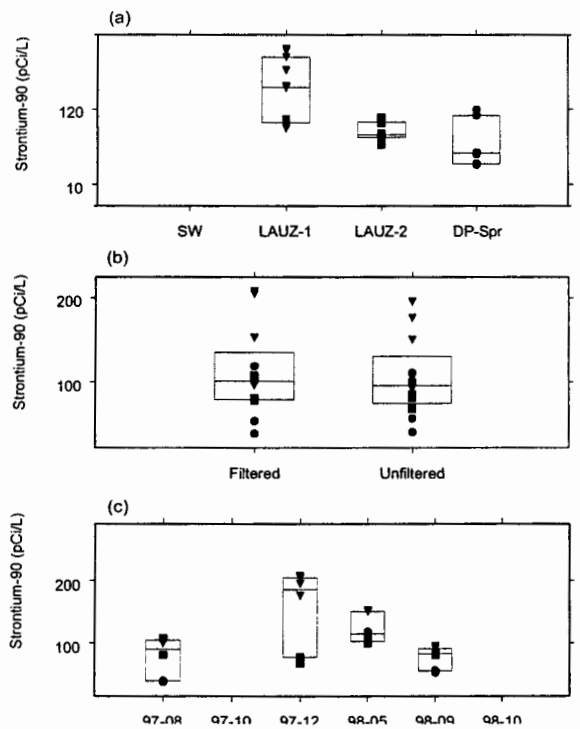


Figure E-6.2-2. Strontium-90 concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

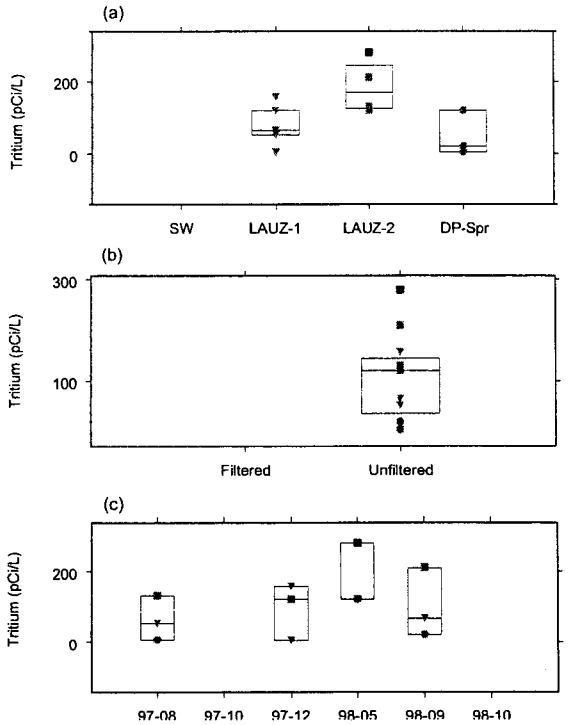


Figure E-6.2-3. Tritium concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

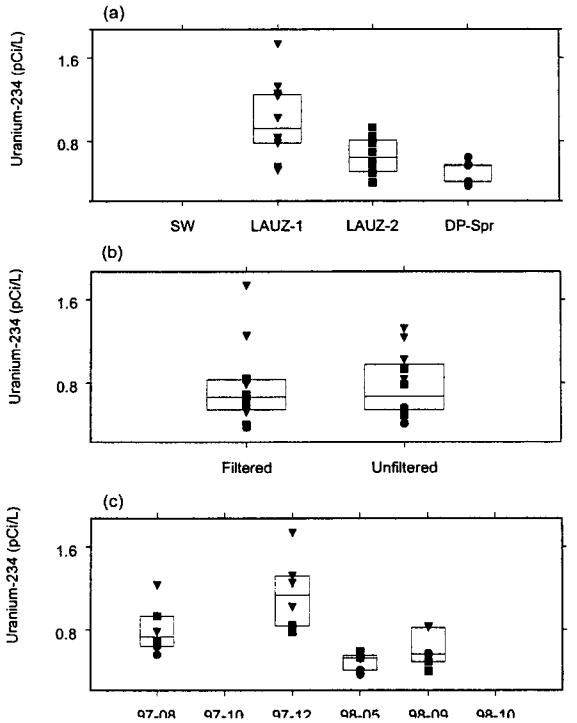


Figure E-6.2-4. Uranium-234 concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

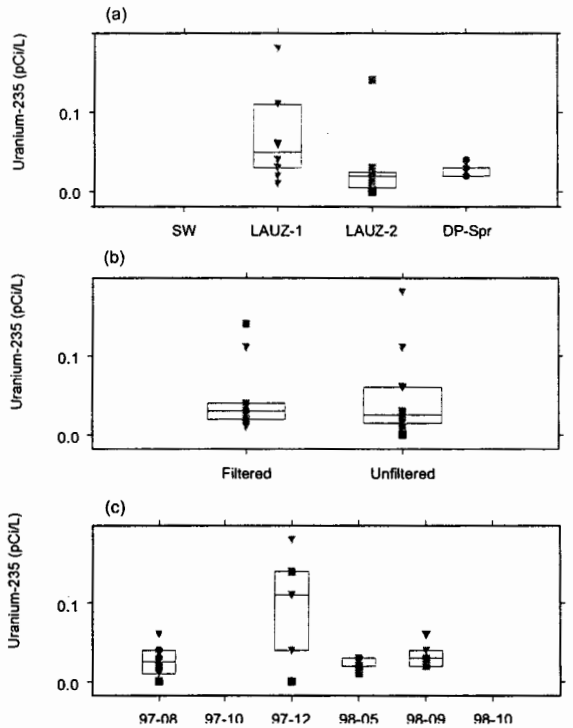


Figure E-6.2-5. Uranium-235 concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

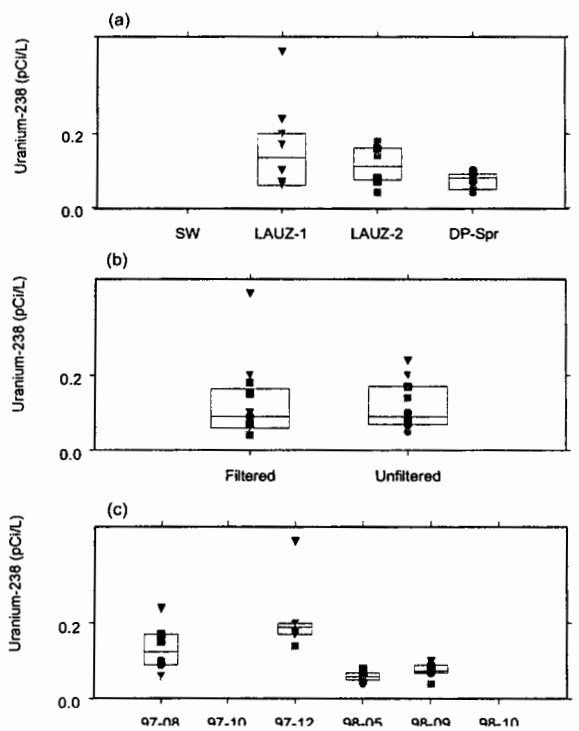


Figure E-6.2-6. Uranium-238 concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

E-7.0 STATISTICAL EVALUATIONS OF ORGANIC CHEMICAL DATA FROM WATER SAMPLES

The objective of this section is to present graphical analyses of organic chemical data from DP Canyon water samples. These analyses are used to determine whether the water data show evidence of contaminant releases through a qualitative evaluation of concentration trends by sampling location.

The figures for this section are placed at the end of the section.

E-7.1 Methods

There is assumed to be no natural background for organic chemicals in alluvial water. The analysis here focuses on presenting concentration trends between sample locations. Of particular importance is the detection status of analytes in surface water versus alluvial groundwater and DP Spring. Detection of organic chemicals in unfiltered surface water samples is viewed to present important information for contaminant transport, but is not viewed to be relevant to defining COPCs for alluvial water. Concentrations were evaluated based on graphical displays called "box plots," which show the actual values for each inorganic chemical. The ends of each box represent the "interquartile" range of the data distribution, which is specified by the 25th percentile and 75th percentile of the data distribution. The horizontal line within each box is the median (50th percentile) of the data distribution (if the number of samples is four or fewer, the line is not displayed). Thus, each box indicates concentration values for the central half of the data, and concentration shifts can readily be assessed by comparing the boxes. If most of the data are represented by a single concentration value (usually the detection limit), the box is reduced to a single line.

A trio of box plots is presented for each analyte. First the data are presented by sampling location, where the two surface water (SW) sampling locations are presented as one data group. The alluvial groundwater is represented by samples collected in two wells (LAUZ-1 and LAUZ-2). The location plot also shows sample data for DP Spring (DP Spr). A second box plot shows the difference between filtered and unfiltered sample results (note that both filtered and unfiltered are presented in the location box plot). Lastly, the temporal variation is shown in a box plot that displays the data by the month collected. The main evidence used to assess whether a analyte should be retained as a COPC is the pattern of sample results noted by location. Organic chemicals detected in alluvial groundwater or DP Spring are retained as COPCs.

In these box plots, a different symbol is used for the laboratory results for each sampling location, and the symbols are used consistently in each box plot in this section. DP Spring data are represented by an inverted triangle, LAUZ-1 data by a square, LAUZ-2 data by a diamond, and surface water data by a triangle. Also note that nondetected sample results are plotted as the detection limit value and the symbol is shaded in a light gray pattern.

E-7.2 Results

The results of the statistical evaluation are presented for each analyte.

E-7.2.1 Acetone

Figure E-7.2-1a shows the variation in concentration by sample location; the plot shows that acetone was detected in a single surface water sample. Volatile organic chemicals, like acetone, are only analyzed from unfiltered samples, which means that Figure E-7.2-1b shows only a single data group. Lastly, because there is only a single detected acetone sample result, Figure E-7.2-1c shows little evidence for temporal variation in acetone concentrations. Acetone is not retained as a COPC in water based on the lack of detection in alluvial groundwater or DP Spring samples.

E-7.2.2 Benzo(b)fluoranthene

Figure E-7.2-2a shows the variation in concentration by sample location; the plot shows that benzo(b)fluoranthene was only detected in surface water samples. Figure E-7.2-2b shows that the detected results were in unfiltered samples. Lastly, because there are only three detected benzo(b)fluoranthene sample results, Figure E-7.2-2c shows little evidence for temporal variation in benzo(b)fluoranthene concentrations. Benzo(b)fluoranthene is not retained as a COPC in water based on the lack of detection in alluvial groundwater or DP Spring samples.

E-7.2.3 Benzoic Acid

Figure E-7.2-3a shows the variation in concentration by sample location; the plot shows that benzoic acid was detected in a single surface water sample. Figure E-7.2-3b shows that the detected result was in a filtered sample. Lastly, because there was only a single detected benzoic acid sample result, Figure E-7.2-3c shows little evidence for temporal variation in benzoic acid concentrations. Benzoic acid is not retained as a COPC in water based on the lack of detection in alluvial groundwater or DP Spring samples.

E-7.2.4 Bis(2-ethylhexyl)phthalate

Figure E-7.2-4a shows the variation in concentration by sample location; the plot shows that bis(2-ethylhexyl)phthalate was detected in surface water and alluvial groundwater samples. Figure E-7.2-4b shows that the detected results were in both unfiltered and filtered samples. Figure E-7.2-4c shows little evidence for temporal variation in bis(2-ethylhexyl)phthalate concentrations. Bis(2-ethylhexyl)phthalate is retained as a COPC in water based on its detection in alluvial groundwater samples.

E-7.2.5 2-Butanone

Figure E-7.2-5a shows the variation in concentration by sample location; the plot shows that 2-butanone was only detected in surface water samples. Volatile organic chemicals, like 2-butanone, are only analyzed from unfiltered samples, which means that Figure E-7.2-5b shows only a single data group. Lastly, because there are only two detected 2-butanone sample results, Figure E-7.2-5c shows little evidence for temporal variation in 2-butanone concentrations (symbols overlap). Butanone[2-] is not retained as a COPC in water based on the lack of detection in alluvial groundwater or DP Spring samples.

E-7.2.6 Chrysene

Figure E-7.2-6a shows the variation in concentration by sample location; the plot shows that chrysene was detected in a single surface water sample. Figure E-7.2-6b shows that the detected result was in an unfiltered sample. Lastly, because there was only a single detected chrysene sample result, Figure E-7.2-3c shows little evidence for temporal variation in chrysene concentrations. Chrysene is not retained as a COPC in water based on the lack of detection in alluvial groundwater or DP Spring samples.

E-7.2.7 Di-n-butylphthalate

Figure E-7.2-7a shows the variation in concentration by sample location; the plot shows that di-n-butylphthalate was detected in a single surface water sample. Figure E-7.2-7b shows that the detected result was in an unfiltered sample. Lastly, because there was only a single detected di-n-butylphthalate sample result, Figure E-7.2-7c shows little evidence for temporal variation in di-n-butylphthalate

concentrations. Di-n-butylphthalate is not retained as a COPC in water based on the lack of detection in alluvial groundwater or DP Spring samples.

E-7.2.8 Di-n-octylphthalate

Figure E-7.2-8a shows the variation in concentration by sample location; the plot shows that di-n-octylphthalate was detected in three surface water samples (symbols overlap). Figure E-7.2-8b shows that the detected results were in unfiltered samples. Figure E-7.2-8c shows that all of the detected di-n-octylphthalate sample results were from the August 1997 sampling event. Di-n-octylphthalate is not retained as a COPC in water based on the lack of detection in alluvial groundwater or DP Spring samples.

E-7.2.9 1,2-Dichloroethane

Figure E-7.2-9a shows the variation in concentration by sample location; the plot shows that 1,2-dichloroethane was detected in a single DP Spring sample. Volatile organic chemicals, like 1,2-dichloroethane, are measured only in unfiltered samples, which means that Figure E-7.2-9b shows only a single data group. Lastly, because there is only a single detected 1,2-dichloroethane sample result, Figure E-7.2-9c shows little evidence for temporal variation in 1,2-dichloroethane concentrations. It is worth noting that the detection of 1,2-dichloroethane in DP Spring led to an additional resampling of the DP Spring for volatile organic chemicals, which did not detect 1,2-dichloroethane. Dichloroethane[1,2-] is retained as a COPC in water based on its detection in a single DP Spring sample.

E-7.2.10 Fluoranthene

Figure E-7.2-10a shows the variation in concentration by sample location; the plot shows that fluoranthene was detected in two surface water samples. Figure E-7.2-10b shows that the detected results were in unfiltered samples. Figure E-7.2-10c shows that both of the detected fluoranthene sample results were from the August 1997 sampling event. Fluoranthene is not retained as a COPC in water based on the lack of detection in alluvial groundwater or DP Spring samples.

E-7.2.11 Phenanthrene

Figure E-7.2-11a shows the variation in concentration by sample location; the plot shows that phenanthrene was detected in a single surface water sample. Figure E-7.2-11b shows that the detected result was in an unfiltered sample. Figure E-7.2-11c shows that the detected phenanthrene sample result was from the August 1997 sampling event. Phenanthrene is not retained as a COPC in water based on the lack of detection in alluvial groundwater or DP Spring samples.

E-7.2.12 Pyrene

Figure E-7.2-12a shows the variation in concentration by sample location; the plot shows that pyrene was detected in three surface water samples. Figure E-7.2-12b shows that the detected results were in unfiltered samples. Figure E-7.2-12c shows that the detected pyrene sample results were from the August 1997 sampling event. Pyrene is not retained as a COPC in water based on the lack of detection in alluvial groundwater or DP Spring samples.

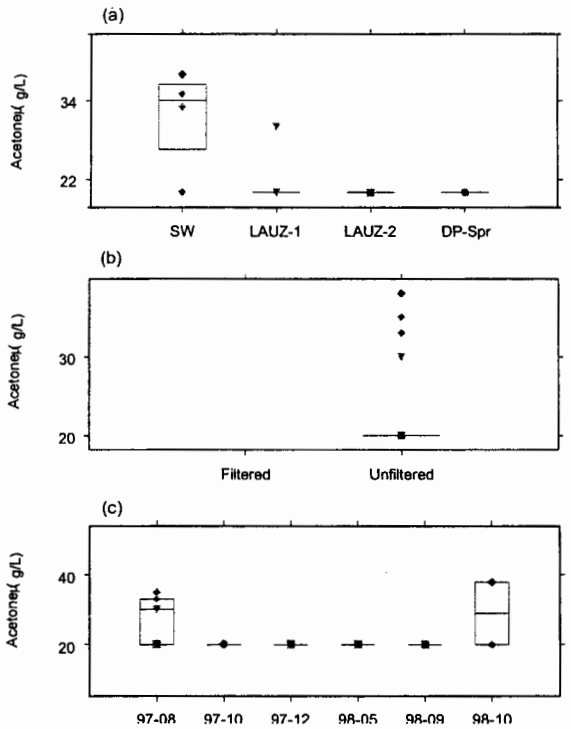


Figure E-7.2-1. Acetone concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

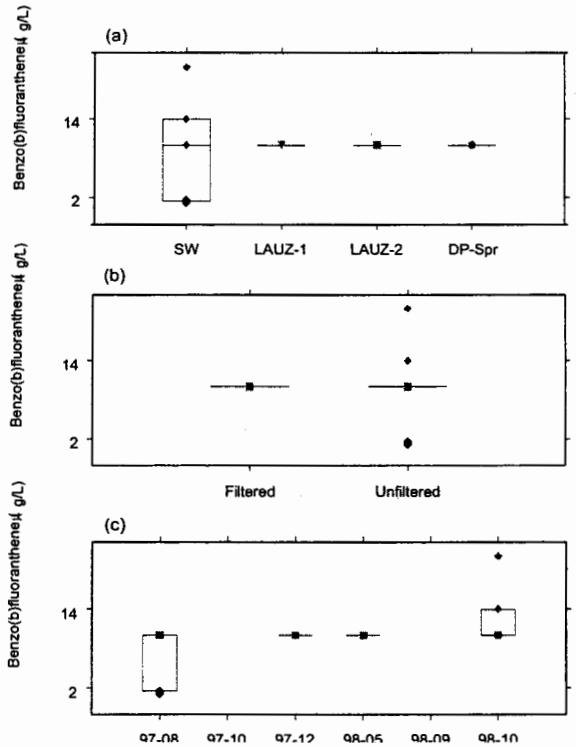


Figure E-7.2-2. Benzo(b)fluoranthene concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

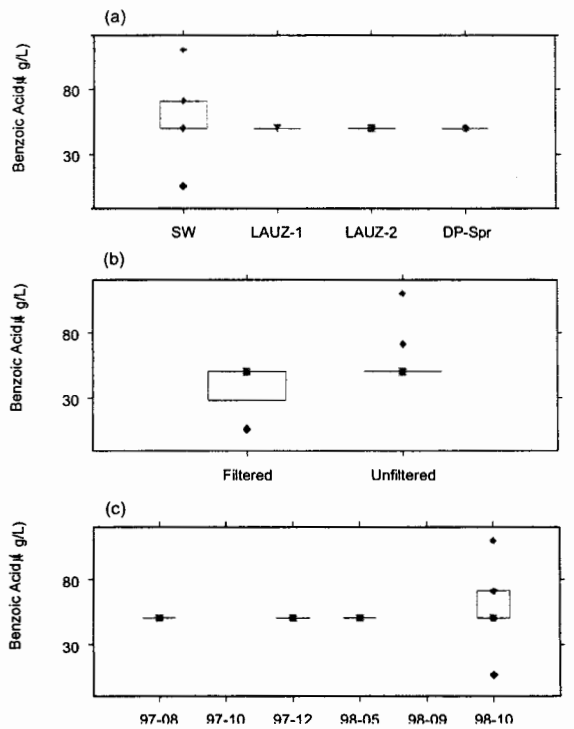


Figure E-7.2-3. Benzoic acid concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

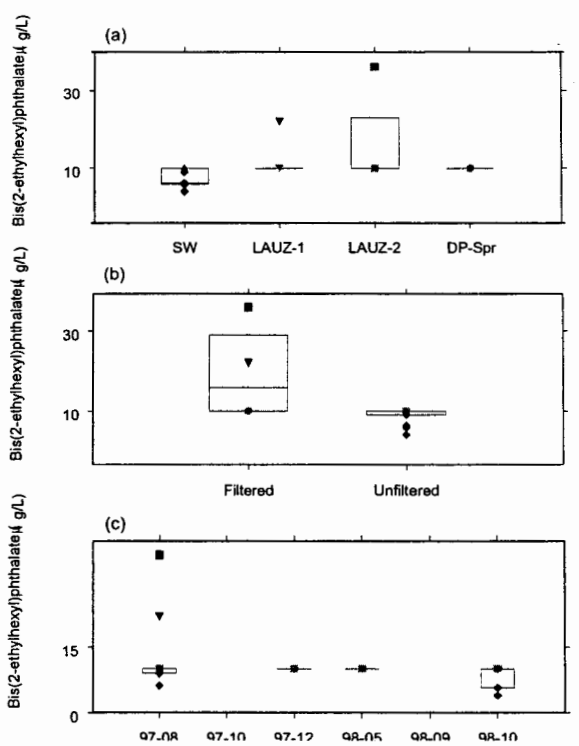


Figure E-7.2-4. Bis(2-ethylhexyl)phthalate concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

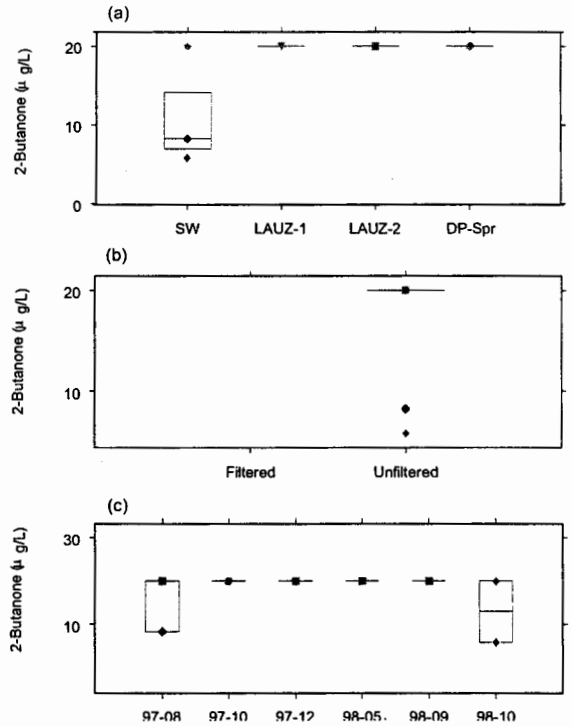


Figure E-7.2-5. 2-Butanone concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

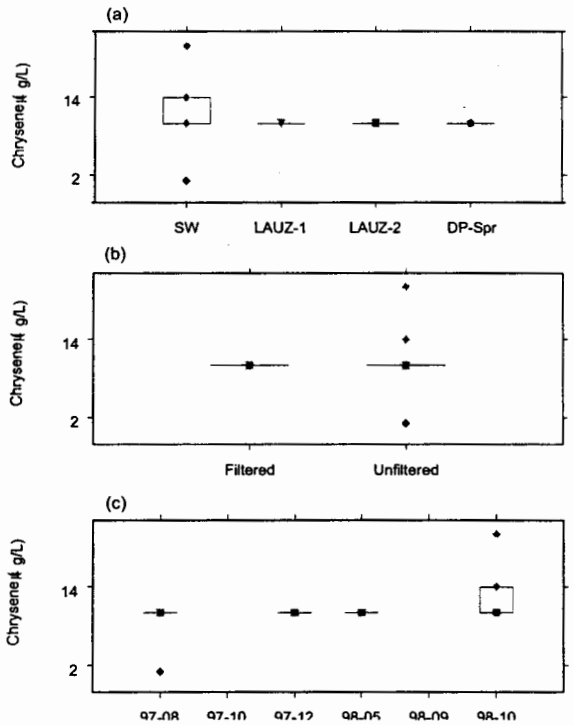


Figure E-7.2-6. Chrysene concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

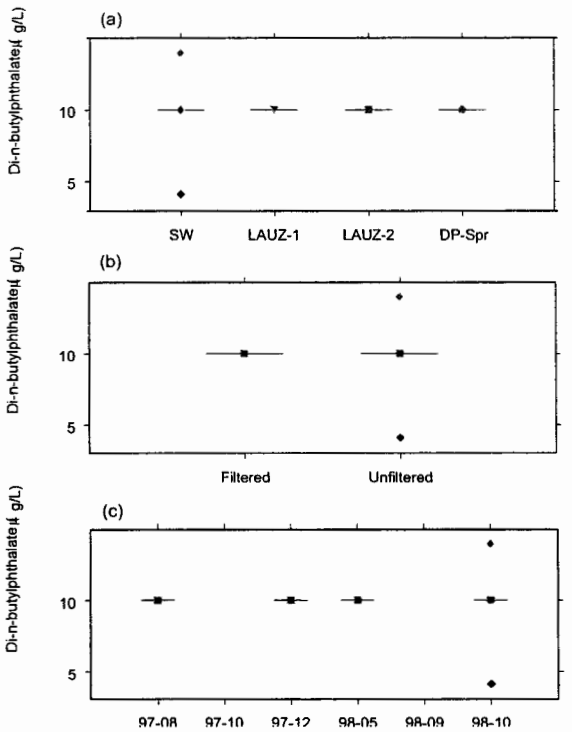


Figure E-7.2-7. Di-n-butylphthalate concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

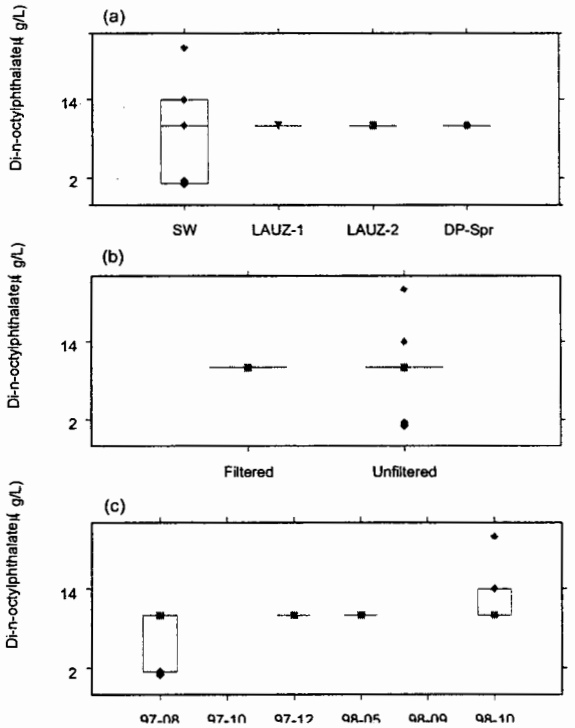


Figure E-7.2-8. Di-n-octylphthalate concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

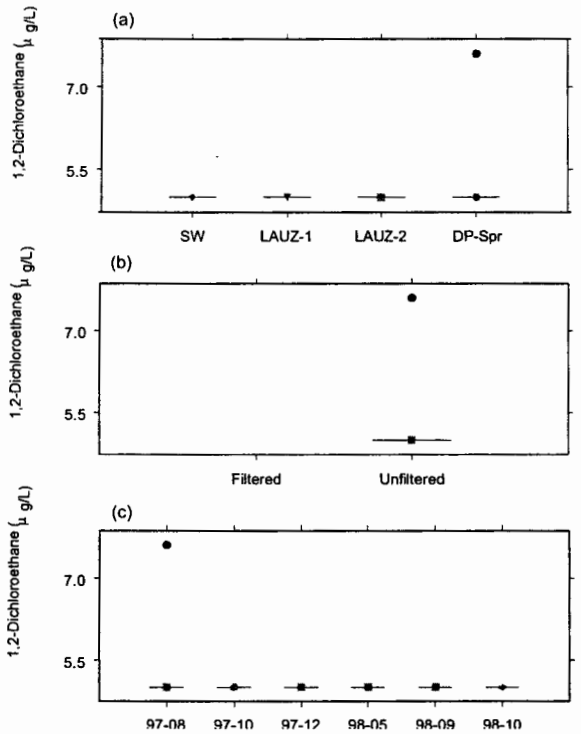


Figure E-7.2-9. 1,2-Dichloroethane concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

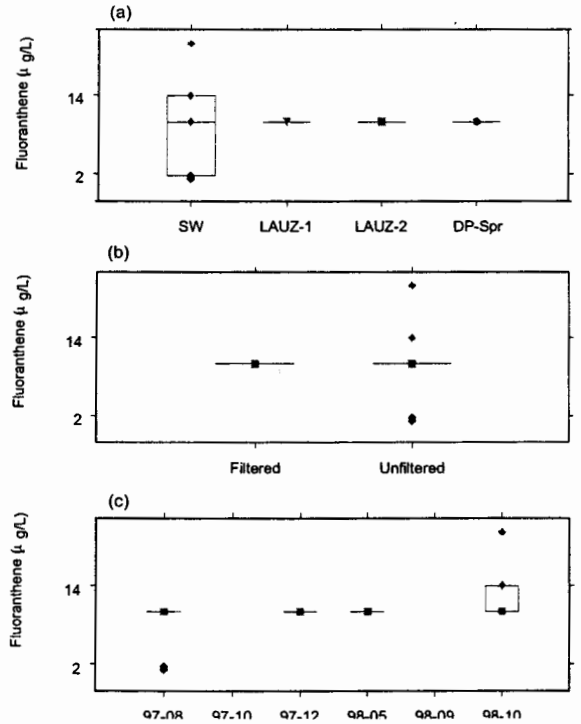


Figure E-7.2-10. Fluoranthene concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

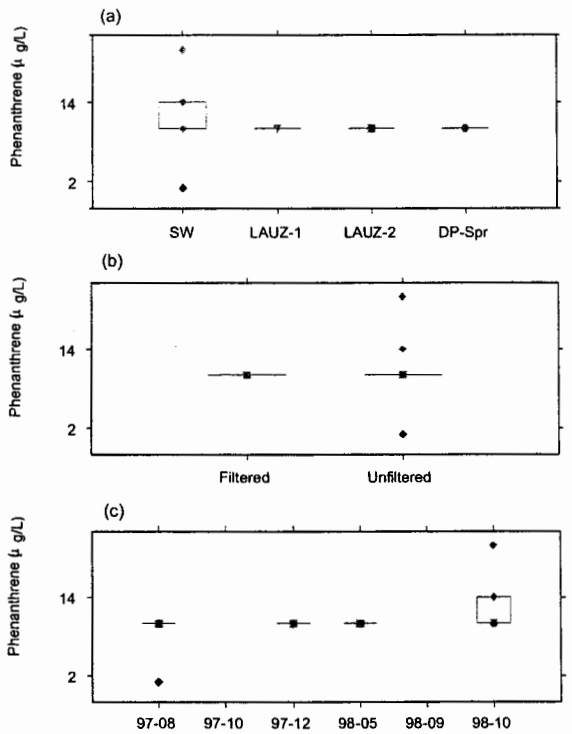


Figure E-7.2-11. Phenanthrene concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

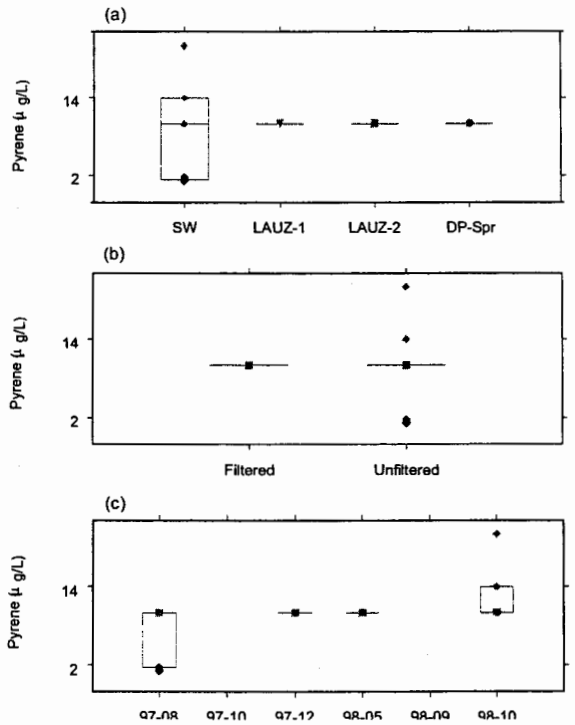


Figure E-7.2-12. Pyrene concentrations in water by (a) sample location; (b) sample preparation; and (c) sample date

E-8.0 ANALYSIS OF SELECTED COPCs IN WATER QA SAMPLES

An important aspect of the uncertainty associated with determining either time trends or risk resulting from contaminants in DP Canyon alluvial groundwater is the repeatability of replicated field samples. Some water samples were also filtered, which can be evaluated as field duplicates to determine the effect (if any) of filtering on the concentration of various analytes. Because of the infrequent detection of all organic chemicals and some of the inorganic chemicals and radionuclides, these infrequently detected analytes are excluded from this analysis.

The figures and tables for this section are placed at the end of the section; the figures appear first, then the tables.

Table E-8.0-1 provides the field duplicate (FD) sample results for selected inorganic chemicals and radionuclides. Nondetect sample results are excluded from this analysis as they do not provide a meaningful estimate of variability in detected sample results. Figure E-8.0-1 shows the first sample result for these FD samples plotted as the x-axis variable and the second result plotted as the y-axis variable. The line of equality (y = x) is also plotted as a point of reference. In general, the FD samples for inorganic chemicals showed little variation from the original sample result (variability of inorganic FD values was ±10% [based on standard deviation of relative difference values]). The radionuclide FD sample results were more variable than the inorganics (variability of radionuclide FD values was ±55% [based on standard deviation of relative difference values]). Variability in the radionuclide sample results is attributed to the results for plutonium-239,240 and isotopic uranium. In contrast, the pair of strontium-90 FD sample results had small relative difference values, and these values were within the variability of inorganic FD results. As noted in Appendix C, a review of the strontium-90 sample results led to switching the laboratory-reported sample results for sample IDs 0121-97-1429 and 0121-97-1430. The basis for switching these results is the time series for sample data for alluvial wells LAUZ-1 and LAUZ-2. This switch in strontium-90 sample results has a large impact on the variability of strontium-90 FD sample results.

Table E-8.0-2 provides the comparison between filtered and unfiltered results for selected inorganic chemicals collected from surface water samples. Nondetect sample results are excluded from this analysis as they do not provide a meaningful estimate of variability in detected sample results. Table E-8.0-3 provides the comparison between filtered and unfiltered results for selected inorganic chemicals and radionuclides collected from alluvial groundwater or DP Spring water samples. Nondetect sample results are excluded from this analysis as they do not provide a meaningful estimate of variability in detected sample results. These data are plotted in Figure E-8.0-2, which shows the unfiltered sample result plotted as the x-axis variable and the filtered result plotted as the y-axis variable. The line of equality (y = x) is also plotted as a point of reference. It is expected that values above the line of equality are impossible because this would suggest a greater quantity of the analyte in the filtered sample. With one exception, for plutonium-239,240 at the lower range of detection, there are no values above the line of equality. All of the inorganic chemicals measured in surface water show a large difference between the filtered and unfiltered sample results (average relative difference is –99% for values in Table E-8.0-2). For samples collected in alluvial groundwater or DP Spring, some analytes show a large difference and others seem to be equivalent to FD sample variability. Overall, the inorganic chemicals are variable (variability of inorganic filtered and unfiltered values was ±41% [based on standard deviation of relative difference values]); variability is small if aluminum, iron, and zinc are excluded (variability of calcium, magnesium, manganese, potassium and sodium filtered and unfiltered values was ±17% [based on standard deviation of relative difference values]). Variability of filtered and unfiltered differs between the radionuclides. Strontium-90 is the lowest (variability of strontium-90 filtered and unfiltered values was ±8% [based on standard deviation of relative difference values]); uranium-234 is intermediate (variability of

uranium-234 filtered and unfiltered values was ±15% [based on standard deviation of relative difference values]); and plutonium-239,240 is the largest (variability of plutonium-239,240 filtered-unfiltered values was ±70% [based on standard deviation of relative difference values]). Variation between the filtered and unfiltered fractions provides information on the mode of transport for various analytes; analytes with large differences between these values are moving associated with large particles that are removed by filtering samples. The close agreement of filtered and unfiltered values for some analytes suggests that these samples should be regarded in the same manner as FD sample results. Thus, statistical analysis should not use the filtered and unfiltered values for those analytes as independent samples results to avoid biasing the number of samples in calculations like the 95% upper confidence levels of the mean. Where there are large differences between the filtered and unfiltered values, these data should be regarded as separate populations for statistical purposes.

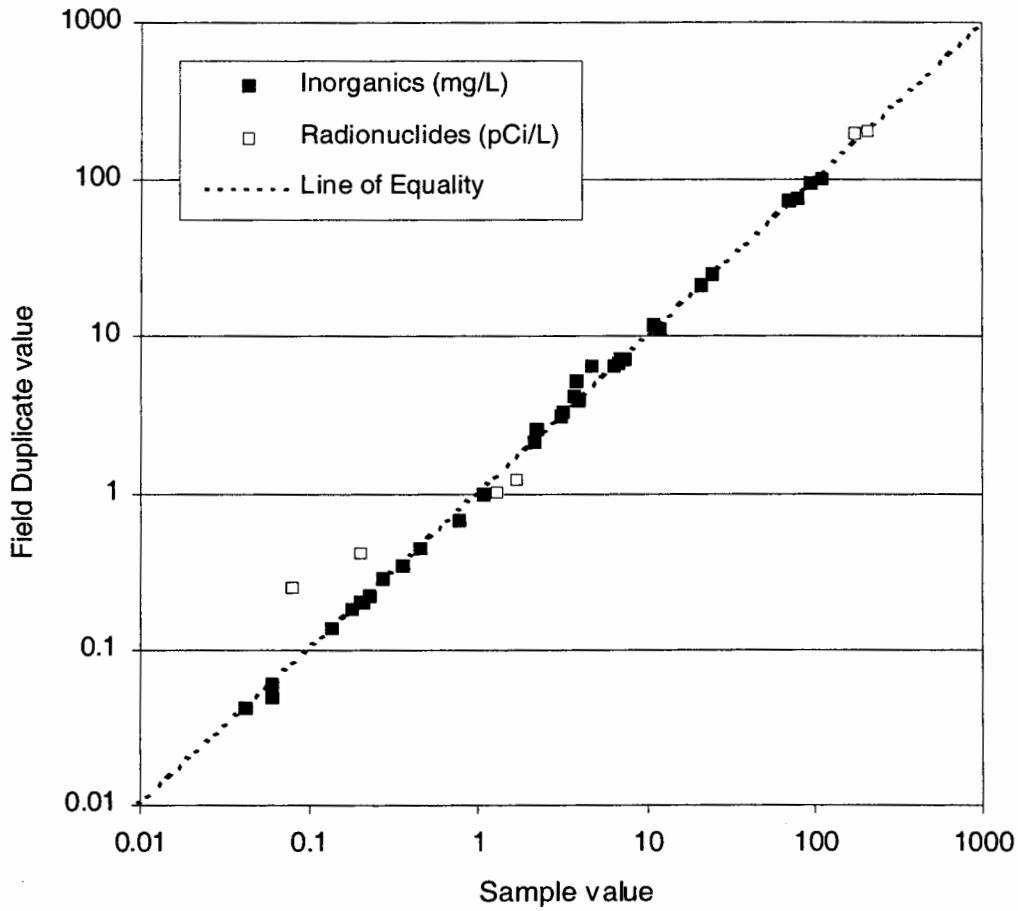


Figure E-8.0-1. Evaluation of field duplicate water samples

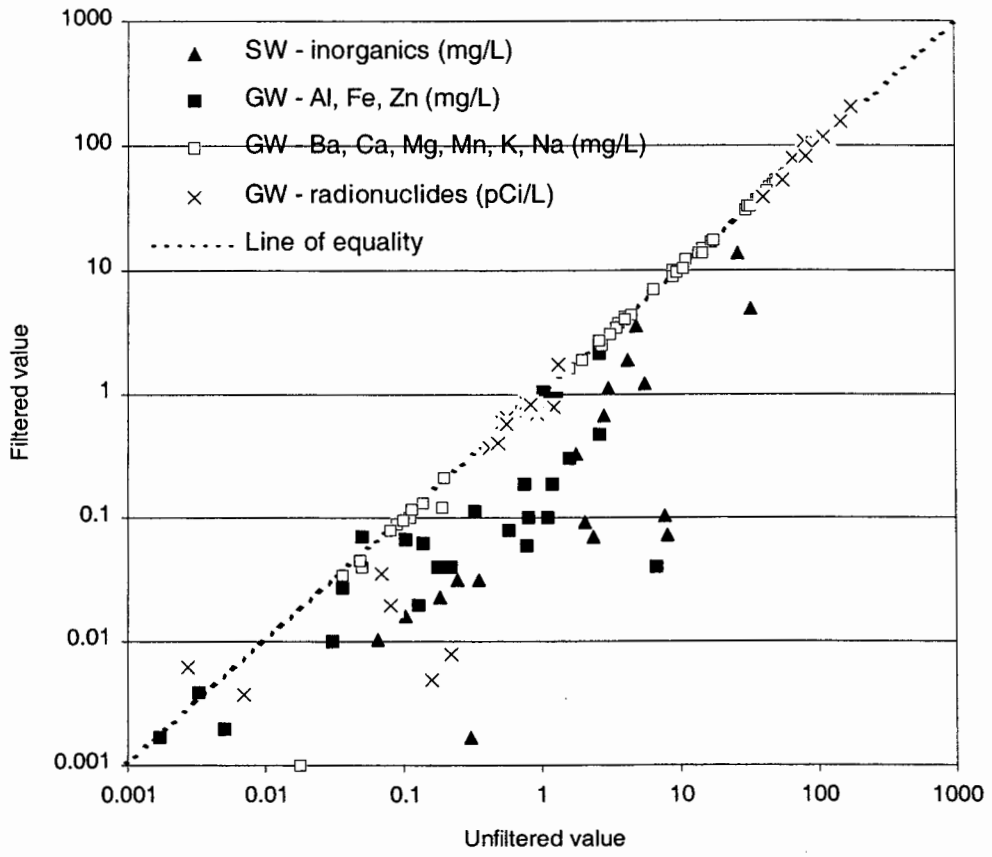


Figure E-8.0-2. Comparison of filtered and unfiltered sample results

Table E-8.0-1
Summary of Water Field Duplicate QA Results

Analyte	Original Sample ID	Related Sample ID	Sample Result (mg/L)[a]	FD Result (mg/L)[a]	Relative Difference[b]
Aluminum	0121-97-1424	0121-97-1426	1.1	1	7%
Aluminum	0121-97-1381	0121-97-1382	3.25	3.31	-1%
Aluminum	0121-97-1383	0121-97-1384	4.75	6.48	-22%
Barium	0121-97-1424	0121-97-1426	0.2	0.2	0%
Barium	0121-97-1428	0121-97-1430	0.21	0.2	3%
Barium	0121-97-1381	0121-97-1382	0.138	0.137	1%
Barium	0121-97-1383	0121-97-1384	0.18	0.183	-1%
Calcium	0121-97-1424	0121-97-1426	95	95	0%
Calcium	0121-97-1428	0121-97-1430	110	100	7%
Calcium	0121-97-1381	0121-97-1382	24.9	24.5	1%
Calcium	0121-97-1383	0121-97-1384	21.4	21.2	1%
Iron	0121-97-1424	0121-97-1426	0.78	0.68	10%
Iron	0121-97-1428	0121-97-1430	0.06	0.05	13%
Iron	0121-97-1381	0121-97-1382	3.13	3.15	0%
Iron	0121-97-1383	0121-97-1384	3.86	5.12	-20%
Lead	0121-97-1381	0121-97-1382	0.0426	0.0421	1%
Lead	0121-97-1383	0121-97-1384	0.0602	0.0598	0%
Magnesium	0121-97-1424	0121-97-1426	6.4	6.5	-1%
Magnesium	0121-97-1428	0121-97-1430	6.9	6.6	3%
Magnesium	0121-97-1381	0121-97-1382	2.16	2.13	1%
Magnesium	0121-97-1383	0121-97-1384	2.26	2.58	-9%
Manganese	0121-97-1381	0121-97-1382	0.226	0.222	1%
Manganese	0121-97-1383	0121-97-1384	0.45	0.447	0%
Potassium	0121-97-1424	0121-97-1426	11	12	-6%
Potassium	0121-97-1428	0121-97-1430	12	11	6%
Potassium	0121-97-1381	0121-97-1382	3.93	3.9	1%
Potassium	0121-97-1383	0121-97-1384	3.68	4.1	-8%
Sodium	0121-97-1424	0121-97-1426	71	74	-3%
Sodium	0121-97-1428	0121-97-1430	81	76	5%
Sodium	0121-97-1381	0121-97-1382	7.34	7.21	1%
Sodium	0121-97-1383	0121-97-1384	7.02	7.2	-2%
Zinc	0121-97-1381	0121-97-1382	0.353	0.347	1%
Zinc	0121-97-1383	0121-97-1384	0.276	0.282	-2%
Plutonium-239,240	0121-97-1424	0121-97-1426	0.08	0.25	-73%
Strontium-90	0121-97-1424	0121-97-1426	176.47	195.72	-7%
Strontium-90	0121-97-1428	0121-97-1430	207.83	204.78	1%
Uranium-234	0121-97-1424	0121-97-1426	1.32	1.02	18%
Uranium-234	0121-97-1428	0121-97-1430	1.73	1.25	23%
Uranium-238	0121-97-1428	0121-97-1430	0.2	0.42	-50%

[a] Radionuclide results are in units of pCi/L.

[b] Relative difference = relative percent difference between the two results.

Table E-8.0-2
Summary of Selected Surface Water Filter-Unfiltered Sample Results

Sample ID	Related Sample ID	Analyte	Filtered Sample Result (mg/L)	Unfiltered Sample Result (mg/L)	Relative Difference*
CA21-98-0014	CA21-98-0013	Aluminum	0.0711	2.34	-133%
CA21-98-0016	CA21-98-0015	Aluminum	0.0742	8.1	-139%
CA21-98-0014	CA21-98-0013	Barium	0.0104	0.0648	-102%
CA21-98-0016	CA21-98-0015	Barium	0.0231	0.185	-110%
CA21-98-0014	CA21-98-0013	Calcium	4.97	33.3	-105%
CA21-98-0016	CA21-98-0015	Calcium	13.8	26.4	-44%
CA21-98-0014	CA21-98-0013	Iron	0.092	2.06	-129%
CA21-98-0016	CA21-98-0015	Iron	0.105	7.76	-138%
CA21-98-0014	CA21-98-0013	Magnesium	0.328	1.76	-97%
CA21-98-0016	CA21-98-0015	Magnesium	0.671	2.8	-87%
CA21-98-0014	CA21-98-0013	Manganese	0.0158	0.102	-103%
CA21-98-0016	CA21-98-0015	Manganese	0.0017	0.309	-140%
CA21-98-0014	CA21-98-0013	Potassium	1.13	3.03	-65%
CA21-98-0016	CA21-98-0015	Potassium	1.88	4.29	-55%
CA21-98-0014	CA21-98-0013	Sodium	1.23	5.58	-90%
CA21-98-0016	CA21-98-0015	Sodium	3.52	4.9	-23%
CA21-98-0014	CA21-98-0013	Zinc	0.0321	0.245	-109%
CA21-98-0016	CA21-98-0015	Zinc	0.0311	0.358	-119%

*Relative difference = relative percent difference between the two results.

Table E-8.0-3
Summary of Selected Surface Water and DP Spring Filtered-Unfiltered Sample Results

Sample ID	Related Sample ID	Analyte	Filtered Sample Result (mg/L)[a]	Unfiltered Sample Result (mg/L)[a]	Relative Difference[b]
0121-97-1397	0121-97-1396	Aluminum	0.1	0.8	-110%
0121-97-1428	0121-97-1424	Aluminum	0.1	1.1	-118%
CA21-98-0002	CA21-98-0001	Aluminum	0.3	1.6	-97%
0121-97-1399	0121-97-1398	Aluminum	0.1	1.1	-118%
0121-97-1401	0121-97-1400	Aluminum	2.1	2.6	-15%
CA21-98-0008	CA21-98-0007	Aluminum	0.0628	0.137	-53%
CA21-98-0010	CA21-98-0009	Aluminum	0.0271	0.0366	-21%
CA21-98-0012	CA21-98-0011	Aluminum	0.186	0.751	-85%
0121-97-1397	0121-97-1396	Iron	0.04	0.22	-98%
0121-97-1428	0121-97-1424	Iron	0.06	0.78	-121%
CA21-98-0002	CA21-98-0001	Iron	0.19	1.2	-103%
0121-97-1399	0121-97-1398	Iron	0.04	6.7	-140%
0121-97-1429	0121-97-1425	Iron	0.08	0.58	-107%
CA21-98-0004	CA21-98-0003	Iron	0.47	2.6	-98%
0121-97-1401	0121-97-1400	Iron	0.94	1.3	-23%
CA21-98-0006	CA21-98-0005	Iron	0.04	0.18	-90%
CA21-98-0008	CA21-98-0007	Iron	0.068	0.103	-29%
CA21-98-0010	CA21-98-0009	Iron	1.05	1.05	0%
CA21-98-0012	CA21-98-0011	Iron	0.114	0.326	-68%
0121-97-1397	0121-97-1396	Zinc	0.02	0.13	-104%
0121-97-1399	0121-97-1398	Zinc	0.01	0.03	-71%
0121-97-1401	0121-97-1400	Zinc	0.07	0.05	24%
CA21-98-0008	CA21-98-0007	Zinc	0.0039	0.0033	12%
CA21-98-0010	CA21-98-0009	Zinc	0.0017	0.0017	0%
CA21-98-0012	CA21-98-0011	Zinc	0.002	0.0051	-62%
0121-97-1397	0121-97-1396	Barium	0.09	0.09	0%
0121-97-1428	0121-97-1424	Barium	0.21	0.2	3%
CA21-98-0002	CA21-98-0001	Barium	0.13	0.14	-5%
0121-97-1399	0121-97-1398	Barium	0.12	0.19	-32%
0121-97-1429	0121-97-1425	Barium	0.1	0.11	-7%
CA21-98-0004	CA21-98-0003	Barium	0.13	0.14	-5%
0121-97-1401	0121-97-1400	Barium	0.04	0.05	-16%
CA21-98-0006	CA21-98-0005	Barium	0.08	0.08	0%
CA21-98-0008	CA21-98-0007	Barium	0.0978	0.1	-2%
CA21-98-0010	CA21-98-0009	Barium	0.115	0.116	-1%
CA21-98-0012	CA21-98-0011	Barium	0.0444	0.049	-7%
0121-97-1397	0121-97-1396	Calcium	38	42	-7%
0121-97-1428	0121-97-1424	Calcium	110	95	10%
CA21-98-0002	CA21-98-0001	Calcium	47	46	2%

Table E-8.0-3 (continued)

Sample ID	Related Sample ID	Analyte	Filtered Sample Result (mg/L)[a]	Unfiltered Sample Result (mg/L)[a]	Relative Difference[b]
0121-97-1399	0121-97-1398	Calcium	42	45	-5%
0121-97-1429	0121-97-1425	Calcium	52	50	3%
CA21-98-0004	CA21-98-0003	Calcium	58	59	-1%
0121-97-1401	0121-97-1400	Calcium	15	15	0%
CA21-98-0006	CA21-98-0005	Calcium	30	30	0%
CA21-98-0008	CA21-98-0007	Calcium	36.7	36.4	1%
CA21-98-0010	CA21-98-0009	Calcium	51.5	52.4	-1%
CA21-98-0012	CA21-98-0011	Calcium	17.7	17.8	0%
0121-97-1397	0121-97-1396	Magnesium	2.5	2.7	-5%
0121-97-1428	0121-97-1424	Magnesium	6.9	6.4	5%
CA21-98-0002	CA21-98-0001	Magnesium	3.7	3.7	0%
0121-97-1399	0121-97-1398	Magnesium	3.4	3.5	-2%
0121-97-1429	0121-97-1425	Magnesium	4.2	4	3%
CA21-98-0004	CA21-98-0003	Magnesium	4.4	4.5	-2%
0121-97-1401	0121-97-1400	Magnesium	1.6	1.6	0%
CA21-98-0006	CA21-98-0005	Magnesium	3.1	3.2	-2%
CA21-98-0008	CA21-98-0007	Magnesium	2.65	2.67	-1%
CA21-98-0010	CA21-98-0009	Magnesium	4.08	4.11	-1%
CA21-98-0012	CA21-98-0011	Magnesium	1.92	1.96	-1%
0121-97-1399	0121-97-1398	Manganese	0.72	0.79	-7%
0121-97-1429	0121-97-1425	Manganese	0.83	0.87	-3%
CA21-98-0004	CA21-98-0003	Manganese	0.76	0.87	-10%
CA21-98-0008	CA21-98-0007	Manganese	0.0339	0.0371	-6%
CA21-98-0010	CA21-98-0009	Manganese	0.726	0.729	0%
CA21-98-0012	CA21-98-0011	Manganese	0.001	0.0176	-126%
0121-97-1397	0121-97-1396	Potassium	9	9	0%
0121-97-1428	0121-97-1424	Potassium	12	11	6%
CA21-98-0002	CA21-98-0001	Potassium	10	9	7%
0121-97-1399	0121-97-1398	Potassium	17	17	0%
0121-97-1429	0121-97-1425	Potassium	14	14	0%
CA21-98-0004	CA21-98-0003	Potassium	14	14	0%
0121-97-1401	0121-97-1400	Potassium	9	9	0%
CA21-98-0006	CA21-98-0005	Potassium	14	15	-5%
CA21-98-0008	CA21-98-0007	Potassium	9.6	9.74	-1%
CA21-98-0010	CA21-98-0009	Potassium	17.7	17.7	0%
CA21-98-0012	CA21-98-0011	Potassium	10.4	10.6	-1%
0121-97-1397	0121-97-1396	Sodium	49	49	0%
0121-97-1428	0121-97-1424	Sodium	81	71	9%
CA21-98-0002	CA21-98-0001	Sodium	110	100	7%
0121-97-1399	0121-97-1398	Sodium	49	50	-1%
0121-97-1429	0121-97-1425	Sodium	59	61	-2%

Table E-8.0-3 (continued)

Sample ID	Related Sample ID	Analyte	Filtered Sample Result (mg/L)[a]	Unfiltered Sample Result (mg/L)[a]	Relative Difference[b]
CA21-98-0004	CA21-98-0003	Sodium	84	84	0%
0121-97-1401	0121-97-1400	Sodium	33	32	2%
CA21-98-0006	CA21-98-0005	Sodium	50	54	-5%
CA21-98-0008	CA21-98-0007	Sodium	37.8	38.3	-1%
CA21-98-0010	CA21-98-0009	Sodium	43.9	43.6	0%
CA21-98-0012	CA21-98-0011	Sodium	33	33.2	0%
0121-97-1428	0121-97-1424	Plutonium-239,240	0.02	0.08	-85%
CA21-98-0002	CA21-98-0001	Plutonium-239,240	0.008	0.223	-132%
0121-97-1399	0121-97-1398	Plutonium-239,240	0.0048	0.16	-133%
CA21-98-0004	CA21-98-0003	Plutonium-239,240	0.0061	0.0027	55%
0121-97-1401	0121-97-1400	Plutonium-239,240	0.035	0.071	-48%
CA21-98-0006	CA21-98-0005	Plutonium-239,240	0.0037	0.007	-44%
0121-97-1397	0121-97-1396	Strontium-90	100	105	-3%
0121-97-1428	0121-97-1424	Strontium-90	207.83	176.47	12%
CA21-98-0002	CA21-98-0001	Strontium-90	153	151	1%
0121-97-1399	0121-97-1398	Strontium-90	108	81	20%
0121-97-1429	0121-97-1425	Strontium-90	77.99	68.51	9%
CA21-98-0004	CA21-98-0003	Strontium-90	103	100	2%
0121-97-1401	0121-97-1400	Strontium-90	38.9	40.7	-3%
CA21-98-0006	CA21-98-0005	Strontium-90	119	111	5%
CA21-98-0008	CA21-98-0007	Strontium-90	96	92	3%
CA21-98-0010	CA21-98-0009	Strontium-90	81	85	-3%
CA21-98-0012	CA21-98-0011	Strontium-90	54	57	-4%
0121-97-1397	0121-97-1396	Uranium-234	0.779	1.23	-32%
0121-97-1428	0121-97-1424	Uranium-234	1.73	1.32	19%
CA21-98-0002	CA21-98-0001	Uranium-234	0.523	0.545	-3%
0121-97-1399	0121-97-1398	Uranium-234	0.687	0.93	-21%
0121-97-1429	0121-97-1425	Uranium-234	0.84	0.78	5%
CA21-98-0004	CA21-98-0003	Uranium-234	0.595	0.526	9%
0121-97-1401	0121-97-1400	Uranium-234	0.636	0.561	9%
CA21-98-0006	CA21-98-0005	Uranium-234	0.373	0.415	-8%
CA21-98-0008	CA21-98-0007	Uranium-234	0.825	0.835	-1%
CA21-98-0010	CA21-98-0009	Uranium-234	0.403	0.49	-14%
CA21-98-0012	CA21-98-0011	Uranium-234	0.574	0.557	2%

[a] Radionuclide results are in units of pCi/L.

[b] Relative difference = relative percent difference between the two results.

Appendix F

Site Assessment Supporting Information

This appendix contains the information that supports the site assessments presented in Chapter 5; the ecological scoping checklist (Section F-1.0); the average concentrations used in the hazard quotient/hazard index, or HQ/HI analysis (Section F-2.0); the receptor-specific results of the HQ/HI analysis (Section F-3.0); and plots that show the estimated dose and risk to the resource user and construction worker (Section F-4.0).

F-1.0 ECOLOGICAL SCOPING CHECKLIST

The scoping checklist is a useful tool for organizing existing ecological information and for focusing the site visit on the information needed to develop the site conceptual model (SCM). The scoping checklist also provides the basis for evaluating the adequacy of the data for ecological risk screening.

F-1.1 Part A–Scoping Meeting Documentation

Site ID	DP Canyon reaches
Nature of PRS releases **(indicate all that apply)**	**Solid** – Yes (see the Sampling Plan for DP Canyon C-0-021 [LANL 1998, 57595]) **Liquid** – Yes (see the Sampling Plan for DP Canyon C-0-021 [LANL 1998, 57595]) **Gaseous** – No **Other, explain**
List of Primary Impacted Media **(indicate all that apply)**	**Surface soil** – Active channel, floodplains **Surface water/sediment** – Yes **Subsurface** – Yes, associated with alluvial groundwater **Groundwater** – Alluvial aquifer **Other, explain**
FIMAD vegetation class **(indicate all that apply)**	**Water** – No **Bare Ground/Unvegetated** – No **Spruce/fir/aspen/mixed conifer** – No **Ponderosa pine** – Yes **Piñon juniper/juniper savannah** – Yes **Grassland/shrubland** – No **Developed** – No
Is T&E habitat present? **(list species if applicable)**	Yes DP Canyon provides a potential foraging habitat for the peregrine falcon and the Mexican spotted owl.
Provide list and description of neighboring/ contiguous/ upgradient PRSs **(consider need to aggregate PRS for screening)**	Significant potential release sites (PRSs) include • PRS 21-029 – DP Tank Farm • PRS 21-011(k) – Outfall • Material Disposal Area (MDA) T • MDA U
SOP 2.01Part B Information **Run-off score (out of 46)** **Terminal point of surface water transport**	This section does not apply because the site is not a PRS.
Other Scoping Meeting Notes	None

F-1.2 Part B—Site Visit Documentation

F-1.2.1 Reach DP-1 West

Site ID	Reach DP-1 West
Date of Site Visit	11/4/98, 5/14/99
Site Visit Conducted by	R. Ryti, M. Tardiff, S. Reneau (11/4/98); R. Ryti, M. Tardiff, D. Katzman (5/14/99)

Receptor Information:

Estimate cover	**% vegetated** = variable within reach – up to 30% **% wetland** = approximately 30% of the reach in the active channel **% structures/asphalt, etc.** = part of reach is bare rock with little vegetation
Field notes on the FIMAD vegetation class	Few ponderosa pines are in this part of DP Canyon.
Field notes on T&E habitat, if applicable	This reach provides potential spotted owl and falcon foraging habitat. Avian ecological screening levels (ESLs) (particularly for the kestrel flesh diet) are important in screening; lack of avian ESLs should be considered a valid reason for specifying an analyte to be a chemical of potential ecological concern (COPEC). The hazard quotient (HQ)/hazard index (HI) analysis should address potential bioaccumulative effects for raptors.
Are ecological receptors present at the PRS? **(yes/no/uncertain)** **Provide explanation**	Yes Aquatic and terrestrial receptors are present.

Contaminant Transport Information:

Surface water transport **Field notes on the terminal point of surface water transport (if applicable)**	This section does not apply because the site is not a PRS.
Are there any off-site transport pathways? **(yes/no/uncertain)** **Provide explanation**	Yes Surface water/erosion is an obvious pathway.

Ecological Effects Information:

Physical Disturbance **(provide list of major types of disturbances)**	Minimal, except for the scouring effects of high volumes of surface water. Much debris (concrete, asphalt, and other trash) was noted.
Are there obvious ecological effects? **(yes/no/uncertain)** **Provide explanation**	No There are no obvious effects of physical disturbance or contaminants on vegetation.

No Receptor/No Pathways:

If there are no receptors and no offsite transport pathways the remainder of the checklist should not be completed. Stop here and provide any additional explanation/justification for proposing an ecological No Further Action recommendation (if needed). This section does not apply.

Data Adequacy:

Do existing data provide information on the nature, rate and extent of contamination? **(yes/no/uncertain)** **Provide explanation** **(consider if the maximum value was captured by existing sample data)**	Yes. The existing sediment data show the baseline concentrations of organic, inorganic, and radionuclide chemicals of potential concern (COPCs) in this reach. Most of the inventory of COPCs identified in this reach is assumed to represent baseline concentrations (or the impacts of non-LANL sources in the Los Alamos townsite on DP Canyon sediments). A surface water sample station located at the east end of the drainage culvert was sampled during two storm water events to help characterize the baseline concentrations of COPCs entering DP Canyon.
Do existing data for the PRS address potential pathways of site contamination? **(yes/no/uncertain)** **Provide explanation** **(consider if other sites could be impacting this PRS)**	Yes Known sources of contaminants from TA-0, and other possible sources associated with the Los Alamos townsite (parking lots, streets, and businesses) have been detailed in the work plan.

Additional Field Notes:

Provide additional field notes on the site setting and potential ecological receptors. Few pools were noted in this reach. The volume of surface water is expected to be related to timing and duration of rain events as well as snowmelt events. There is little opportunity for the stream channel to have migrated in this part of DP Canyon. The aquatic pathways seem important in this reach, but a small contaminant source term is expected within either the active channel sediments or surface water. During a field visit to this reach on 5/14/99 water was noted in several pools. Because more than a week had passed since the last precipitation, it is possible that these pools are fed by surface water flow from garden or lawn irrigation in the townsite. The western-most pools (located directly below the drainage culvert) had little visible evidence of aquatic biota. These pools contained water with a brown color, possibly related to the influx of organic matter (possibly leaf litter). Pools located downstream had moderate to abundant algal growth, which suggests a high nutrient influx and also suggests that much of the water must be related to garden irrigation runoff. No data on major anions and cations exist to help identify the source of water for these pools.

F-1.2.2 Reach DP-1 Central

Site ID	Reach DP-1 Central
Date of Site Visit	11/4/98, 5/14/99
Site Visit Conducted by	R. Ryti, M. Tardiff, S. Reneau (11/4/98); R. Ryti, M. Tardiff, D. Katzman (5/14/99)

Receptor Information:

Estimate cover	**% vegetated** = approximately 10% (although trees and shrubs are abundant beyond the active sediment deposits) **% wetland** = approximately 30% of the reach in the active channel **% structures/asphalt, etc.** = most of reach is bare rock with little vegetation
Field notes on the FIMAD vegetation class	More ponderosa pine trees were noted in DP-1 Central than in DP-1 West.
Field notes on T&E habitat, if applicable	Reach DP-1 Central provides potential spotted owl and falcon foraging habitat. Avian ESLs (particularly for the kestrel flesh diet) are important in screening; lack of avian ESLs should be considered a valid reason for specifying an analyte to be a COPEC; the HQ/HI analysis should address potential bioaccumulative effects for raptors.
Are ecological receptors present at the PRS? **(yes/no/uncertain)** **Provide explanation**	Yes Aquatic and terrestrial receptors are present.

Contaminant Transport Information:

Surface water transport **Field notes on the terminal point of surface water transport (if applicable)**	This section does not apply because the site is not a PRS.
Are there any off-site transport pathways? **(yes/no/uncertain)** **Provide explanation**	Yes Surface water/erosion is an obvious pathway.

Ecological Effects Information:

Physical Disturbance **(provide list of major types of disturbances)**	Minimal, except for the scouring effects of high volumes of surface water. Some debris (concrete, asphalt, and other trash) was noted.
Are there obvious ecological effects? **(yes/no/uncertain)** **Provide explanation**	No No obvious effects of contaminants on vegetation were noted.

No Receptor/No Pathways:

If there are no receptors and no offsite transport pathways the remainder of the checklist should not be completed. Stop here and provide any additional explanation/justification for proposing an ecological No Further Action recommendation (if needed). This section does not apply.

Data Adequacy:

Do existing data provide information on the nature, rate and extent of contamination? **(yes/no/uncertain)** **Provide explanation** **(consider if the maximum value was captured by existing sample data)**	Yes Sediment samples have been collected to document trends in contaminant concentrations for this section of DP Canyon. Samples were located to help determine if releases from DP Tank Farm are contributing contamination.
Do existing data for the PRS address potential pathways of site contamination? **(yes/no/uncertain)** **Provide explanation** **(consider if other sites could be impacting this PRS)**	Yes The known source of contaminants associated with DP Tank Farm has been detailed in the work plan.

Additional Field Notes:

Provide additional field notes on the site setting and potential ecological receptors. Aquatic receptors and pathways are expected to be important for this reach. Many shrubs, including oaks, were noted in soil adjacent to the post-1942 geomorphic deposits. There are more boulders and a greater drop in elevation in the stream channel than in DP-1 West. There is little opportunity for the stream channel to have migrated in this part of DP Canyon. On the site visit on 5/14/99, water was noted in the pool just downstream of the "hydrocarbon seep" area. This pool was more than one foot in depth and had abundant algal growth. The smaller pools just upstream of this pool were choked with algae.

F-1.2.3 Reach DP-1 East

Site ID	Reach DP-1 East
Date of Site Visit	11/4/98
Site Visit Conducted by	R. Ryti, M. Tardiff, S. Reneau

Receptor Information:

Estimate cover	**% vegetated** = approximately 50% **% wetland** = approximately 20% of the reach in the active channel **% structures/asphalt, etc.** = remainder
Field notes on the FIMAD vegetation class	More ponderosa pine trees were noted in this part of DP Canyon than in DP-1 West and Central, and some grass was noted near the stream channel.
Field notes on T&E habitat, if applicable	Reach DP-1 East provides potential spotted owl and falcon foraging habitat. Avian ESLs (particularly for the kestrel flesh diet) are important in screening; lack of avian ESLs should be considered a valid reason for specifying an analyte to be a COPEC; the HQ/ HI analysis should address potential bioaccumulative effects for raptors.
Are ecological receptors present at the PRS? **(yes/no/uncertain)** **Provide explanation**	Yes Aquatic and terrestrial receptors are present.

Contaminant Transport Information:

Surface water transport **Field notes on the terminal point of surface water transport (if applicable)**	This section does not apply because the site is not a PRS.
Are there any off-site transport pathways? **(yes/no/uncertain)** **Provide explanation**	Yes Surface water/erosion is an obvious pathway, and transport to perched alluvial groundwater may also be important.

Ecological Effects Information:

Physical Disturbance **(provide list of major types of disturbances)**	Minimal Little debris (concrete, asphalt, and other trash) was noted.
Are there obvious ecological effects? **(yes/no/uncertain)** **Provide explanation**	No obvious effects of contaminants on vegetation were noted.

No Receptor/No Pathways:

If there are no receptors and no offsite transport pathways the remainder of the checklist should not be completed. Stop here and provide any additional explanation/justification for proposing an ecological No Further Action recommendation (if needed). This section does not apply.

Data Adequacy:

Do existing data provide information on the nature, rate and extent of contamination? **(yes/no/uncertain)** **Provide explanation** **(consider if the maximum value was captured by existing sample data)**	Yes Data were collected to determine if businesses located in the commercial district of DP Road are contaminant sources for DP Canyon sediments, and these data do not suggest any major new contaminant sources. A surface water sample station is located at the eastern end of this reach to provide another "baseline" measurement of water chemicals of potential concern (COPCs) entering DP-2. This surface water station could have COPCs associated with DP Tank Farm and some other minor Laboratory-related contaminant sources.
Do existing data for the PRS address potential pathways of site contamination? **(yes/no/uncertain)** **Provide explanation** **(consider if other sites could be impacting this PRS)**	No No known sources of contaminants are associated with the businesses located on DP Road.

Additional Field Notes:

Provide additional field notes on the site setting and potential ecological receptors. The elevational gradient in this part of DP Canyon is small, and the canyon bottom is a little wider than upstream reaches. Historical aerial photographs show little historical migration of the stream channel in this part of DP Canyon. Some water was noted in the stream channel.

F-1.2.4 Reach DP-2

Site ID	Reach DP-2
Date of Site Visit	11/4/98, 5/14/99
Site Visit Conducted by	R. Ryti, M. Tardiff, S. Reneau (11/4/98); R. Ryti, M. Tardiff, D. Katzman (5/14/99)

Receptor Information:

Estimate cover	**% vegetated** = 80% (mostly grassland or meadow with scattered shrubs noted) **% wetland** = 20% (active channel) **% structures/asphalt, etc.** = none
Field notes on the FIMAD vegetation class	Few ponderosa pines were noted, and most apparently suffered from a historical fire. Vegetative cover primarily consists of grasses on the historical floodplains.
Field notes on T&E habitat, if applicable	Reach DP-2 provides potential spotted owl and falcon habitat. Avian ESLs (particularly for the kestrel flesh diet) are important in screening; lack of avian ESLs should be considered a valid reason for specifying an analyte to be a COPEC; the HQ/HI analysis should address potential bioaccumulative effects for raptors.
Are ecological receptors present at the PRS? **(yes/no/uncertain)** **Provide explanation**	Yes Terrestrial and aquatic receptors are present.

Contaminant Transport Information:

Surface water transport **Field notes on the terminal point of surface water transport (if applicable)**	This section does not apply because the site is not a PRS.
Are there any off-site transport pathways? **(yes/no/uncertain)** **Provide explanation**	Yes Surface water/erosion is an obvious pathway. Perched alluvial groundwater may also be important.

Ecological Effects Information:

Physical Disturbance **(provide list of major types of disturbances)**	Minimal
Are there obvious ecological effects? **(yes/no/uncertain)** **Provide explanation**	No No obvious effects of either physical disturbance or contaminants on vegetation. Some stressed or dead ponderosa pines were noted and are discussed below.

No Receptor/No Pathways:

If there are no receptors and no offsite transport pathways the remainder of the checklist should not be completed. Stop here and provide any additional explanation/justification for proposing an ecological No Further Action recommendation (if needed).

This section does not apply.

Data Adequacy:

Do existing data provide information on the nature, rate and extent of contamination? **(yes/no/uncertain)** **Provide explanation** **(consider if the maximum value was captured by existing sample data)**	Yes The sediment data were collected to estimate COPC concentrations in the major geomorphic units present in this reach. The data should also document concentration trends, if any exist, and support an evaluation of contaminant collocation. There are data available from alluvial wells LAUZ-1 and LAUZ-2. The alluvial well data should provide a conservative estimate of the surface water concentrations because the source of the base flow in the eastern end of Reach DP-2 is likely to be the alluvial groundwater.
Do existing data for the PRS address potential pathways of site contamination? **(yes/no/uncertain)** **Provide explanation** **(consider if other sites could be impacting this PRS)**	Yes A dominant source in DP Canyon is PRS 21-011(k). There may be minor contributions from other MDAs that drain into this reach (MDA T and MDA U). These sources are documented in the sampling and analysis plan for DP Canyon.

Additional Field Notes:

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

Reach DP-2 is heavily vegetated with grasses, forbs, a few shrubs, and some ponderosa pines. Some ponderosa pines were dead, either the result of a historical fire or water-logged roots. Harvester ants were observed near the active channel; other evidence of bioturbation was noted in the post-1942 sediments.

The stream channel has migrated some, which means that the post-1942 sediments are fairly broadly distributed within the meadow area. Surface water frequently flows in this reach during snowmelt events and during rainfall events and is assumed to recharge the alluvial aquifer. There are some pools in the stream channel. The highest concentrations of contaminants have been noted at depth and outside of the active stream channel. Strontium-90 was detected in the alluvial water, which emphasizes the surface water transport pathway for some contaminants. The potential for terrestrial food chain uptake is viewed to be high because of the high concentrations of cesium-137 and strontium-90 within the rooting zone in heavily vegetated areas.

On 5/14/99, water was noted flowing only in the eastern half of this reach. The channel sands were damp in the western half of the reach, which suggests that water was recently flowing throughout the reach. A boundary that may correlate to the post-1942 sediment boundary was noted in the species composition of the vegetation. There is also a large patch of willows at the very eastern end of the reach, which seems somewhat anomalous.

F-1.2.5 Reach DP-3

Site ID	Reach DP-3
Date of Site Visit	11/4/98
Site Visit Conducted by	R. Ryti, M. Tardiff, S. Reneau

Receptor Information:

Estimate cover	**% vegetated** = low **% wetland** = active channel downstream of DP Spring **% structures/asphalt, etc.** = none (cover is mostly exposed rock)
Field notes on the FIMAD vegetation class	Ponderosa pine with some fir was noted.
Field notes on T&E habitat, if applicable	Reach DP-3 provides a potential spotted owl and falcon habitat. Avian ESLs (particularly for the kestrel flesh diet) are important in screening; lack of avian ESLs should be considered a valid reason for specifying an analyte to be a COPEC; the HQ/HI analysis should address potential bioaccumulative effects for raptors.
Are ecological receptors present at the PRS? **(yes/no/uncertain)** **Provide explanation**	Yes. Terrestrial and aquatic receptors are present.

Contaminant Transport Information:

Surface water transport **Field notes on the terminal point of surface water transport (if applicable)**	This section does not apply because the site is not a PRS.
Are there any off-site transport pathways? **(yes/no/uncertain)** **Provide explanation**	Surface water/erosion is an obvious pathway.

Ecological Effects Information:

Physical Disturbance **(provide list of major types of disturbances)**	Minimal, except for the scouring effects of high-energy water flows.
Are there obvious ecological effects? **(yes/no/uncertain)** **Provide explanation**	No obvious effects of contaminants on vegetation were noted.

No Receptor/No Pathways:

If there are no receptors and no offsite transport pathways the remainder of the checklist should not be completed. Stop here and provide any additional explanation/justification for proposing an ecological No Further Action recommendation (if needed). This section does not apply.

Data Adequacy:

Do existing data provide information on the nature, rate and extent of contamination? **(yes/no/uncertain)** **Provide explanation** **(consider if the maximum value was captured by existing sample data)**	Yes The sediment data were collected to estimate COPC concentrations in the major geomorphic units present in this reach. The data should also document concentration trends for radionuclides and other COPCs, if any exist, and support an evaluation of contaminant collocation.
Do existing data for the PRS address potential pathways of site contamination? **(yes/no/uncertain)** **Provide explanation** **(consider if other sites could be impacting this PRS)**	Uncertain at this time. No significant new sources of contaminants are expected for reach DP-3 (only known source would be the wastewater treatment plant at the end of DP Mesa).

Additional Field Notes:

Provide additional field notes on the site setting and potential ecological receptors. Limited interaction of terrestrial receptors with sediments is expected because of the small volume of sediments contained in this reach. The stream is contained within an incised cut through the tuff, and most of the ground cover in this reach is rock. Surface water could be an important pathway if contaminants are being mobilized in storm events. Water flow in the reach is reported to be ephemeral. During a previous field visit, mountain lion tracks were noted. No large mammals were noted on this visit.

F-1.2.6 Reach DP-4

Site ID	Reach DP-4
Date of Site Visit	Scoping is based on visit to Reach LA-2 on 7/24/98 and 5/14/99 to Reach DP-4
Site Visit Conducted by	R. Ryti, M. Tardiff, D. Katzman (5/14/99)

Receptor Information:

Estimate cover	**% vegetated** = 90% (some dense shrub thickets noted) **% wetland** = none **% structures/asphalt, etc.** = none
Field notes on the FIMAD vegetation class	Ponderosa pine is dominant.
Field notes on T&E habitat, if applicable	Reach DP-4 provides potential spotted owl and falcon habitat. Avian ESLs (particularly for the kestrel flesh diet) are important in screening; lack of avian ESLs should be considered a valid reason for specifying an analyte to be a COPEC; the HQ/HI analysis should address potential bioaccumulative effects for raptors.
Are ecological receptors present at the PRS? **(yes/no/uncertain)** **Provide explanation**	Yes Terrestrial receptors are present in the reach, and aquatic receptors are present at DP Spring.

Contaminant Transport Information:

Surface water transport **Field notes on the terminal point of surface water transport (if applicable)**	This section does not apply because the site is not a PRS.
Are there any off-site transport pathways? **(yes/no/uncertain)** **Provide explanation**	Yes Surface water/erosion is an obvious pathway. Perched alluvial groundwater may also be important.

Ecological Effects Information:

Physical Disturbance **(provide list of major types of disturbances)**	Minimal Some effects of the installation of Los Alamos County gas line were noted.
Are there obvious ecological effects? **(yes/no/uncertain)** **Provide explanation**	No No obvious effects of either physical disturbance or contaminants on vegetation were noted.

No Receptor/No Pathways:

If there are no receptors and no offsite transport pathways the remainder of the checklist should not be completed. Stop here and provide any additional explanation/justification for proposing an ecological No Further Action recommendation (if needed).

This section does not apply.

Data Adequacy:

Do existing data provide information on the nature, rate and extent of contamination? **(yes/no/uncertain)** **Provide explanation** **(consider if the maximum value was captured by existing sample data)**	Yes Sediment samples have been collected to estimate COPC concentrations in the major geomorphic units. Sediment samples were collected to specifically address data quality problems for polycyclic aromatic hydrocarbons. Water samples have been collected for DP Spring.
Do existing data for the PRS address potential pathways of site contamination? **(yes/no/uncertain)** **Provide explanation** **(consider if other sites could be impacting this PRS)**	Yes The major source of contamination is PRS 21-011(k), and there are also minor contributions from MDA T and MDA U. These contaminant sources are documented in the sampling and analysis plan for DP Canyon.

Additional Field Notes:

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

A typical ponderosa pine plant community was observed. Harvester ants were observed near the active channel and other evidence of bioturbation was noted in the post-1942 sediments.

The post-1942 sediments are typically constrained to a narrow portion of the canyon floor. Surface water flows during snowmelt events and during large storm events. Much of the Los Alamos townsite drains into DP Canyon, and the DP Canyon watershed includes paved areas (roadways and parking lots). The channel sands were moist from a recent summer rainstorm (likely during the night of 7/22/98).

The installation of the Los Alamos County gas pipeline has created some disturbed areas in the post-1942 sediments, but of quite limited spatial extent.

During the site visit on 5/14/99 the entire reach from the Los Alamos Canyon confluence to DP Spring was traversed. A few scattered pools were noted in the lower part of the reach, but no aquatic receptors were noted in these pools. DP Spring and associated seeps have obvious algal growth. Visual inspection of the spring did not identify any other aquatic biota.

Historical sediment deposits are found as discontinuous pockets through this reach. There are abundant boulders in the active channel and surrounding canyon bottom.

DP Spring is located roughly 40 feet up the canyon wall from the canyon floor, and the water-flow path has a thick plant covering. There are some small pools in the active channel up to about 40 feet from the spring. No aquatic biota was noted in these pools. There is also evidence of mass wasting of the cliff above these pools, and this mass-wasted material was noted downstream in the active channel.

F-1.3 Part C—Ecological Pathways Conceptual Exposure Model

Provide answers to Questions A to R and use this information to complete the Ecological Pathways Conceptual Exposure Model

Figure F-1.3-1 shows the completed conceptual exposure model for ecological pathways.

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 some volatile organic compound (VOC) sources from PRSs in the DP Canyon watershed (e.g., PRS 21-029). However, VOCs are not expected to persist in active geomorphic settings. It is also worth noting that very low concentrations of VOCs were detected in sediment and water samples.

Question B:

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

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

Answer (likely/unlikely/uncertain) Likely

Provide explanation:

Some areas have surficial contamination, so the pathway is complete; however, most contamination is subsurface. In addition, most areas of contaminated sediments are well-vegetated or remain moist from surface water.

Question C:

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

- **If the SOP 2.01run-off score* equal to zero, this suggests that erosion at PRS is not a transport pathway. (* note that the runoff score is not the entire erosion potential score, rather it is a subtotal of this score with a maximum value of 46 points)**
- **If erosion is a transport pathway, evaluate the terminal point to see if aquatic receptors could be affected.**

Answer (likely/unlikely/uncertain) Likely

Provide explanation:

The canyon has no SOP 2.01 score, but sediment transport is an obvious and important transport pathway.

Question D:

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

- **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) Likely

Provide explanation:

The alluvial aquifer is known to carry some contaminants from PRS 21-011(k), and the alluvial groundwater would be commingled with surface water and sediments at certain points in Los Alamos Canyon. DP Spring is also known to have some of the same contaminants as the alluvial groundwater.

Question E:

Is infiltration/percolation from contaminated subsurface material a viable transport 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.**
- **Also consider the importance of mass wasting as a potential release mechanism for subsurface material.**

Answer (likely/unlikely/uncertain) Likely

Provide explanation:

Because the alluvial groundwater is contaminated, contact of this alluvial groundwater with subsurface material could leave some residual contamination on the alluvium or tuff; however, transport from the subsurface to deep aquifers has not yet been characterized. Transport to deep aquifers is not relevant to ecological scoping because contamination has already been documented in the alluvial aquifer and DP Spring.

Question F:

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

- **Consider, particularly, the erodability of fill material and the geologic processes of canyon/mesa edges.**

Answer (likely/unlikely/uncertain): Unlikely

Provide explanation:

Mass wasting could lead to burial of contamination in reaches DP-3 and DP-4, but it is not considered relevant to the time scale of the current assessment. Sediment erosion has been addressed in the response to Question C.

Question G:

Could airborne contaminants interact with receptors through respiration of vapors?

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

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

Terrestrial/Emergent Plants: 1 = unlikely pathway

Terrestrial Animals: 1 = unlikely pathway

Provide explanation:

Because some VOCs were detected, this exposure pathway must be considered complete. However, vapors would seem to be an unlikely pathway based on the nature of contaminant releases and the actively disturbed geomorphic settings being assessed.

Question H:

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

- **Contaminants must be present as particulates in the air or as dust for this pathway to be viable.**
- **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 pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway)

Terrestrial/Emergent Plants: 2 = minor pathway

Terrestrial Animals: 2 = minor pathway

Provide explanation:

Most contamination is expected to be subsurface, and vegetative cover is generally high in reach DP-2 where the largest inventory of radionuclide contamination exists. Where isolated packages of radionuclide-contaminated sediments exist in reaches DP-3 and DP-4, vegetative cover is also generally high. Some of the contaminated deposits in reach DP-1 may have little vegetative cover. In general, little contaminated dust is expected to be generated. In addition, the canyon bottom is moist much of the year, further limiting the potential importance of this exposure pathway.

Question I:

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

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

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

Terrestrial Plants: 3 = major pathway

Provide explanation:

Strontium-90, and to a lesser extent cesium-137, can be readily absorbed by plants, and much of the contaminant source term is expected to be within the rooting zone and thus accessible to plant root uptake.

Question J:

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

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

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

Terrestrial Animals: 3 = major pathway

Provide explanation:

This is a major pathway because some chemicals of potential concern (COPCs) are bioaccumulators in terrestrial and aquatic environments (which are present in some parts of DP Canyon). Again, strontium-90 and cesium-137 are two COPCs, which have a high bioaccumulation potential.

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 pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway)

Terrestrial Animals: 2 = minor pathway

Provide explanation:

This exposure pathway is likely to be minor because most contamination is subsurface.

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 pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway)

Terrestrial Animals: 2 = minor pathway

Provide explanation:

This is a minor pathway because of the type of COPCs present in Los Alamos Canyon (most are not lipophilic) and because most contamination is subsurface. Greater attention should be given to this

pathway for amphibians. It is assumed that this pathway is not significant for burrowing mammals because of their specialized pelts. Thus, for burrowing mammals incidental soil ingestion (partly obtained during grooming) is assumed to be a more important exposure pathway.

Question M:

Could contaminants interact with plants or animals through external irradiation?

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

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

Terrestrial Plants: 3 = major pathway

Terrestrial Animals: 3 = major pathway

Provide explanation:

This could be a major pathway because field screening can detect an elevated gamma field from reach DP-2 downstream to the confluence with Los Alamos Canyon; the major gamma radiation emitter is cesium-137.

Question N:

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

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

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

Terrestrial Plants: 3 = major pathway

Aquatic Plants: 2 = minor pathway

Provide explanation:

This could be a major pathway for terrestrial plants in reach DP-2 because strontium-90 is present in the alluvial water. This exposure pathway is expected to be less important for aquatic receptors because of the lower concentrations of contaminants expected in surface water (either base flow or storm events).

Question O:

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

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

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

Terrestrial Animals: 2 = minor pathway

Aquatic Animals: 2 = minor pathway

Provide explanation:

This pathway is based on exposure to surface water. The exposure pathway is expected to be minor because concentrations of contaminants are expected to be low in the surface water.

Question P:

Could contaminants interact with receptors via incidental ingestion of water and sediment?

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

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

Terrestrial Animals: 2 = minor pathway

Aquatic Animals: 2 = minor pathway

Provide explanation:

This pathway is based on exposure to surface water. The exposure pathway is expected to be minor because concentrations of contaminants are expected to be low in the surface water.

Question Q:

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

- **If sediments are present in an area that is only periodically inundated with water, terrestrial species may be dermally exposed during dry periods.**
- **Terrestrial organisms may be dermally exposed to water-borne contaminants as a result of wading or swimming in contaminated waters.**
- **Aquatic receptors may be directly exposed to sediments or may be exposed 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 pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway)

Terrestrial Animals: 2 = minor pathway

Aquatic Animals: 2 = minor pathway

Provide explanation:

This pathway is based on exposure to surface water. Most COPCs are not likely to be lipophilic, and concentrations of those that are potentially lipophilic are expected to be low. Thus, this exposure pathway is expected to be minor because concentrations of lipophilic contaminants are expected to be low in surface water.

Question R:

Could contaminants interact with plants or animals through external irradiation?

- **External irradiation effects are most relevant for gamma emitting radionuclides.**
- **Burial of contamination severely attenuates radiological exposure.**
- **The water column acts to absorb radiation, thus external irradiation is typically more important for sediment dwelling organisms.**

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

Terrestrial Plants: 2 = minor pathway

Aquatic Plants: 2 = minor pathway

Terrestrial Animals: 2 = minor pathway

Aquatic Animals: 2 = minor pathway

Provide explanation:

Cesium-137 is a key COPC, but this exposure pathway is expected to be minor because of the low concentrations of cesium-137 in surface water and active channel sediments.

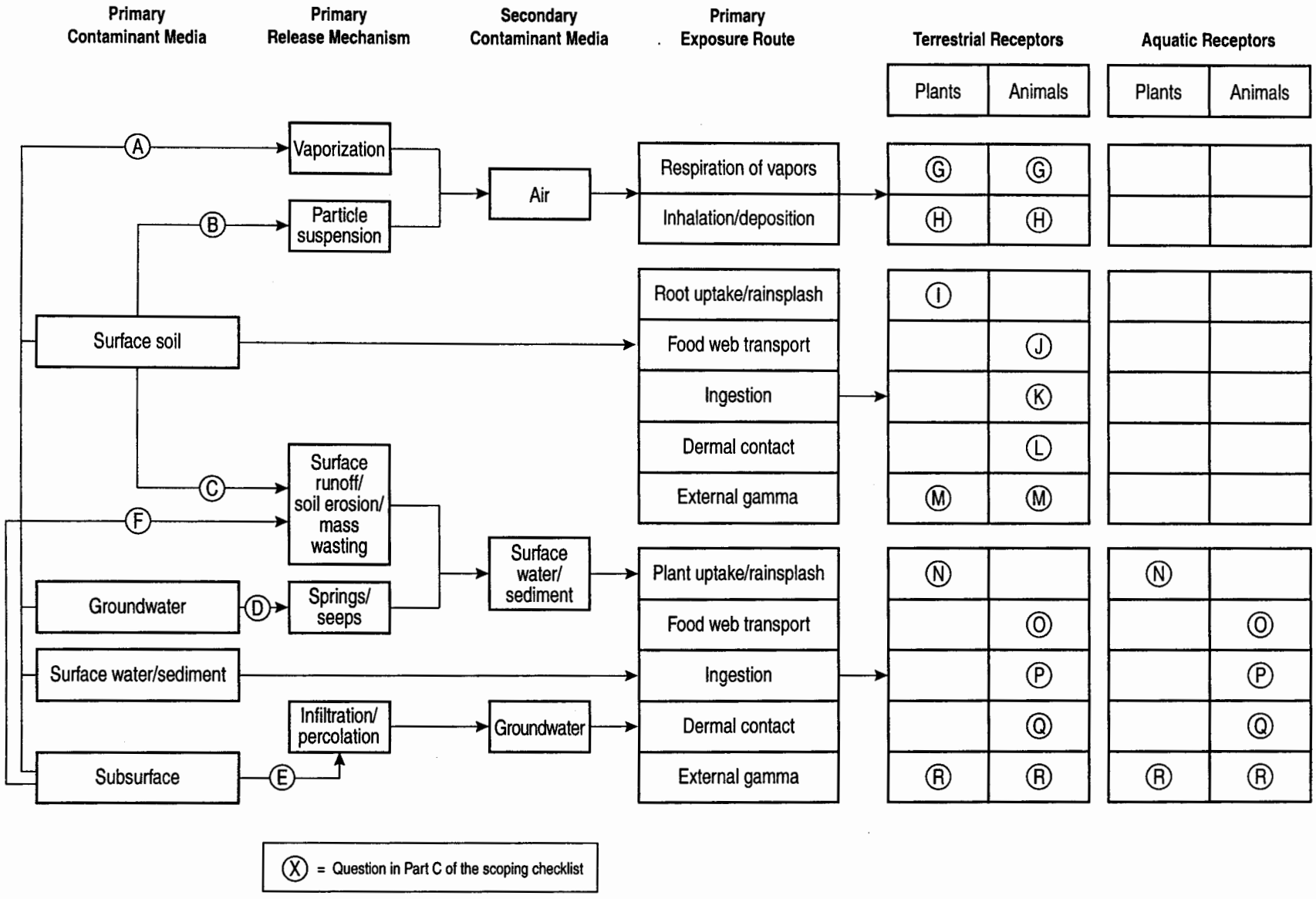


Figure F-1.3-1. Conceptual exposure model for ecological pathways

Signatures and certifications:

Checklist completed by (provide name, organization and phone number)

Name (printed): Randall Ryti

Name (signature):

Organization: Neptune and Company, Inc.

Phone number: (505) 662-0707, ext. 12

Date completed: November 18, 1998, and revised May 14, 1999

Verification by a member of ER Project Ecological Risk Task Team (provide name, organization and phone number)

Name (printed): Mark Tardiff

Name (signature):

Organization: Neptune and Company, Inc.

Phone number: (505) 662-0730, ext. 12

F-2.0 AVERAGE CONCENTRATIONS IN DP CANYON WATER AND SEDIMENT

This section provides the average concentrations of chemicals of potential concern (COPCs) in DP Canyon water and sediment for use in the ecological screening assessment. Averages provide a more realistic estimate of the contaminant concentrations experienced by wide-ranging species or by populations of any ecological receptor. These averages are used to place a more realistic bound on the contaminant concentrations. Because the averages are being used in a screening assessment, some choices were made that intentionally overestimate the average contaminant concentrations.

Average concentrations in water are simple arithmetic averages of the alluvial groundwater and DP Spring water samples. Average concentrations in sediment are based on the average concentrations of COPCs by reach in two classes of geomorphic units. One sediment class is the active channel sediment deposits, which represent potential aquatic receptor habitat. The other sediment class is inactive channel and floodplain deposits, which are habitat for terrestrial receptors. The geomorphic subdivisions for the inactive channel and floodplain deposits are ignored in the calculation of these averages, which will overestimate the average concentration because samples were collected preferentially from geomorphic units with higher average concentrations.

For all calculations, the reported detection limit value is used for nondetected inorganic and organic chemical sample results. The radionuclide sample results typically were not censored at the minimum detectable activity, and the raw reported radionuclide sample result was used in the calculation of averages. Because there are elevated detection limits for some analytes in some samples, the average concentration calculated in this way is greater than the maximum detected sample result.

Table F-2.0-1 provides the average concentrations of COPCs in alluvial groundwater by sample location and field preparation method (filtered versus unfiltered), and the grand average water concentration. The grand average water calculation is used, along with the maximum water concentration, in the ecological screening assessment.

Table F-2.0-2 provides the weighting factors used for channel sediment and nonchannel (inactive channel and floodplains) sediments. Note that analytes that are missing results for a subreach are assumed to have the maximum average concentration in a sampled subreach. The weighting factors are based on the areal extent of these geomorphic units sampled in each subreach, and the extrapolated area to account for areas between subreaches. The extrapolated areas include reach DP-1C extended east to reach DP-1E, reach DP-1E extended east to reach DP-2, and reach DP-3 extended west to reach DP-2 and east to reach DP-4. These weighting factors were applied to the inactive channel and floodplain average results (Table F-2.0-3) and to the active channel sample results to obtain a spatially weighted average concentration for each COPC (Table F-2.0-4).

Table F-2.0-1
Average Concentrations of COPCs in Alluvial Groundwater and DP Spring

Analyte	Filtered				Unfiltered				
	DP Spring	LAUZ-1	LAUZ-2	Average	DP Spring	LAUZ-1	LAUZ-2	Average	Grand Average
Inorganics									
Barium	54.8	146	116	113	59.7	146	139	122	118
Boron	46.6	53.6	67	55.7	41.1	59	64.6	54.9	55.3
Calcium	20900	66300	50900	49800	20900	62900	51600	48600	49200
Iron	365	81.6	410	262	602	597	2730	1310	786
Lithium	12.1	9	10	10.4	13.5	8.5	9	10.3	10.4
Magnesium	2210	4470	4020	3750	2250	4390	4030	3740	3750
Manganese	6.99	26.8	759	266	12.5	53.4	815	297	281
Potassium	11100	10300	15700	12300	11500	10100	15700	12300	12300
Sodium	38700	70800	59000	58800	39700	66500	59700	57500	58200
Semivolatiles									
Bis(2-ethylhexyl)phthalate	10	22	36	22.7	10	10	10	10	12.7
Radionuclides									
Plutonium-239,240	0.0158	0.0153	0.0022	0.0111	0.0277	0.109	0.0573	0.0713	0.0412
Strontium-90	70.6	127	124	112	69.6	144	83.6	105	109
Uranium-234	0.528	1.02	0.631	0.768	0.511	0.99	0.682	0.767	0.768
Uranium-235	0.036	0.047	0.050	0.045	0.027	0.084	0.012	0.046	0.045

Table F-2.0-2
Weighting Factors used for Channel and Nonchannel Sediment Packages

Reach	Length of Sampled Reach (m)	Length Extrapolated (m)	Area of Channel Sediments (m^2)	Extrapolated Channel Area (m^2)	Channel Weighting Factor	Area Outside of Channel (m^2)	Extrapolated Nonchannel Area (m^2)	Nonchannel Weighting Factor
DP-1W	70	70	154.9	155	1.8%	159.8	160	1.3%
DP-1C	101	779	219.3	1691	19.8%	120.3	928	7.6%
DP-1E	102	977	224	2146	25.2%	528.2	5059	41.6%
DP-2	316	316	606	606	7.1%	3174.9	3175	26.1%
DP-3	212	934	506.4	2231	26.2%	439.4	1936	15.9%
DP-4	454	454	1697.3	1697	19.9%	916.1	916	7.5%
Total	1255	3530	3407.9	8526	100%	5338.7	12174	100%

Table F-2.0-3
Average COPC Concentration in
Inactive Channels and Floodplains by Subreach and for DP Canyon

Analyte	Inactive Channel and Floodplain Averages							
	Background	Reach DP-1W	Reach DP-1C	Reach DP-1E	Reach DP-2	Reach DP-3	Reach DP-4	Spatially Weighted Average
Sample count	19	4	5	6	35	20	25	n/a[a]
Inorganics								
Antimony	4.92	0.71	0.75	0.68	3.6	0.69	1.23	1.49
Cadmium	0.15	0.31	0.42	0.22	0.34	0.15	0.1	0.25
Calcium	1880	4360	3390	2270	2830	2070	1850	2470
Chromium, total	5.8	12.4	13	12.7	6.26	7.07	4.32	9.49
Cobalt	2.46	3.6	3.23	2.76	3.33	2.81	2.39	2.94
Copper	4.8	11.4	10.4	8.72	9.48	4.9	10.6	8.62
Lead	9.85	117	153	100	46.6	38.1	33.2	75.6
Mercury	0.02	0.09	0.13	0.036	0.048	0.028	0.028	0.045
Selenium	0.2	0.75	0.61	0.55	0.6	0.58	0.56	0.58
Zinc	32.4	109	87.7	74.1	57.9	37.6	42.9	63.2
PCBs/Pesticides								
Aroclor-1260	N.A.[b]	0.67	0.36	0.047	0.12	0.089	0.053	0.11
4,4'-DDE	N.A.	0.067	0.067	0.067	0.013	0.011	0.0065	0.04
4,4'-DDT	N.A.	0.08	0.08	0.021	0.045	0.018	0.011	0.031
Heptachlor Epoxide	N.A.	0.057	0.057	0.057	0.0064	0.0055	0.0033	0.032
Semivolatiles								
Anthracene	N.A.	2.26	1.69	2.64	0.78	1.85	2.25	1.92
Benz(a)anthracene	N.A.	1.21	1.02	1.58	0.33	1.05	2.26	1.17
Benzo(a)pyrene	N.A.	2.17	1.77	1.54	0.55	1.07	2.26	1.29
Benzo(b)fluoranthene	N.A.	1.62	1.78	1.63	0.46	0.59	2.19	1.21
Benzo(g,h,i)perylene	N.A.	4.23	2.32	2.68	0.62	1.85	2.26	1.97
Bis(2-ethylhexyl)phthalate	N.A.	1.66	1	1.6	0.71	1.9	2.25	1.42
Carbazole	N.A.	3.1	2.32	2.68	0.82	1.85	2.43	2.02
Chrysene	N.A.	1.36	1	1.57	0.38	1.04	2.26	1.18
Dibenz(a,h)anthracene	N.A.	3.22	2.32	2.68	0.91	1.85	2.31	2.04
Di-n-butylphthalate	N.A.	4	2.32	2.68	0.91	1.55	2.29	2
Fluoranthene	N.A.	2.57	1.07	1.73	0.63	0.55	2.19	1.25
Indeno(1,2,3-cd)pyrene	N.A.	3.15	2.32	2.65	0.62	1.57	2.06	1.89
Naphthalene	N.A.	3.18	1.69	2.64	0.81	1.85	2.3	1.95
Phenanthrene	N.A.	1.62	0.64	1.02	0.44	1.01	2.18	0.93
Pyrene	N.A.	4.61	1.15	1.24	1	0.63	2.2	1.19
2,4,6-Trichlorophenol	N.A.	4	2.32	2.68	0.91	2.75	2.31	2.19

Table F-2.0-3 (continued)

Analyte	Inactive Channel and Floodplain Averages							
	Background	Reach DP-1W	Reach DP-1C	Reach DP-1E	Reach DP-2	Reach DP-3	Reach DP-4	Spatially Weighted Average
Radionuclides								
Americium-241	0.027	0.15	0.15	0.11	4.46	11.5	5.56	3.48
Cesium-137	0.21	0.41	0.12	0.14	37.4	40.4	50.3	20
Plutonium-238	0.0015	0.0047	0.011	0.005	0.33	0.73	0.49	0.24
Plutonium-239,240	0.026	0.058	0.044	0.057	2.73	4.53	5.97	1.91
Strontium-90	0.25	0.24	0.19	0.1	5.43	4.84	8.97	2.92
Uranium-234	1.47	1.34	0.92	0.75	0.85	1.71	1.34	0.99

[a] n/a = not applicable.
[b] N.A. = not available.

Table F-2.0-4
Average COPC Concentrations in Active Channels by Subreach and for DP Canyon

Analyte	Active Channel Data Averages							
	Background	Reach DP-1W	Reach DP-1C	Reach DP-1E	Reach DP-2	Reach DP-3	Reach DP-4	Spatially Weighted Average
Sample count	12	2	1	1	1	1	1	n/a[a]
Inorganics								
Antimony	4.93	0.88	0.71	0.56	0.96	0.57	0.55	0.68
Calcium	1370	8860	5610	1370	419	554	282	1330
Copper	4.19	10.4	11	7.9	1.3	2.8	3.8	5.33
Lead	8.48	15.6	9.8	13.8	6.8	9.8	5.9	10.5
Semivolatiles								
Anthracene	N.A.[b]	3.45	3.5	0.069	0.84	0.35	0.34	0.64
Benz(a)anthracene	N.A.	0.61	1.2	0.29	0.84	0.026	0.031	0.45
Benzo(a)pyrene	N.A.	2.07	3.5	0.26	0.84	0.35	0.03	0.68
Benzo(b)fluoranthene	N.A.	0.94	1.7	0.28	0.84	0.037	0.035	0.49
Benzo(g,h,i)perylene	N.A.	3.45	3.5	0.27	0.84	0.35	0.34	0.72
Bis(2-ethylhexyl)phthalate	N.A.	0.76	0.6	0.13	0.075	0.17	0.034	0.16
Carbazole	N.A.	3.45	0.27	0.045	0.84	0.35	0.34	0.38
Chrysene	N.A.	0.7	0.99	0.29	0.84	0.033	0.03	0.43
Fluoranthene	N.A.	0.86	2.2	0.22	0.84	0.046	0.034	0.5
Indeno(1,2,3-cd)pyrene	N.A.	1.98	3.5	0.24	0.84	0.35	0.34	0.69
Phenanthrene	N.A.	0.68	1.1	0.31	0.84	0.027	0.34	0.47
Pyrene	N.A.	2.05	3.6	0.78	0.84	0.097	0.075	0.87
Radionuclides								
Cesium-137	0.31	1.11	1.11	1.11	0.27	1.03	1.11	0.88
Plutonium-239,240	0.025	0.084	0.084	0.084	0.027	0.084	0.054	0.067

[a] n/a = not applicable.
[b] N.A. = not available.

F-3.0 RECEPTOR-SPECIFIC HQ/HI RESULTS

Receptor-specific HQ/HI results are provided in Tables F-3.0-1 through F-3.0-11. These tables provide the average and maximum value of the COPCs retained for the multimedia assessment, and the HQ for each COPC based on these data. Media-specific HI subtotals for non-radionuclides and radionuclides are also provided in these tables. Examining the HQ values in these tables show which COPCs contribute most to the media-specific HI for each receptor.

Table F-3.0-1 shows the results for the kestrel (flesh diet). This table also shows that Aroclor-1260, DDE, DDT in soil (inactive channel and floodplain sediments), and barium and bis(2-ethylhexyl)phthalate (BEHP) in water contribute the largest fraction of the HI.

Table F-3.0-2 shows the results for the kestrel. This table also shows that Aroclor-1260, DDE, DDT, BEHP, di-n-butylphthalate, and naphthalene in soil, and barium and BEHP in water contribute the largest fraction of the HI.

Table F-3.0-3 shows the results for the robin (omnivore diet). This table also shows that cobalt, lead, organic mercury, Aroclor-1260, DDE, DDT, di-n-butylphthalate, and naphthalene in soil, and barium and BEHP in water contribute the largest fraction of the HI.

Table F-3.0-4 shows the results for the robin (insectivore diet). This table also shows that cobalt, lead, organic mercury, zinc, Aroclor-1260, DDE, DDT, di-n-butylphthalate, and naphthalene in soil, and barium and BEHP in water contribute the largest fraction of the HI.

Table F-3.0-5 shows the results for the robin (herbivore diet). This table also shows that cobalt, lead, organic mercury, zinc, DDT, di-n-butylphthalate, and naphthalene in soil, and barium and BEHP in water contribute the largest fraction of the HI.

Table F-3.0-6 shows the results for the swallow. This table also shows that barium and BEHP in water contribute the largest fraction of the HI.

Table F-3.0-7 shows the results for the fox. This table also shows that Aroclor-1260 in soil and barium and manganese in water contribute the largest fraction of the HI.

Table F-3.0-8 shows the results for the cottontail rabbit. This table also shows that cobalt in soil and barium and manganese in water contribute the largest fraction of the HI.

Table F-3.0-9 shows the results for the shrew. This table also shows that antimony, cobalt, organic mercury, selenium, Aroclor-1260, benzo(a)pyrene, and chrysene in soil and barium and manganese in water contribute the largest fraction of the HI.

Table F-3.0-10 shows the results for the deer mouse. This table also shows that antimony, cobalt, organic mercury, selenium, Aroclor-1260 in soil and barium and manganese in water contribute the largest fraction of the HI.

Table F-3.0-11 shows the results for the bat. This table also shows that antimony in soil and barium and manganese in water contribute the largest fraction of the HI.

Table F-3.0-1
HQ/HI Results for the Kestrel (Flesh Diet)

Analyte	Soil					Water				
	ESL	Average	HQ for Average	Maximum	HQ for Maximum	ESL	Average	HQ for Average	Maximum	HQ for Maximum
Inorganics										
Antimony	N.A.[a]	1.49	N.A.	1.4	N.A.	—[b]	—	—	—	—
Barium	—	—	—	—	—	52	122	0.704	210	1.212
Boron	—	—	—	—	—	110	54.9	0.150	67	0.183
Cadmium	210	0.25	<0.001	0.67	0.001	—	—	—	—	—
Calcium	N.A.	2470	N.A.	8080	N.A.	N.A.	48600	N.A.	110000	N.A.
Chromium, total[c]	480	9.49	0.006	20.4	0.013	—	—	—	—	—
Cobalt	12	2.94	0.073	4.8	0.120	—	—	—	—	—
Copper	5000	8.62	0.001	36.1	0.002	—	—	—	—	—
Iron	—	—	—	—	—	N.A.	1310	N.A.	6700	N.A.
Lead	580	75.6	0.039	207	0.107	—	—	—	—	—
Lithium	—	—	—	—	—	N.A.	10.3	N.A.	13.5	N.A.
Manganese	—	—	—	—	—	1400	297	0.064	870	0.186
Mercury[d]	0.071	0.045	0.192	0.25	1.056	—	—	—	—	—
Selenium	11	0.58	0.016	1.3	0.035	—	—	—	—	—
Zinc	250	63.2	0.076	166	0.199	—	—	—	—	—
PCBs/Pesticides										
Aroclor-1260	0.059	0.11	0.537	1	5.085	—	—	—	—	—
4,4'-DDE	0.00056	0.04	21.192	0.0042	2.250	—	—	—	—	—
4,4'-DDT	0.0012	0.031	7.813	0.12	30.000	—	—	—	—	—
Heptachlor Epoxide	N.A.	0.032	N.A.	0.11	N.A.	—	—	—	—	—
Semivolatiles										
Anthracene	N.A.	1.92	N.A.	0.62	N.A.	—	—	—	—	—
Benz(a)anthracene	N.A.	1.17	N.A.	3	N.A.	—	—	—	—	—
Benzo(a)pyrene	N.A.	1.29	N.A.	3.2	N.A.	—	—	—	—	—
Benzo(b)fluoranthene	N.A.	1.21	N.A.	3.8	N.A.	—	—	—	—	—
Benzo(g,h,i)perylene	N.A.	1.97	N.A.	5	N.A.	—	—	—	—	—
Bis(2-ethylhexyl)phthalate	0.072	1.42	5.918	1.7	7.083	2.7	10	1.111	36	4.000
Carbazole	N.A.	2.02	N.A.	0.5	N.A.	—	—	—	—	—
Chrysene	N.A.	1.18	N.A.	3.3	N.A.	—	—	—	—	—
Dibenz(a,h)anthracene	N.A.	2.04	N.A.	0.98	N.A.	—	—	—	—	—
Di-n-butylphthalate	4.3	2	0.140	2.1	0.147	—	—	—	—	—
Fluoranthene	N.A.	1.25	N.A.	4.4	N.A.	—	—	—	—	—
Indeno(1,2,3-cd)pyrene	N.A.	1.89	N.A.	3.8	N.A.	—	—	—	—	—
Naphthalene	18	1.95	0.032	0.62	0.010	—	—	—	—	—

Table F-3.0-1 (continued)

Analyte	Soil					Water				
	ESL	Average	HQ for Average	Maximum	HQ for Maximum	ESL	Average	HQ for Average	Maximum	HQ for Maximum
Semivolatiles (continued)										
Phenanthrene	N.A.	0.93	N.A.	3.2	N.A.	—	—	—	—	—
Pyrene	N.A.	1.19	N.A.	12	N.A.	—	—	—	—	—
2,4,6-Trichlorophenol	N.A.	2.19	N.A.	9.3	N.A.	—	—	—	—	—
HI subtotal			36.036		46.109			2.029		5.581
Radionuclides										
Americium-241	52000	3.48	<0.001	71	0.001	—	—	—	—	—
Cesium-137	7100	20	0.001	442	0.062	—	—	—	—	—
Plutonium-238	28000	0.24	<0.001	2.79	<0.001	—	—	—	—	—
Plutonium-239,240	28000	1.91	<0.001	48.3	0.002	480000	0.071	<0.001	0.25	<0.001
Strontium-90	6500	2.92	<0.001	32.8	0.005	260000	105	<0.001	207.83	0.001
Uranium-234	200000	0.99	<0.001	1.84	<0.001	3400000	0.767	<0.001	1.73	<0.001
HI subtotal			0.001		0.070			<0.001		0.001

[a] N.A. = not available.

[b] A dash in the table means not a COPC for this media.

[c] Hexavalent chromium assumed.

[d] Organic mercury assumed.

Table F-3.0-2
HQ/HI Results for the Kestrel

Analyte	Soil					Water				
	ESL	Average	HQ for Average	Maximum	HQ for Maximum	ESL	Average	HQ for Average	Maximum	HQ for Maximum
Inorganics										
Antimony	N.A.[a]	1.49	N.A.	1.4	N.A.	—[b]	—	—	—	—
Barium	—	—	—	—	—	52	122	0.704	210	1.212
Boron	—	—	—	—	—	110	54.9	0.150	67	0.183
Cadmium	13	0.25	0.006	0.67	0.015	—	—	—	—	—
Calcium	N.A.	2470	N.A.	8080	N.A.	N.A.	48600	N.A.	110000	N.A.
Chromium, total[c]	130	9.49	0.022	20.4	0.047	—	—	—	—	—
Cobalt	1.1	2.94	0.801	4.8	1.309	—	—	—	—	—
Copper	960	8.62	0.003	36.1	0.011	—	—	—	—	—
Iron	—	—	—	—	—	N.A.	1310	N.A.	6700	N.A.
Lead	290	75.6	0.078	207	0.214	—	—	—	—	—
Lithium	—	—	—	—	—	N.A.	10.3	N.A.	13.5	N.A.
Manganese	—	—	—	—	—	1400	297	0.064	870	0.186
Mercury[d]	0.033	0.045	0.412	0.25	2.273	—	—	—	—	—
Selenium	2.4	0.58	0.072	1.3	0.163	—	—	—	—	—
Zinc	210	63.2	0.090	166	0.237	—	—	—	—	—
PCBs/Pesticides										
Aroclor-1260	0.074	0.11	0.428	1	4.054	—	—	—	—	—
4,4'-DDE	0.0015	0.04	7.912	0.0042	0.840	—	—	—	—	—
4,4'-DDT	0.0027	0.031	3.473	0.12	13.333	—	—	—	—	—
Heptachlor Epoxide	N.A.	0.032	N.A.	0.11	N.A.	—	—	—	—	—
Semivolatiles										
Anthracene	N.A.	1.92	N.A.	0.62	N.A.	—	—	—	—	—
Benz(a)anthracene	N.A.	1.17	N.A.	3	N.A.	—	—	—	—	—
Benzo(a)pyrene	N.A.	1.29	N.A.	3.2	N.A.	—	—	—	—	—
Benzo(b)fluoranthene	N.A.	1.21	N.A.	3.8	N.A.	—	—	—	—	—
Benzo(g,h,i)perylene	N.A.	1.97	N.A.	5	N.A.	—	—	—	—	—
Bis(2-ethylhexyl)phthalate	0.25	1.42	1.704	1.7	2.040	2.7	10	1.111	36	4.000
Carbazole	N.A.	2.02	N.A.	0.5	N.A.	—	—	—	—	—
Chrysene	N.A.	1.18	N.A.	3.3	N.A.	—	—	—	—	—
Dibenz(a,h)anthracene	N.A.	2.04	N.A.	0.98	N.A.	—	—	—	—	—
Di-n-butylphthalate	0.29	2	2.069	2.1	2.172	—	—	—	—	—
Fluoranthene	N.A.	1.25	N.A.	4.4	N.A.	—	—	—	—	—
Indeno(1,2,3-cd)pyrene	N.A.	1.89	N.A.	3.8	N.A.	—	—	—	—	—
Naphthalene	0.43	1.95	1.357	0.62	0.433	—	—	—	—	—

Table F-3.0-2 (continued)

Analyte	Soil					Water				
	ESL	Average	HQ for Average	Maximum	HQ for Maximum	ESL	Average	HQ for Average	Maximum	HQ for Maximum
Semivolatiles (continued)										
Phenanthrene	N.A.	0.93	N.A.	3.2	N.A.	—	—	—	—	—
Pyrene	N.A.	1.19	N.A.	12	N.A.	—	—	—	—	—
2,4,6-Trichlorophenol	N.A.	2.19	N.A.	9.3	N.A.	—	—	—	—	—
HI subtotal			18.427		27.142			2.029		5.581
Radionuclides										
Americium-241	2100	3.48	<0.001	71	0.034	—	—	—	—	—
Cesium-137	2700	20	0.002	442	0.164	—	—	—	—	—
Plutonium-238	1000	0.24	<0.001	2.79	0.003	—	—	—	—	—
Plutonium-239,240	1100	1.91	0.001	48.3	0.044	480000	0.071	<0.001	0.25	<0.001
Strontium-90	570	2.92	0.002	32.8	0.058	260000	105	<0.001	207.83	0.001
Uranium-234	7900	0.99	<0.001	1.84	<0.001	3400000	0.767	<0.001	1.73	<0.001
HI subtotal			0.005		0.302			<0.001		0.001

[a] N.A. = not available.

[b] A dash in the table means not a COPC for this media.

[c] Hexavalent chromium assumed.

[d] Organic mercury assumed.

Table F-3.0-3
HQ/HI Results for the Robin (Omnivore Diet)

Analyte	Soil					Water				
	ESL	Average	HQ for Average	Maximum	HQ for Maximum	ESL	Average	HQ for Average	Maximum	HQ for Maximum
Inorganics										
Antimony	N.A.[a]	1.49	N.A.	1.4	N.A.	—[b]	—	—	—	—
Barium	—	—	—	—	—	44	122	0.832	210	1.432
Boron	—	—	—	—	—	99	54.9	0.166	67	0.203
Cadmium	1.8	0.25	0.042	0.67	0.112	—	—	—	—	—
Calcium	N.A.	2470	N.A.	8080	N.A.	N.A.	48600	N.A.	110000	N.A.
Chromium, total[c]	17	9.49	0.167	20.4	0.360	—	—	—	—	—
Cobalt	0.21	2.94	4.195	4.8	6.857	—	—	—	—	—
Copper	64	8.62	0.040	36.1	0.169	—	—	—	—	—
Iron	—	—	—	—	—	N.A.	1310	N.A.	6700	N.A.
Lead	20	75.6	1.133	207	3.105	—	—	—	—	—
Lithium	—	—	—	—	—	N.A.	10.3	N.A.	13.5	N.A.
Manganese	—	—	—	—	—	1200	297	0.074	870	0.218
Mercury[d]	0.0049	0.045	2.775	0.25	15.306	—	—	—	—	—
Selenium	0.44	0.58	0.392	1.3	0.886	—	—	—	—	—
Zinc	12	63.2	1.580	166	4.150	—	—	—	—	—
PCBs/Pesticides										
Aroclor-1260	0.028	0.11	1.132	1	10.714	—	—	—	—	—
4,4'-DDE	0.0012	0.04	9.890	0.0042	1.050	—	—	—	—	—
4,4'-DDT	0.0016	0.031	5.860	0.12	22.500	—	—	—	—	—
Heptachlor Epoxide	N.A.	0.032	N.A.	0.11	N.A.	—	—	—	—	—
Semivolatiles										
Anthracene	N.A.	1.92	N.A.	0.62	N.A.	—	—	—	—	—
Benz(a)anthracene	N.A.	1.17	N.A.	3	N.A.	—	—	—	—	—
Benzo(a)pyrene	N.A.	1.29	N.A.	3.2	N.A.	—	—	—	—	—
Benzo(b)fluoranthene	N.A.	1.21	N.A.	3.8	N.A.	—	—	—	—	—
Benzo(g,h,i)perylene	N.A.	1.97	N.A.	5	N.A.	—	—	—	—	—
Bis(2-ethylhexyl)phthalate	0.59	1.42	0.722	1.7	0.864	2.3	10	1.304	36	4.696
Carbazole	N.A.	2.02	N.A.	0.5	N.A.	—	—	—	—	—
Chrysene	N.A.	1.18	N.A.	3.3	N.A.	—	—	—	—	—
Dibenz(a,h)anthracene	N.A.	2.04	N.A.	0.98	N.A.	—	—	—	—	—
Di-n-butylphthalate	0.077	2	7.794	2.1	8.182	—	—	—	—	—
Fluoranthene	N.A.	1.25	N.A.	4.4	N.A.	—	—	—	—	—
Indeno(1,2,3-cd)pyrene	N.A.	1.89	N.A.	3.8	N.A.	—	—	—	—	—
Naphthalene	0.094	1.95	6.208	0.62	1.979	—	—	—	—	—

Table F-3.0-3 (continued)

Analyte	Soil					Water				
	ESL	Average	HQ for Average	Maximum	HQ for Maximum	ESL	Average	HQ for Average	Maximum	HQ for Maximum
Semivolatiles (continued)										
Phenanthrene	N.A.	0.93	N.A.	3.2	N.A.	—	—	—	—	—
Pyrene	N.A.	1.19	N.A.	12	N.A.	—	—	—	—	—
2,4,6-Trichlorophenol	N.A.	2.19	N.A.	9.3	N.A.	—	—	—	—	—
		HI subtotal	41.932		76.235			2.377		6.548
Radionuclides										
Americium-241	3200	3.48	<0.001	71	0.022	—	—	—	—	—
Cesium-137	870	20	0.007	442	0.508	—	—	—	—	—
Plutonium-238	1600	0.24	<0.001	2.79	0.002	—	—	—	—	—
Plutonium-239,240	1700	1.91	<0.001	48.3	0.028	2600000	0.071	<0.001	0.25	<0.001
Strontium-90	350	2.92	0.003	32.8	0.094	1200000	105	<0.001	207.83	<0.001
Uranium-234	2000	0.99	<0.001	1.84	0.001	3000000	0.767	<0.001	1.73	<0.001
		HI subtotal	0.010		0.655			<0.001		<0.001

[a] N.A. = not available.

[b] A dash in the table means not a COPC for this media.

[c] Hexavalent chromium assumed.

[d] Organic mercury assumed.

Table F-3.0-4
HQ/HI Results for the Robin (Insectivore Diet)

Analyte	Soil					Water				
	ESL	Average	HQ for Average	Maximum	HQ for Maximum	ESL	Average	HQ for Average	Maximum	HQ for Maximum
Inorganics										
Antimony	N.A.[a]	1.49	N.A.	1.4	N.A.	—[b]	—	—	—	—
Barium	—	—	—	—	—	44	122	0.832	210	1.432
Boron	—	—	—	—	—	99	54.9	0.166	67	0.203
Cadmium	1.7	0.25	0.044	0.67	0.118	—	—	—	—	—
Calcium	N.A.	2470	N.A.	8080	N.A.	N.A.	48600	N.A.	110000	N.A.
Chromium, total[c]	14	9.49	0.203	20.4	0.437	—	—	—	—	—
Cobalt	0.15	2.94	5.873	4.8	9.600	—	—	—	—	—
Copper	110	8.62	0.024	36.1	0.098	—	—	—	—	—
Iron	—	—	—	—	—	N.A.	1310	N.A.	6700	N.A.
Lead	23	75.6	0.986	207	2.700	—	—	—	—	—
Lithium	—	—	—	—	—	N.A.	10.3	N.A.	13.5	N.A.
Manganese	—	—	—	—	—	1200	297	0.074	870	0.218
Mercury[d]	0.0049	0.045	2.775	0.25	15.306	—	—	—	—	—
Selenium	0.34	0.58	0.508	1.3	1.147	—	—	—	—	—
Zinc	31	63.2	0.612	166	1.606	—	—	—	—	—
PCBs/Pesticides										
Aroclor-1260	0.015	0.11	2.113	1	20.000	—	—	—	—	—
4,4'-DDE	0.00066	0.04	17.982	0.0042	1.909	—	—	—	—	—
4,4'-DDT	0.00085	0.031	11.030	0.12	42.353	—	—	—	—	—
Heptachlor Epoxide	N.A.	0.032	N.A.	0.11	N.A.	—	—	—	—	—
Semivolatiles										
Anthracene	N.A.	1.92	N.A.	0.62	N.A.	—	—	—	—	—
Benz(a)anthracene	N.A.	1.17	N.A.	3	N.A.	—	—	—	—	—
Benzo(a)pyrene	N.A.	1.29	N.A.	3.2	N.A.	—	—	—	—	—
Benzo(b)fluoranthene	N.A.	1.21	N.A.	3.8	N.A.	—	—	—	—	—
Benzo(g,h,i)perylene	N.A.	1.97	N.A.	5	N.A.	—	—	—	—	—
Bis(2-ethylhexyl)phthalate	0.3	1.42	1.420	1.7	1.700	2.3	10	1.304	36	4.696
Carbazole	N.A.	2.02	N.A.	0.5	N.A.	—	—	—	—	—
Chrysene	N.A.	1.18	N.A.	3.3	N.A.	—	—	—	—	—
Dibenz(a,h)anthracene	N.A.	2.04	N.A.	0.98	N.A.	—	—	—	—	—
Di-n-butylphthalate	0.041	2	14.637	2.1	15.366	—	—	—	—	—
Fluoranthene	N.A.	1.25	N.A.	4.4	N.A.	—	—	—	—	—
Indeno(1,2,3-cd)pyrene	N.A.	1.89	N.A.	3.8	N.A.	—	—	—	—	—
Naphthalene	0.06	1.95	9.726	0.62	3.100	—	—	—	—	—

Table F-3.0-4 (continued)

Analyte	Soil					Water				
	ESL	Average	HQ for Average	Maximum	HQ for Maximum	ESL	Average	HQ for Average	Maximum	HQ for Maximum
Semivolatiles (continued)										
Phenanthrene	N.A.	0.93	N.A.	3.2	N.A.	—	—	—	—	—
Pyrene	N.A.	1.19	N.A.	12	N.A.	—	—	—	—	—
2,4,6-Trichlorophenol	N.A.	2.19	N.A.	9.3	N.A.	—	—	—	—	—
HI subtotal			67.933		115.441			2.377		6.548
Radionuclides										
Americium-241	1800	3.48	0.001	71	0.039	—	—	—	—	—
Cesium-137	550	20	0.011	442	0.804	—	—	—	—	—
Plutonium-238	890	0.24	<0.001	2.79	0.003	—	—	—	—	—
Plutonium-239,240	940	1.91	0.001	48.3	0.051	2600000	0.071	<0.001	0.25	<0.001
Strontium-90	440	2.92	0.002	32.8	0.075	1200000	105	<0.001	207.83	<0.001
Uranium-234	1100	0.99	<0.001	1.84	0.002	3000000	0.767	<0.001	1.73	<0.001
HI subtotal			0.014		0.974			<0.001		<0.001

[a] N.A. = not available.

[b] A dash in the table means not a COPC for this media.

[c] Hexavalent chromium assumed.

[d] Organic mercury assumed.

Table F-3.0-5
HQ/HI Results for the Robin (Herbivore Diet)

Analyte	Soil					Water				
	ESL	Average	HQ for Average	Maximum	HQ for Maximum	ESL	Average	HQ for Average	Maximum	HQ for Maximum
Inorganics										
Antimony	N.A.[a]	1.49	N.A.	1.4	N.A.	—[b]	—	—	—	—
Barium	—	—	—	—	—	44	122	0.832	210	1.432
Boron	—	—	—	—	—	99	54.9	0.166	67	0.203
Cadmium	1.9	0.25	0.039	0.67	0.106	—	—	—	—	—
Calcium	N.A.	2470	N.A.	8080	N.A.	N.A.	48600	N.A.	110000	N.A.
Chromium, total[c]	23	9.49	0.124	20.4	0.266	—	—	—	—	—
Cobalt	0.34	2.94	2.591	4.8	4.235	—	—	—	—	—
Copper	44	8.62	0.059	36.1	0.246	—	—	—	—	—
Iron	—	—	—	—	—	N.A.	1310	N.A.	6700	N.A.
Lead	17	75.6	1.333	207	3.653	—	—	—	—	—
Lithium	—	—	—	—	—	N.A.	10.3	N.A.	13.5	N.A.
Manganese	—	—	—	—	—	1200	297	0.074	870	0.218
Mercury[d]	0.0049	0.045	2.775	0.25	15.306	—	—	—	—	—
Selenium	0.62	0.58	0.279	1.3	0.629	—	—	—	—	—
Zinc	7.7	63.2	2.463	166	6.468	—	—	—	—	—
PCBs/Pesticides										
Aroclor-1260	0.36	0.11	0.088	1	0.833	—	—	—	—	—
4,4'-DDE	0.018	0.04	0.659	0.0042	0.070	—	—	—	—	—
4,4'-DDT	0.022	0.031	0.426	0.12	1.636	—	—	—	—	—
Heptachlor Epoxide	N.A.	0.032	N.A.	0.11	N.A.	—	—	—	—	—
Semivolatiles										
Anthracene	N.A.	1.92	N.A.	0.62	N.A.	—	—	—	—	—
Benz(a)anthracene	N.A.	1.17	N.A.	3	N.A.	—	—	—	—	—
Benzo(a)pyrene	N.A.	1.29	N.A.	3.2	N.A.	—	—	—	—	—
Benzo(b)fluoranthene	N.A.	1.21	N.A.	3.8	N.A.	—	—	—	—	—
Benzo(g,h,i)perylene	N.A.	1.97	N.A.	5	N.A.	—	—	—	—	—
Bis(2-ethylhexyl)phthalate	9.2	1.42	0.046	1.7	0.055	2.3	10	1.304	36	4.696
Carbazole	N.A.	2.02	N.A.	0.5	N.A.	—	—	—	—	—
Chrysene	N.A.	1.18	N.A.	3.3	N.A.	—	—	—	—	—
Dibenz(a,h)anthracene	N.A.	2.04	N.A.	0.98	N.A.	—	—	—	—	—
Di-n-butylphthalate	0.51	2	1.177	2.1	1.235	—	—	—	—	—
Fluoranthene	N.A.	1.25	N.A.	4.4	N.A.	—	—	—	—	—
Indeno(1,2,3-cd)pyrene	N.A.	1.89	N.A.	3.8	N.A.	—	—	—	—	—
Naphthalene	0.21	1.95	2.779	0.62	0.886	—	—	—	—	—

Table F-3.0-5 (continued)

Analyte	Soil					Water				
	ESL	Average	HQ for Average	Maximum	HQ for Maximum	ESL	Average	HQ for Average	Maximum	HQ for Maximum
Semivolatiles (continued)										
Phenanthrene	N.A.	0.93	N.A.	3.2	N.A.	—	—	—	—	—
Pyrene	N.A.	1.19	N.A.	12	N.A.	—	—	—	—	—
2,4,6-Trichlorophenol	N.A.	2.19	N.A.	9.3	N.A.	—	—	—	—	—
		HI subtotal	14.838		35.625			2.377		6.548
Radionuclides										
Americium-241	18000	3.48	<0.001	71	0.004	—	—	—	—	—
Cesium-137	2100	20	0.003	442	0.210	—	—	—	—	—
Plutonium-238	9800	0.24	<0.001	2.79	<0.001	—	—	—	—	—
Plutonium-239,240	10000	1.91	<0.001	48.3	0.005	2600000	0.071	<0.001	0.25	<0.001
Strontium-90	280	2.92	0.003	32.8	0.117	1200000	105	<0.001	207.83	<0.001
Uranium-234	11000	0.99	<0.001	1.84	<0.001	3000000	0.767	<0.001	1.73	<0.001
		HI subtotal	0.006		0.337			<0.001		<0.001

[a] N.A. = not available.

[b] A dash in the table means not a COPC for this media.

[c] Hexavalent chromium assumed.

[d] Organic mercury assumed.

Table F-3.0-6
HQ/HI Results for the Swallow

Analyte	Soil					Water				
	ESL	Average	HQ for Average	Maximum	HQ for Maximum	ESL	Average	HQ for Average	Maximum	HQ for Maximum
Inorganics										
Antimony	N.A.[a]	0.68	N.A.	0.96	N.A.	—[b]	—	—	—	—
Barium	—	—	—	—	—	25	122	1.465	210	2.520
Boron	—	—	—	—	—	57	54.9	0.289	67	0.353
Calcium	N.A.	1330	N.A.	12000	N.A.	N.A.	48600	N.A.	110000	N.A.
Copper	210	5.33	0.008	11.4	0.016	—	—	—	—	—
Iron	—	—	—	—	—	N.A.	1310	N.A.	6700	N.A.
Lead	100	10.5	0.031	21.7	0.065	—	—	—	—	—
Lithium	—	—	—	—	—	N.A.	10.3	N.A.	13.5	N.A.
Manganese	—	—	—	—	—	710	297	0.125	870	0.368
Semivolatiles										
Anthracene	N.A.	0.64	N.A.	0.069	N.A.	—	—	—	—	—
Benz(a)anthracene	N.A.	0.45	N.A.	1.2	N.A.	—	—	—	—	—
Benzo(a)pyrene	N.A.	0.68	N.A.	0.74	N.A.	—	—	—	—	—
Benzo(b)fluoranthene	N.A.	0.49	N.A.	1.7	N.A.	—	—	—	—	—
Benzo(g,h,i)perylene	N.A.	0.72	N.A.	0.27	N.A.	—	—	—	—	—
Bis(2-ethylhexyl)phthalate	0.41	0.16	0.116	0.8	0.585	1.3	10	2.308	36	8.308
Carbazole	N.A.	0.38	N.A.	0.27	N.A.	—	—	—	—	—
Chrysene	N.A.	0.43	N.A.	0.99	N.A.	—	—	—	—	—
Fluoranthene	N.A.	0.5	N.A.	2.2	N.A.	—	—	—	—	—
Indeno(1,2,3-cd)pyrene	N.A.	0.69	N.A.	0.55	N.A.	—	—	—	—	—
Phenanthrene	N.A.	0.47	N.A.	1.1	N.A.	—	—	—	—	—
Pyrene	N.A.	0.87	N.A.	3.6	N.A.	—	—	—	—	—
		HI subtotal	0.155		0.667			4.187		11.548
Radionuclides										
Cesium-137	8.4	0.88	0.031	1.11	0.132	—	—	—	—	—
Plutonium-239,240	13	0.067	0.002	0.084	0.006	1500000	0.071	<0.001	0.25	<0.001
Strontium-90	—	—	—	—	—	720000	105	<0.001	207.83	<0.001
Uranium-234	—	—	—	—	—	1700000	0.767	<0.001	1.73	<0.001
		HI subtotal	0.033		0.139			<0.001		<0.001

[a] N.A. = not available.

[b] A dash in the table means not a COPC for this media.

Table F-3.0-7
HQ/HI Results for the Fox

Analyte	Soil					Water				
	ESL	Average	HQ for Average	Maximum	HQ for Maximum	ESL	Average	HQ for Average	Maximum	HQ for Maximum
Inorganics										
Antimony	26	1.49	0.017	1.4	0.016	—[a]	—	—	—	—
Barium	—	—	—	—	—	17	122	2.154	210	3.706
Boron	—	—	—	—	—	97	54.9	0.170	67	0.207
Cadmium	210	0.25	<0.001	0.67	0.001	—	—	—	—	—
Calcium	N.A.[b]	2470	N.A.	8080	N.A.	N.A.	48600	N.A.	110000	N.A.
Chromium, total[c]	640	9.49	0.004	20.4	0.010	—	—	—	—	—
Cobalt	22	2.94	0.040	4.8	0.065	—	—	—	—	—
Copper	2000	8.62	0.001	36.1	0.005	—	—	—	—	—
Iron	—	—	—	—	—	N.A.	1310	N.A.	6700	N.A.
Lead	1700	75.6	0.013	207	0.037	—	—	—	—	—
Lithium	—	—	—	—	—	N.A.	10.3	—	13.5	N.A.
Manganese	—	—	—	—	—	150	297	0.594	870	1.740
Mercury[d]	0.76	0.045	0.018	0.25	0.099	—	—	—	—	—
Selenium	10	0.58	0.017	1.3	0.039	—	—	—	—	—
Zinc	5900	63.2	0.003	166	0.008	—	—	—	—	—
PCBs/Pesticides										
Aroclor-1260	0.11	0.11	0.288	1	2.727	—	—	—	—	—
4,4'-DDE	5.5	0.04	0.002	0.0042	0.000	—	—	—	—	—
4,4'-DDT	0.79	0.031	0.012	0.12	0.046	—	—	—	—	—
Heptachlor Epoxide	N.A.	0.032	N.A.	0.11	N.A.	—	—	—	—	—
Semivolatiles										
Anthracene	8500	1.92	0.000	0.62	0.000	—	—	—	—	—
Benz(a)anthracene	12	1.17	0.029	3	0.075	—	—	—	—	—
Benzo(a)pyrene	2.7	1.29	0.143	3.2	0.356	—	—	—	—	—
Benzo(b)fluoranthene	8.9	1.21	0.041	3.8	0.128	—	—	—	—	—
Benzo(g,h,i)perylene	4.6	1.97	0.129	5	0.326	—	—	—	—	—
Bis(2-ethylhexyl)phthalate	2.6	1.42	0.164	1.7	0.196	63	10	0.048	36	0.171
Carbazole	N.A.	2.02	N.A.	0.5	N.A.	—	—	—	—	—
Chrysene	12	1.18	0.030	3.3	0.083	—	—	—	—	—
Dibenz(a,h)anthracene	0.88	2.04	0.695	0.98	0.334	—	—	—	—	—
Di-n-butylphthalate	42000	2	<0.001	2.1	0.000	—	—	—	—	—
Fluoranthene	360	1.25	0.001	4.4	0.004	—	—	—	—	—
Indeno(1,2,3-cd)pyrene	5.2	1.89	0.109	3.8	0.219	—	—	—	—	—
Naphthalene	1000	1.95	0.001	0.62	0.000	—	—	—	—	—

Table F-3.0-7 (continued)

Analyte	Soil					Water				
	ESL	Average	HQ for Average	Maximum	HQ for Maximum	ESL	Average	HQ for Average	Maximum	HQ for Maximum
Semivolatiles (continued)										
Phenanthrene	4300	0.93	<0.001	3.2	0.000	—	—	—	—	—
Pyrene	220	1.19	0.002	12	0.016	—	—	—	—	—
2,4,6-Trichlorophenol	N.A.	2.19	N.A.	9.3	N.A.	—	—	—	—	—
HI subtotal			1.760		4.790			2.966		5.825
Radionuclides										
Americium-241	100000	3.48	<0.001	71	0.001	—	—	—	—	—
Cesium-137	7700	20	0.001	442	0.057	—	—	—	—	—
Plutonium-238	61000	0.24	<0.001	2.79	<0.001	—	—	—	—	—
Plutonium-239,240	63000	1.91	<0.001	48.3	0.001	1000000	0.071	<0.001	0.25	<0.001
Strontium-90	10000	2.92	<0.001	32.8	0.003	520000	105	<0.001	207.83	<0.001
Uranium-234	290000	0.99	<0.001	1.84	<0.001	4700000	0.767	<0.001	1.73	<0.001
HI subtotal			0.001		0.062			<0.001		<0.001

[a] A dash in the table means not a COPC for this media.

[b] N.A. = not available.

[c] Hexavalent chromium assumed.

[d] Organic mercury assumed.

Table F-3.0-8
HQ/HI Results for the Cottontail

Analyte	Soil					Water				
	ESL	Average	HQ for Average	Maximum	HQ for Maximum	ESL	Average	HQ for Average	Maximum	HQ for Maximum
Inorganics										
Antimony	1.8	1.49	0.248	1.4	0.233	—[a]	—	—	—	—
Barium	—	—	—	—	—	15	122	2.442	210	4.200
Boron	—	—	—	—	—	86	54.9	0.192	67	0.234
Cadmium	5.6	0.25	0.013	0.67	0.036	—	—	—	—	—
Calcium	N.A.[b]	2470	N.A.	8080	N.A.	N.A.	48600	N.A.	110000	N.A.
Chromium, total[c]	160	9.49	0.018	20.4	0.038	—	—	—	—	—
Cobalt	1.5	2.94	0.587	4.8	0.960	—	—	—	—	—
Copper	45	8.62	0.057	36.1	0.241	—	—	—	—	—
Iron	—	—	—	—	—	N.A.	1310	N.A.	6700	N.A.
Lead	220	75.6	0.103	207	0.282	—	—	—	—	—
Lithium	—	—	—	—	—	N.A.	10.3	N.A.	13.5	N.A.
Manganese	—	—	—	—	—	130	297	0.685	870	2.008
Mercury[d]	0.1	0.045	0.136	0.25	0.750	—	—	—	—	—
Selenium	1.2	0.58	0.144	1.3	0.325	—	—	—	—	—
Zinc	330	63.2	0.057	166	0.151	—	—	—	—	—
PCBs/Pesticides										
Aroclor-1260	3.6	0.11	0.009	1	0.083	—	—	—	—	—
4,4'-DDE	1100	0.04	<0.001	0.0042	<0.001	—	—	—	—	—
4,4'-DDT	84	0.031	<0.001	0.12	<0.001	—	—	—	—	—
Heptachlor Epoxide	N.A.	0.032	N.A.	0.11	N.A.	—	—	—	—	—
Semivolatiles										
Anthracene	2800	1.92	<0.001	0.62	<0.001	—	—	—	—	—
Benz(a)anthracene	120	1.17	0.003	3	0.008	—	—	—	—	—
Benzo(a)pyrene	91	1.29	0.004	3.2	0.011	—	—	—	—	—
Benzo(b)fluoranthene	370	1.21	0.001	3.8	0.003	—	—	—	—	—
Benzo(g,h,i)perylene	790	1.97	0.001	5	0.002	—	—	—	—	—
Bis(2-ethylhexyl)phthalate	2200	1.42	<0.001	1.7	<0.001	56	10	0.054	36	0.193
Carbazole	N.A.	2.02	N.A.	0.5	N.A.	—	—	—	—	—
Chrysene	120	1.18	0.003	3.3	0.008	—	—	—	—	—
Dibenz(a,h)anthracene	140	2.04	0.004	0.98	0.002	—	—	—	—	—
Di-n-butylphthalate	16000	2	<0.001	2.1	<0.001	—	—	—	—	—
Fluoranthene	600	1.25	0.001	4.4	0.002	—	—	—	—	—
Indeno(1,2,3-cd)pyrene	780	1.89	0.001	3.8	0.001	—	—	—	—	—
Naphthalene	34	1.95	0.017	0.62	0.005	—	—	—	—	—

Table F-3.0-8 (continued)

Analyte	Soil					Water				
	ESL	Average	HQ for Average	Maximum	HQ for Maximum	ESL	Average	HQ for Average	Maximum	HQ for Maximum
Semivolatiles (continued)										
Phenanthrene	1400	0.93	<0.001	3.2	0.001	—	—	—	—	—
Pyrene	360	1.19	0.001	12	0.010	—	—	—	—	—
2,4,6-Trichlorophenol	N.A.	2.19	N.A.	9.3	N.A.	—	—	—	—	—
		HI subtotal	1.410		3.154			3.372		6.634
Radionuclides										
Americium-241	340000	3.48	<0.001	71	<0.001	—	—	—	—	—
Cesium-137	5800	20	0.001	442	0.076	—	—	—	—	—
Plutonium-238	420000	0.24	<0.001	2.79	<0.001	—	—	—	—	—
Plutonium-239,240	450000	1.91	<0.001	48.3	<0.001	4200000	0.071	<0.001	0.25	<0.001
Strontium-90	1200	2.92	0.001	32.8	0.027	2000000	105	<0.001	207.83	<0.001
Uranium-234	250000	0.99	<0.001	1.84	<0.001	4400000	0.767	<0.001	1.73	<0.001
		HI subtotal	0.002		0.104			<0.001		<0.001

[a] A dash in the table means not a COPC for this media.

[b] N.A. = not available.

[c] Hexavalent chromium assumed.

[d] Organic mercury assumed.

Table F-3.0-9
HQ/HI Results for the Shrew

Analyte	Soil					Water				
	ESL	Average	HQ for Average	Maximum	HQ for Maximum	ESL	Average	HQ for Average	Maximum	HQ for Maximum
Inorganics										
Antimony	0.17	1.49	2.629	1.4	2.471	—[a]	—	—	—	—
Barium	—	—	—	—	—	6.8	122	5.386	210	9.265
Boron	—	—	—	—	—	37	54.9	0.445	67	0.543
Cadmium	2.1	0.25	0.036	0.67	0.096	—	—	—	—	—
Calcium	N.A.[b]	2470	N.A.	8080	N.A.	N.A.	48600	N.A.	110000	N.A.
Chromium, total[c]	21	9.49	0.136	20.4	0.291	—	—	—	—	—
Cobalt	0.27	2.94	3.263	4.8	5.333	—	—	—	—	—
Copper	50	8.62	0.052	36.1	0.217	—	—	—	—	—
Iron	—	—	—	—	—	N.A.	1310	N.A.	6700	N.A.
Lead	86	75.6	0.264	207	0.722	—	—	—	—	—
Lithium	—	—	—	—	—	N.A.	10.3	N.A.	13.5	N.A.
Manganese	—	—	—	—	—	59	297	1.510	870	4.424
Mercury[d]	0.044	0.045	0.309	0.25	1.705	—	—	—	—	—
Selenium	0.27	0.58	0.640	1.3	1.444	—	—	—	—	—
Zinc	600	63.2	0.032	166	0.083	—	—	—	—	—
PCBs/Pesticides										
Aroclor-1260	0.022	0.11	1.441	1	13.636	—	—	—	—	—
4,4'-DDE	5.2	0.04	0.002	0.0042	<0.001	—	—	—	—	—
4,4'-DDT	0.43	0.031	0.022	0.12	0.084	—	—	—	—	—
Heptachlor Epoxide	N.A.	0.032	N.A.	0.11	N.A.	—	—	—	—	—
Semivolatiles										
Anthracene	67	1.92	0.009	0.62	0.003	—	—	—	—	—
Benz(a)anthracene	1	1.17	0.351	3	0.900	—	—	—	—	—
Benzo(a)pyrene	0.56	1.29	0.690	3.2	1.714	—	—	—	—	—
Benzo(b)fluoranthene	2.2	1.21	0.165	3.8	0.518	—	—	—	—	—
Benzo(g,h,i)perylene	3.8	1.97	0.156	5	0.395	—	—	—	—	—
Bis(2-ethylhexyl)phthalate	9	1.42	0.047	1.7	0.057	24	10	0.125	36	0.450
Carbazole	N.A.	2.02	N.A.	0.5	N.A.	—	—	—	—	—
Chrysene	1	1.18	0.355	3.3	0.990	—	—	—	—	—
Dibenz(a,h)anthracene	0.7	2.04	0.874	0.98	0.420	—	—	—	—	—
Di-n-butylphthalate	360	2	0.002	2.1	0.002	—	—	—	—	—
Fluoranthene	7.9	1.25	0.047	4.4	0.167	—	—	—	—	—
Indeno(1,2,3-cd)pyrene	3.8	1.89	0.149	3.8	0.300	—	—	—	—	—
Naphthalene	3.8	1.95	0.154	0.62	0.049	—	—	—	—	—

Table F-3.0-9 (continued)

Analyte	Soil					Water				
	ESL	Average	HQ for Average	Maximum	HQ for Maximum	ESL	Average	HQ for Average	Maximum	HQ for Maximum
Semivolatiles (continued)										
Phenanthrene	34	0.93	0.008	3.2	0.028	—	—	—	—	—
Pyrene	4.7	1.19	0.076	12	0.766	—	—	—	—	—
2,4,6-Trichlorophenol	N.A.	2.19	N.A.	9.3	N.A.	—	—	—	—	—
		HI subtotal	11.904		32.391			7.466		14.682
Radionuclides										
Americium-241	3000	3.48	<0.001	71	0.024	—	—	—	—	—
Cesium-137	830	20	0.007	442	0.533	—	—	—	—	—
Plutonium-238	1500	0.24	<0.001	2.79	0.002	—	—	—	—	—
Plutonium-239,240	1600	1.91	0.000	48.3	0.030	1500000	0.071	<0.001	0.25	<0.001
Strontium-90	660	2.92	0.001	32.8	0.050	730000	105	<0.001	207.83	<0.001
Uranium-234	2000	0.99	<0.001	1.84	0.001	1800000	0.767	<0.001	1.73	<0.001
		HI subtotal	0.009		0.639			<0.001		<0.001

[a] A dash in the table means not a COPC for this media.

[b] N.A. = not available.

[c] Hexavalent chromium assumed.

[d] Organic mercury assumed.

Table F-3.0-10
HQ/HI Results for the Deer Mouse

Analyte	Soil					Water				
	ESL	Average	HQ for Average	Maximum	HQ for Maximum	ESL	Average	HQ for Average	Maximum	HQ for Maximum
Inorganics										
Antimony	0.3	1.49	1.489	1.4	1.400	—[a]	—	—	—	—
Barium	—	—	—	—	—	8	122	4.578	210	7.875
Boron	—	—	—	—	—	44	54.9	0.374	67	0.457
Cadmium	2.5	0.25	0.030	0.67	0.080	—	—	—	—	—
Calcium	N.A.[b]	2470	N.A.	8080	N.A.	N.A.	48600	N.A.	110000	N.A.
Chromium, total[c]	46	9.49	0.062	20.4	0.133	—	—	—	—	—
Cobalt	0.41	2.94	2.148	4.8	3.512	—	—	—	—	—
Copper	32	8.62	0.081	36.1	0.338	—	—	—	—	—
Iron	—	—	—	—	—	N.A.	1310	N.A.	6700	N.A.
Lead	140	75.6	0.162	207	0.444	—	—	—	—	—
Lithium	—	—	—	—	—	N.A.	10.3	N.A.	13.5	N.A.
Manganese	—	—	—	—	—	69	297	1.291	870	3.783
Mercury[d]	0.047	0.045	0.289	0.25	1.596	—	—	—	—	—
Selenium	0.38	0.58	0.454	1.3	1.026	—	—	—	—	—
Zinc	260	63.2	0.073	166	0.192	—	—	—	—	—
PCBs/Pesticides										
Aroclor-1260	0.045	0.11	0.704	1	6.667	—	—	—	—	—
4,4'-DDE	10	0.04	0.001	0.0042	<0.001	—	—	—	—	—
4,4'-DDT	0.87	0.031	0.011	0.12	0.041	—	—	—	—	—
Heptachlor Epoxide	N.A.	0.032	N.A.	0.11	N.A.	—	—	—	—	—
Semivolatiles										
Anthracene	130	1.92	0.004	0.62	0.001	—	—	—	—	—
Benz(a)anthracene	2	1.17	0.176	3	0.450	—	—	—	—	—
Benzo(a)pyrene	1.1	1.29	0.351	3.2	0.873	—	—	—	—	—
Benzo(b)fluoranthene	4.5	1.21	0.081	3.8	0.253	—	—	—	—	—
Benzo(g,h,i)perylene	7.7	1.97	0.077	5	0.195	—	—	—	—	—
Bis(2-ethylhexyl)phthalate	18	1.42	0.024	1.7	0.028	28	10	0.107	36	0.386
Carbazole	N.A.	2.02	N.A.	0.5	N.A.	—	—	—	—	—
Chrysene	2	1.18	0.177	3.3	0.495	—	—	—	—	—
Dibenz(a,h)anthracene	1.4	2.04	0.437	0.98	0.210	—	—	—	—	—
Di-n-butylphthalate	720	2	0.001	2.1	0.001	—	—	—	—	—
Fluoranthene	15	1.25	0.025	4.4	0.088	—	—	—	—	—
Indeno(1,2,3-cd)pyrene	7.7	1.89	0.074	3.8	0.148	—	—	—	—	—
Naphthalene	6.3	1.95	0.093	0.62	0.030	—	—	—	—	—

Table F-3.0-10 (continued)

Analyte	Soil					Water				
	ESL	Average	HQ for Average	Maximum	HQ for Maximum	ESL	Average	HQ for Average	Maximum	HQ for Maximum
Semivolatiles (continued)										
Phenanthrene	67	0.93	0.004	3.2	0.014	—	—	—	—	—
Pyrene	9.4	1.19	0.038	12	0.383	—	—	—	—	—
2,4,6-Trichlorophenol	N.A.	2.19	N.A.	9.3	N.A.	—	—	—	—	—
		HI subtotal	7.066		18.599			6.351		12.500
Radionuclides										
Americium-241	8500	3.48	<0.001	71	0.008	—	—	—	—	—
Cesium-137	1300	20	0.005	442	0.340	—	—	—	—	—
Plutonium-238	4600	0.24	<0.001	2.79	0.001	—	—	—	—	—
Plutonium-239,240	4900	1.91	<0.001	48.3	0.010	2600000	0.071	<0.001	0.25	<0.001
Strontium-90	750	2.92	0.001	32.8	0.044	1200000	100	<0.001	207.83	<0.001
Uranium-234	4200	0.99	<0.001	1.84	<0.001	2300000	0.767	<0.001	1.73	<0.001
		HI subtotal	0.006		0.403			<0.001		<0.001

[a] A dash in the table means not a COPC for this media.

[b] N.A. = not available.

[c] Hexavalent chromium assumed.

[d] Organic mercury assumed.

Table F-3.0-11
HQ/HI Results for the Bat

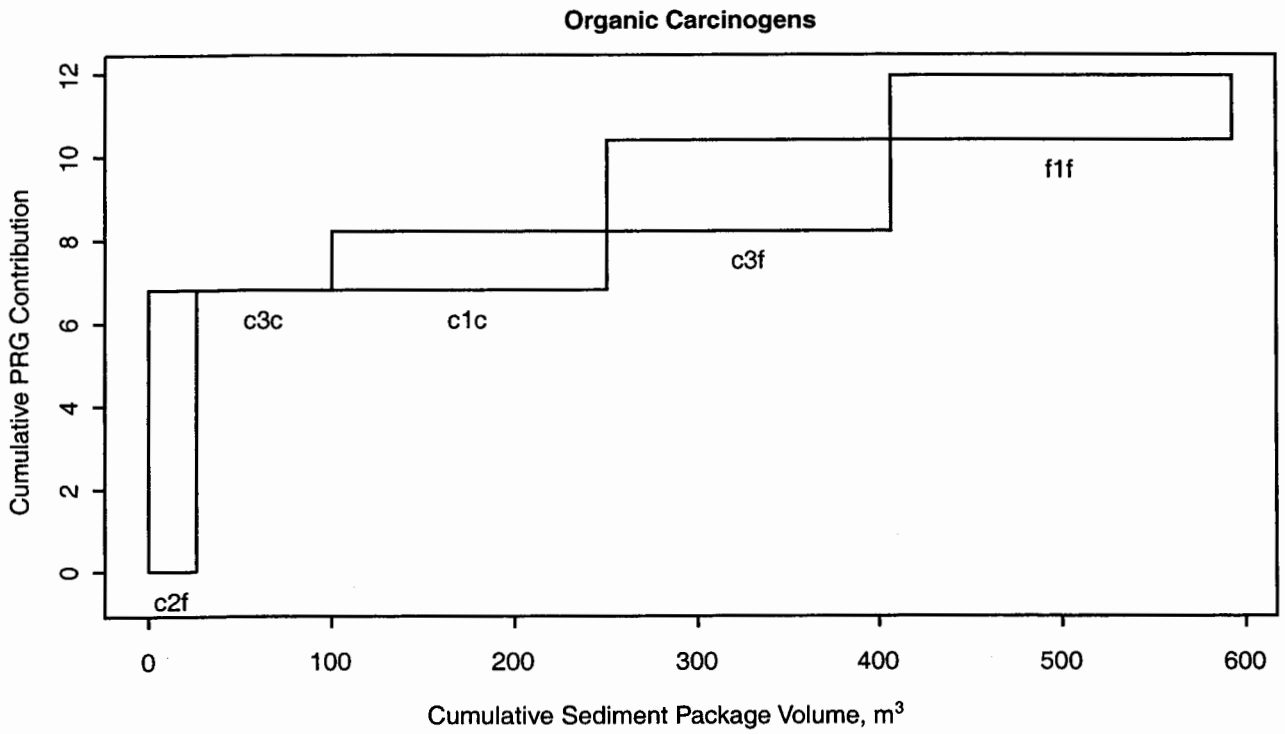
Analyte	Soil					Water				
	ESL	Average	HQ for Average	Maximum	HQ for Maximum	ESL	Average	HQ for Average	Maximum	HQ for Maximum
Inorganics										
Antimony	0.23	0.68	0.888	0.96	1.252	—[a]	—	—	—	—
Barium	—	—	—	—	—	9.6	122	3.815	210	6.563
Boron	—	—	—	—	—	52	54.9	0.317	67	0.387
Calcium	N.A.[b]	1330	N.A.	12000	N.A.	N.A.	48600	N.A.	110000	N.A.
Copper	88	5.33	0.018	11.4	0.039	—	—	—	—	—
Iron	—	—	—	—	—	N.A.	1310	—	6700	N.A.
Lead	370	10.5	0.008	21.7	0.018	—	—	—	—	—
Lithium	—	—	—	—	—	N.A.	10.3	N.A.	13.5	N.A.
Manganese	—	—	—	—	—	83	297	1.073	870	3.145
Semivolatiles										
Anthracene	87	0.64	0.002	0.069	0.000	—	—	—	—	—
Benz(a)anthracene	1.3	0.45	0.103	1.2	0.277	—	—	—	—	—
Benzo(a)pyrene	0.73	0.68	0.279	0.74	0.304	—	—	—	—	—
Benzo(b)fluoranthene	2.9	0.49	0.050	1.7	0.176	—	—	—	—	—
Benzo(g,h,i)perylene	4.9	0.72	0.044	0.27	0.017	—	—	—	—	—
Bis(2-ethylhexyl)phthalate	11	0.16	0.004	0.8	0.022	34	10	0.088	36	0.318
Carbazole	N.A.	0.38	N.A.	0.27	N.A.	—	—	—	—	—
Chrysene	1.3	0.43	0.100	0.99	0.228	—	—	—	—	—
Fluoranthene	10	0.5	0.015	2.2	0.066	—	—	—	—	—
Indeno(1,2,3-cd)pyrene	4.9	0.69	0.042	0.55	0.034	—	—	—	—	—
Phenanthrene	45	0.47	0.003	1.1	0.007	—	—	—	—	—
Pyrene	6.1	0.87	0.043	3.6	0.177	—	—	—	—	—
		HI subtotal	1.600		2.617			5.293		10.411
Radionuclides										
Cesium-137	14	0.88	0.019	1.11	0.079	—	—	—	—	—
Plutonium-239,240	21	0.067	0.001	0.084	0.004	2100000	0.071	<0.001	0.25	<0.001
Strontium-90	—	—	—	—	—	1000000	105	<0.001	207.83	<0.001
Uranium-234	—	—	—	—	—	2600000	0.767	<0.001	1.73	<0.001
		HI subtotal	0.020		0.083			<0.001		<0.001

[a] A dash in the table means not a COPC for this media.

[b] N.A. = not available.

F-4.0 RISK AND DOSE ESTIMATES, CONSTRUCTION-WORKER AND RESOURCE-USER SCENARIOS

The following plots support Tables 5.1-2 through 5.1-5 in Section 5. Section 5.1 contains surface sediment plots for the trail-user scenario. The plots in this appendix show the resource-user and construction-worker scenarios, using the volume weighted averages for the contaminants.



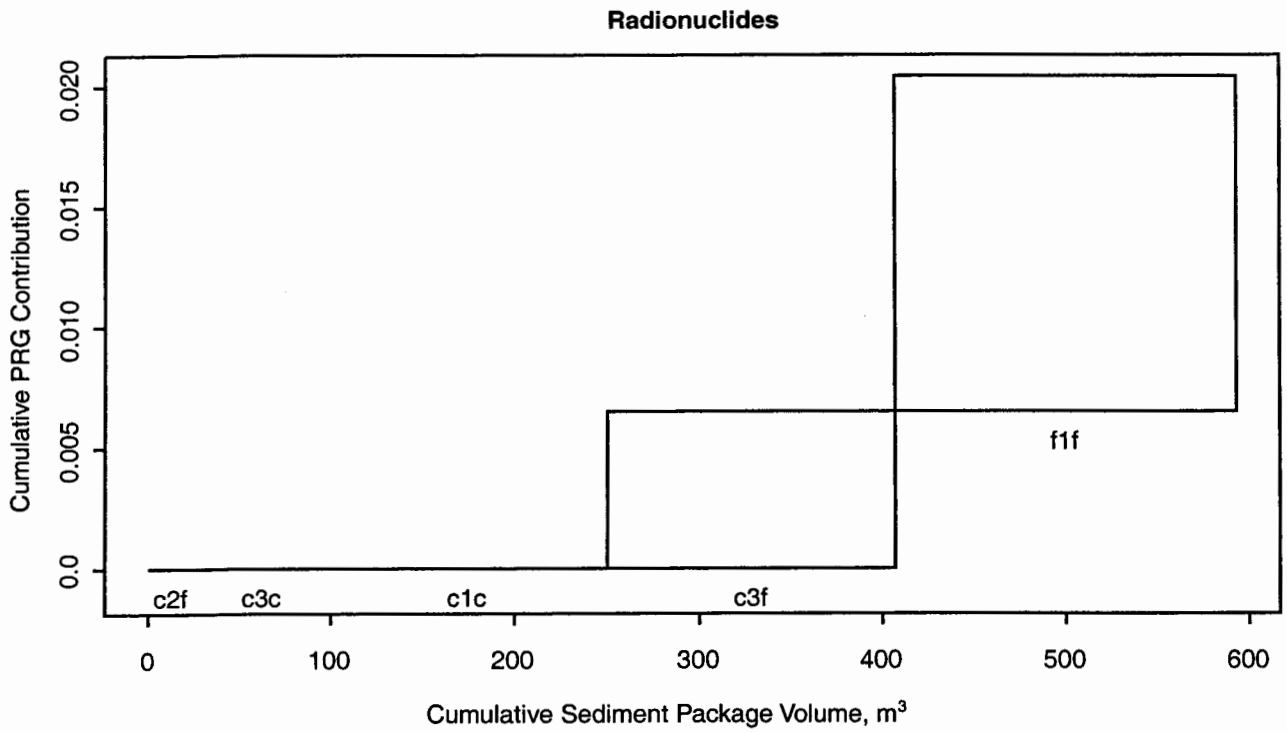


Figure F-4.0-1. Reach DP-1 sediment package volume contributions to summed PRG estimate, resource-user scenario

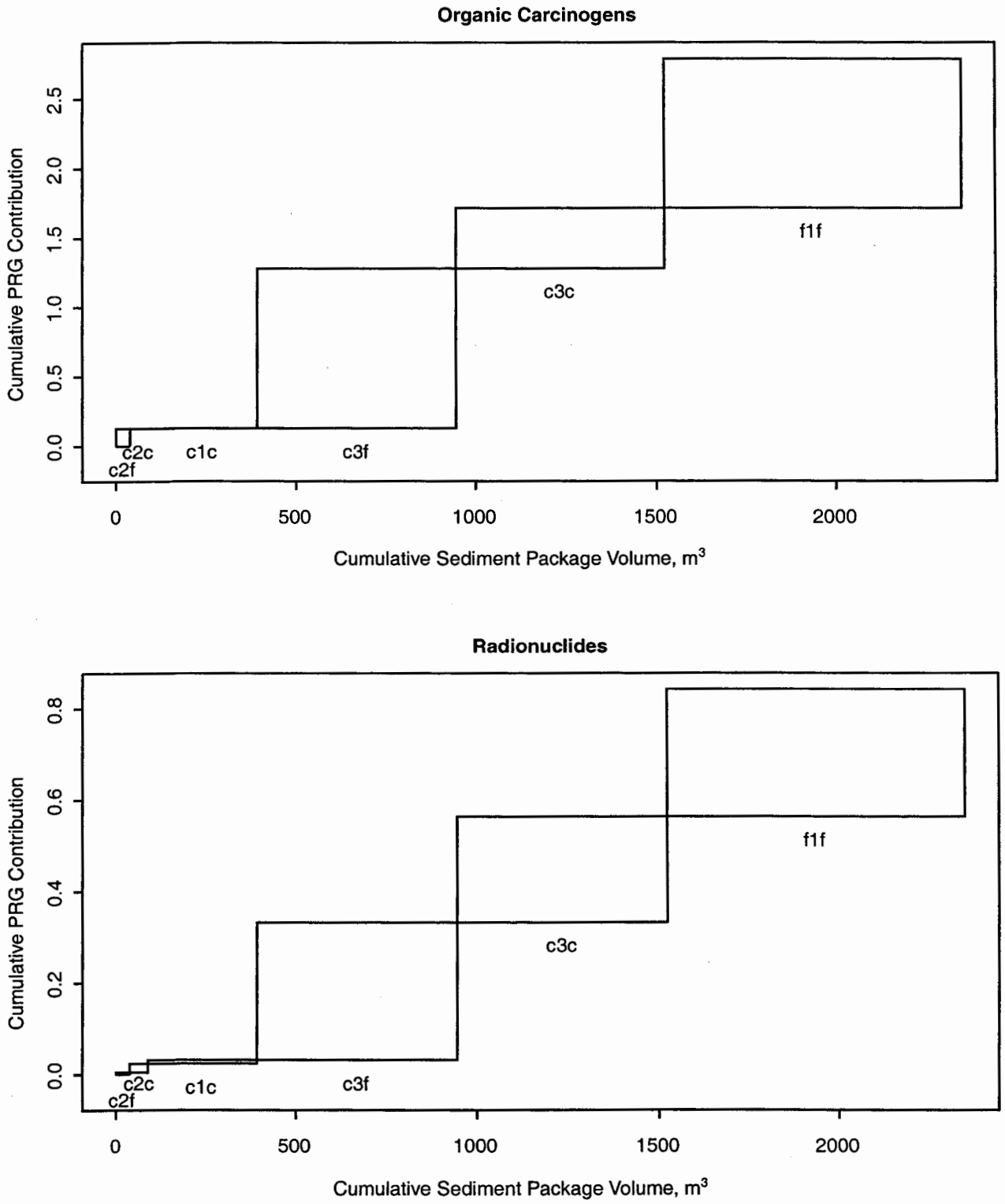


Figure F-4.0-2. Reach DP-2 sediment package volume contributions to summed PRG estimate, resource-user scenario

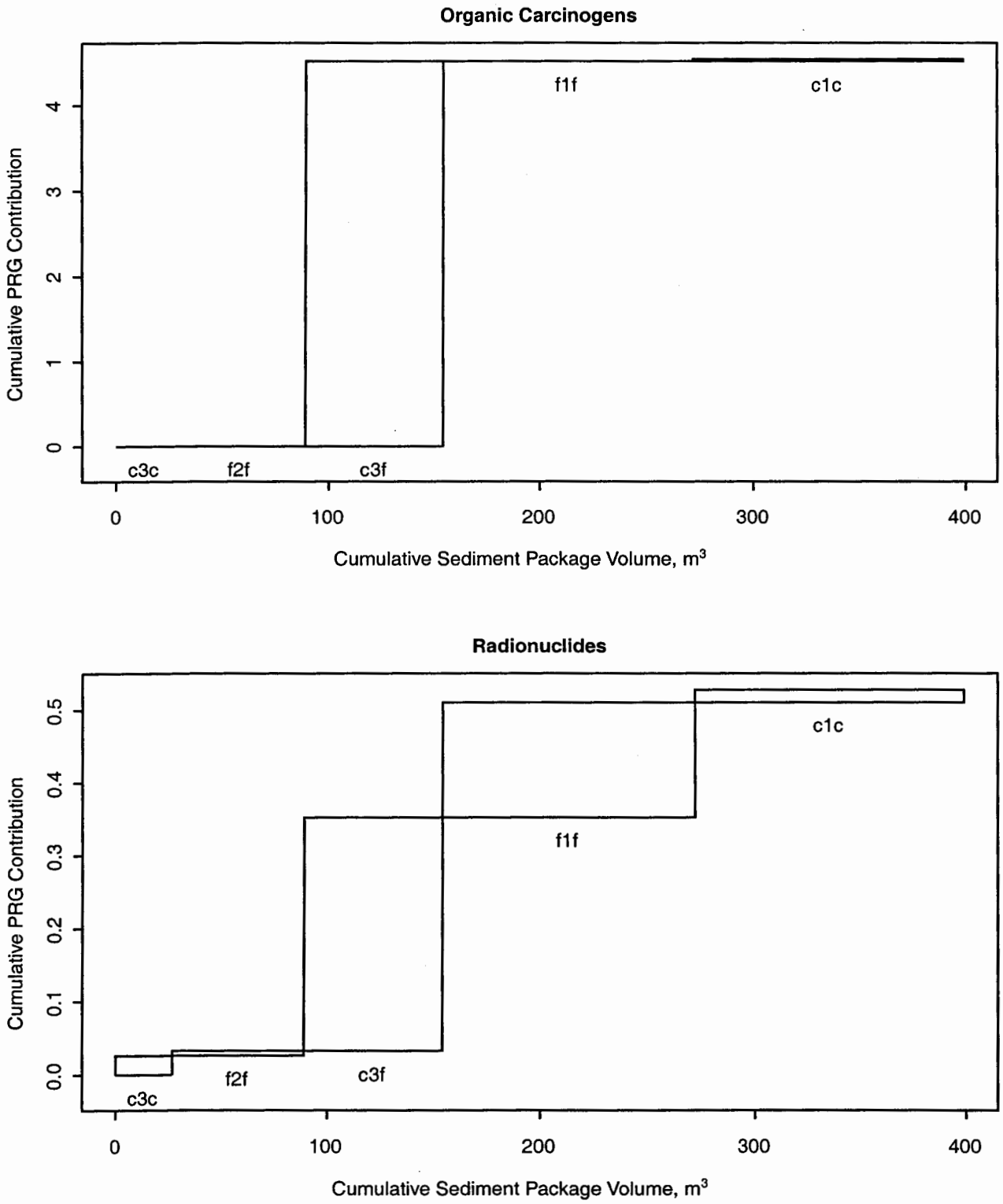
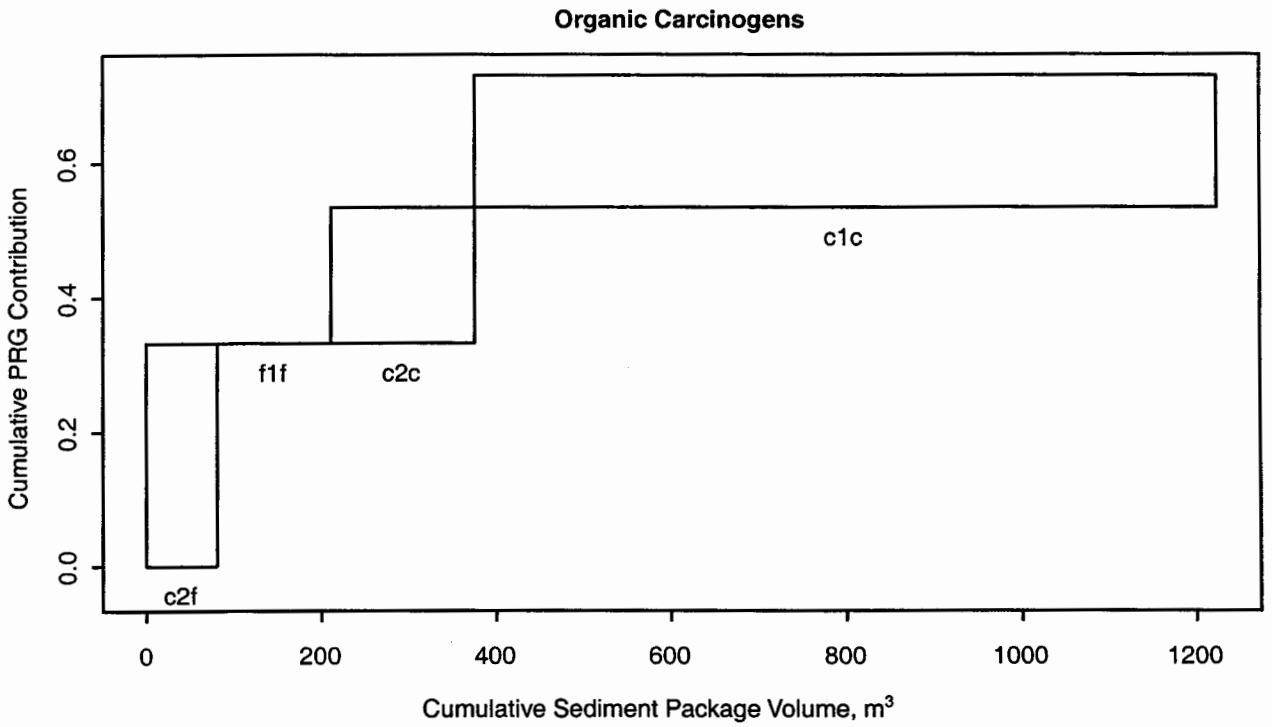


Figure F-4.0-3. Reach DP-3 sediment package volume contributions to summed PRG estimate, resource-user scenario



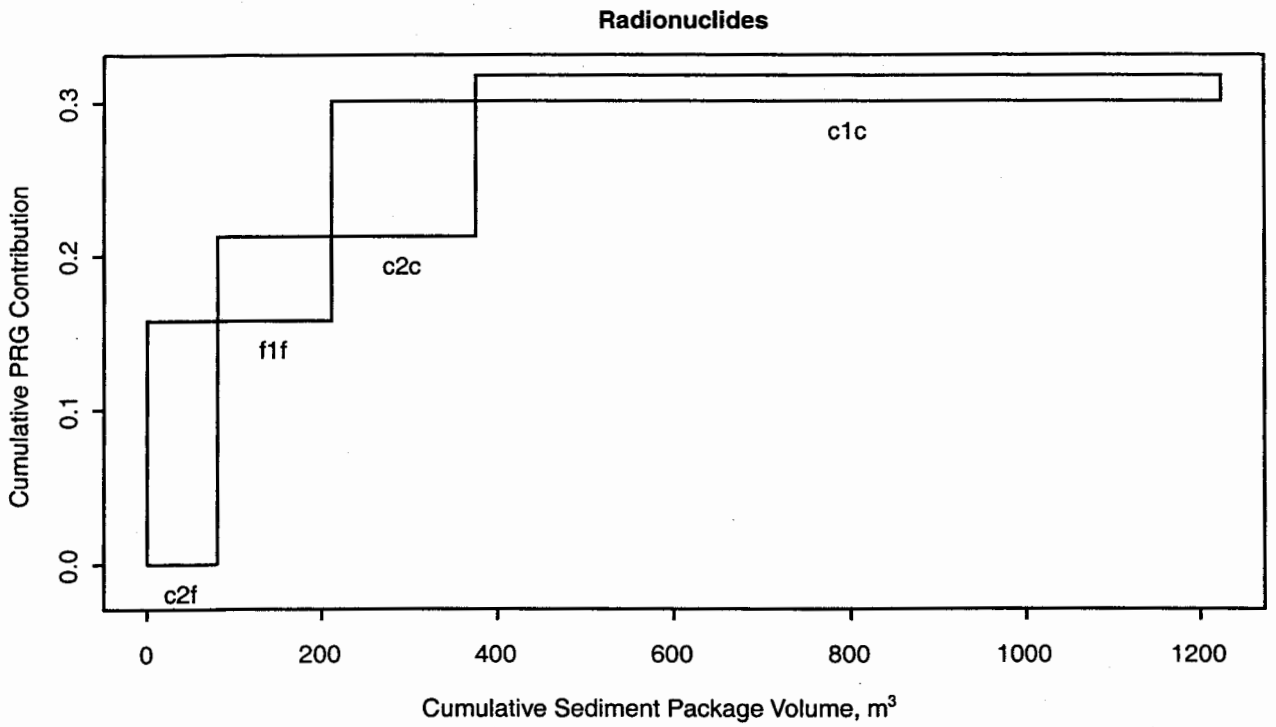


Figure F-4.0-4. Reach DP-4 sediment package volume contributions to summed PRG estimate, resource-user scenario

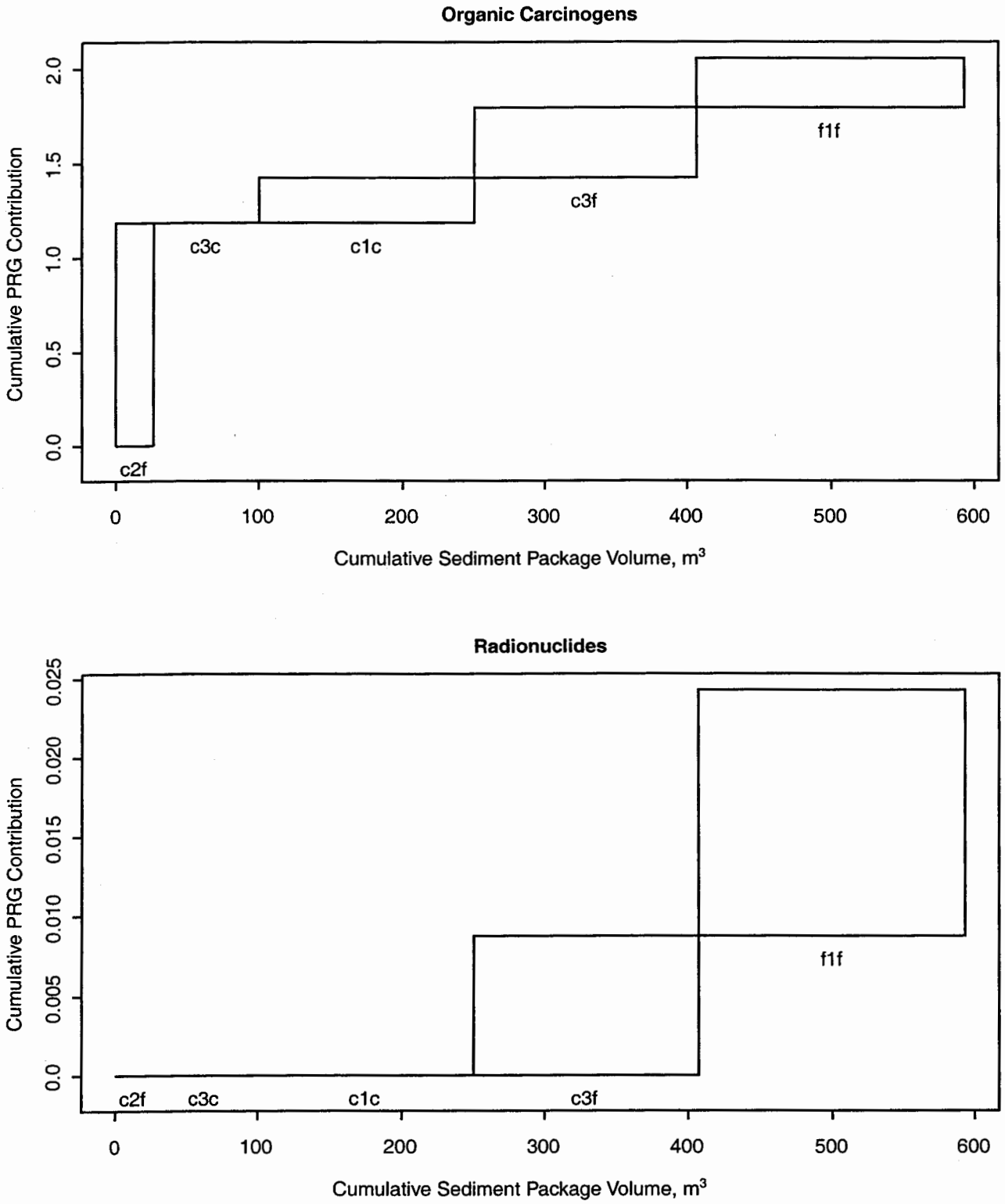


Figure F-4.0-5. Reach DP-1 sediment package volume contributions to summed PRG estimate, construction-worker scenario

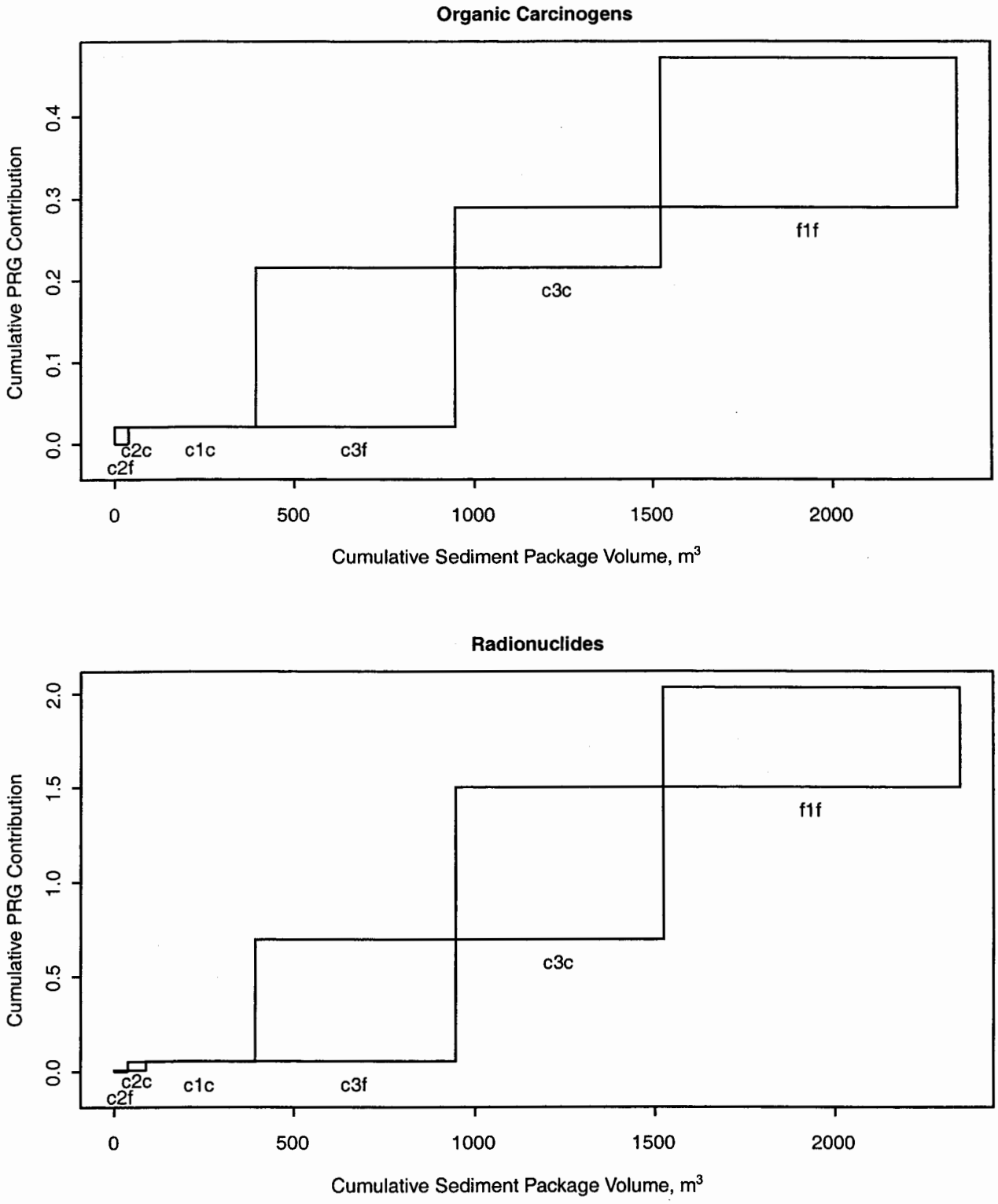


Figure F-4.0-6. Reach DP-2 sediment package volume contributions to summed PRG estimate, construction-worker scenario

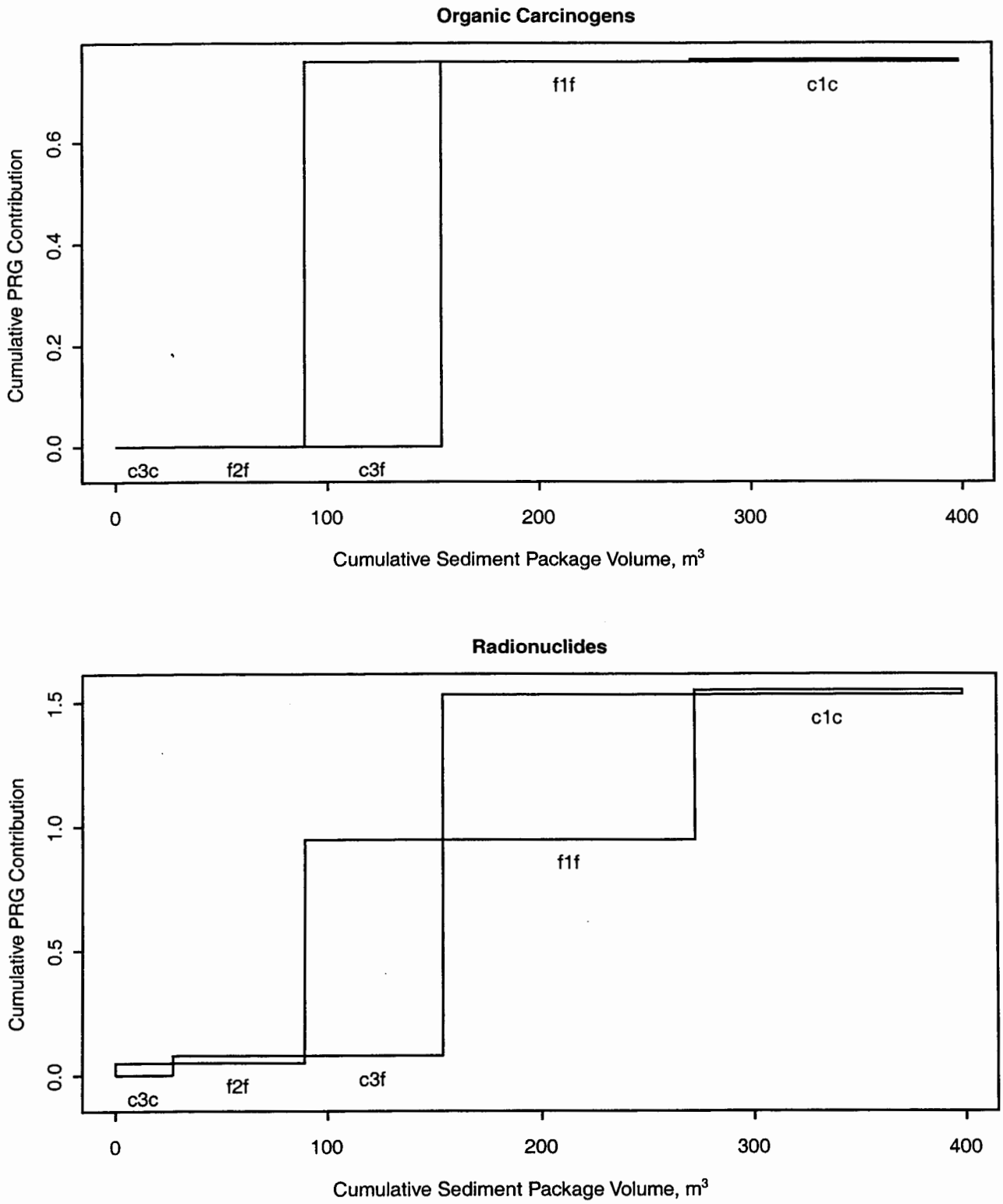


Figure F-4.0-7. Reach DP-3 sediment package volume contributions to summed PRG estimate, construction-worker scenario

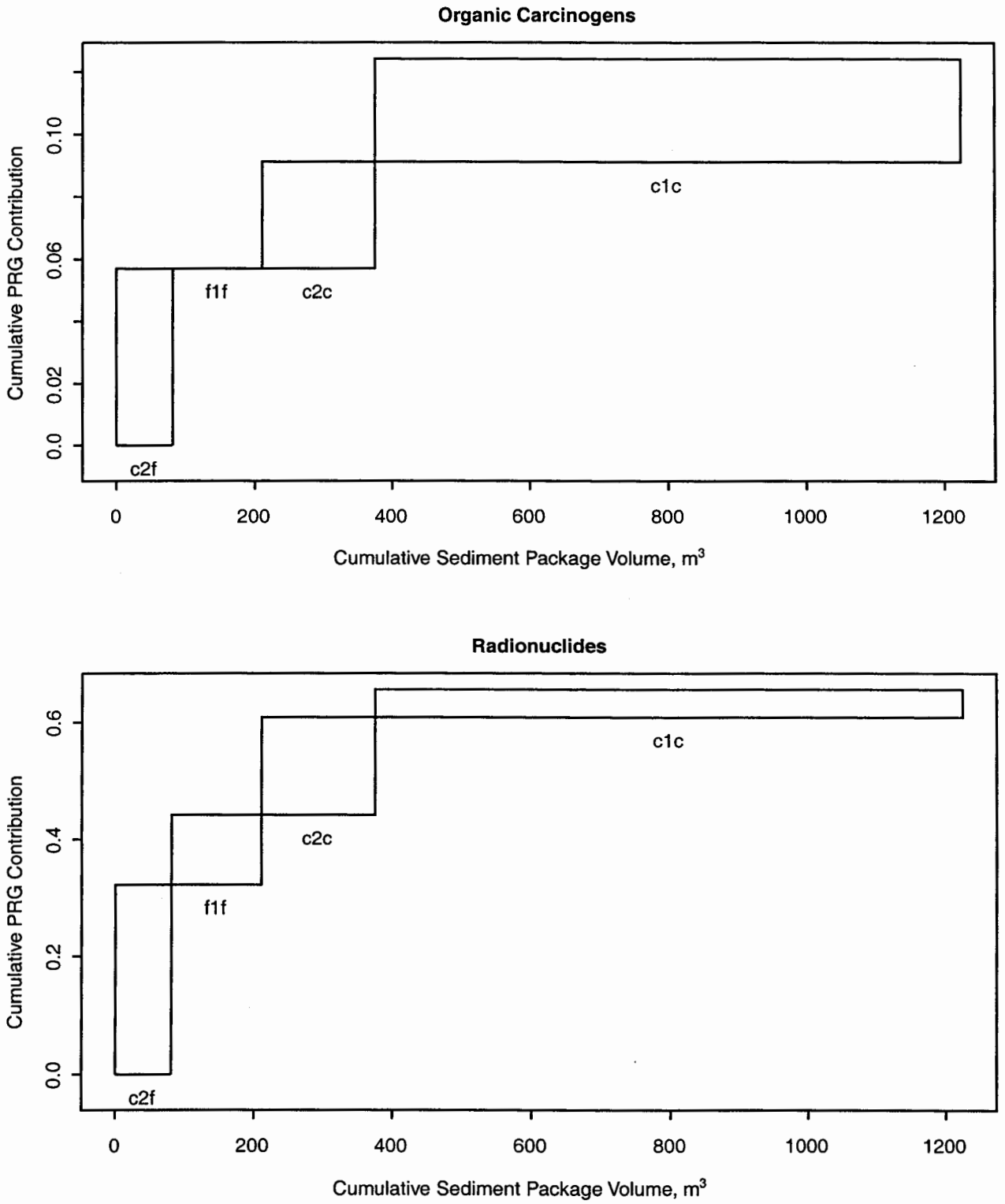


Figure F-4.0-8. Reach DP-4 sediment package volume contributions to summed PRG estimate, construction-worker scenario