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Date: September 30, 1997
Refer to: EM/ER:97-395

Steve/Terri
need to do fatal flaw review on these documents + then remand to LANL/DOE or assign to appropriate staff. Please let me know by mon. your result of fatal flaw review — Benito 10/3/97

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SEP 30 1997

Mr. Benito Garcia
NMED-HRMB
P.O. Box 26110
Santa Fe, NM 87502

SUBJECT: SUBMITTAL OF RFI REPORTs FOR PRSs IN TAs 0, 1, 3, 10, 11, 13, 15, 16, 33, 36, AND 73

Dear Mr. Garcia:

Enclosed are two copies of each of the Los Alamos National Laboratory's Resource Conservation and Recovery Act Facility Investigation Reports for Potential Release Sites in Technical Areas 0, 1, 3, 10, 11, 13, 15, 16, 19, 33, 36, and 73. One copy of each report is for your information and the second copy of each should go to your technical branch. The list of reports submitted is itemized on the following page.

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

Sincerely,

Jorg Jansen, Program Manager
LANL/ER Project

Sincerely,

Theodore J. Taylor, Program Manager
DOE/LAAO

JJ/TT/ss

Enclosures (1) RFI Reports for PRSs in TAs 0, 1, 3, 10, 11, 13, 15, 16, 19, 33, 36, and 73
(2) Certifications

Cy (w/ encs.):
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D. Griswold, AL-ERD, MS A906
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CERTIFICATION

I certify under penalty of law that these documents and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violation.

Document Title: [redacted]

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Joseph Vozella,
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DOE-Los Alamos Area Office

RFI Report for

TA-19
PRSs 19-001, 19-003, and C-19-001

Field Unit 1

Environmental
Restoration
Project

September 1997

A Department of Energy
Environmental Cleanup Program

Los Alamos
NATIONAL LABORATORY

LA-UR-97-3791

LAWL 1/1071/19

1.0 EXECUTIVE SUMMARY

This report presents the results of the Phase I Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) conducted at former Technical Area (TA) 19 at Los Alamos National Laboratory (LANL). This report specifically addresses Potential Release Sites (PRSs) 19-001, 19-003 (collectively known as PRS Aggregate 19-A), and C-19-001. Included in this report are the data assessment and analysis approach used in this investigation, and the site-specific results, conclusions, and recommendations regarding RCRA constituents for the PRSs listed above.

Although radionuclides are regulated by the Department of Energy (DOE) and are not regulated under RCRA, it is more efficient and cost-effective to investigate all types of potential contamination during a single site characterization. Therefore, radiochemical concerns are addressed in this report.

PRS 19-001 is a septic system, consisting of a tank, piping, and outfall, which was reported to have handled sanitary waste from the retreat building. PRS 19-003 is a sewer drainline and outfall which was reported to have handled sanitary waste from the laboratory. PRS C-19-001 is associated with possibly contaminated soil beneath the former laboratory, battery building, guard house, latrine, retreat building, and shelter building.

The objective of the RFI at former TA-19 was to determine whether any residual contamination is present as a result of historical operations. During the RFI at TA-19, 11 surface soil samples were collected from 10 locations from depths ranging from 0–6 in. Thirteen subsurface soil and crushed tuff samples were collected from ten locations from depths ranging from 3–10.5 ft below the ground surface. Samples were screened for radioactivity and volatile organic compounds (VOCs), and were submitted for fixed laboratory analysis for radionuclides, VOCs, semivolatile organic compounds (SVOCs), and total metals. Field screening results indicate that no sample had radiation levels or VOC concentrations exceeding background levels. Background comparisons, screening assessments, and risk assessments of the fixed laboratory analytical results indicated that no chemicals are present at the site at levels that pose an unacceptable risk to human health. Therefore, TA-19 is proposed for no further action (NFA) based on NFA Criterion 5.

TABLE ES-1

SUMMARY OF PROPOSED ACTIONS

			PROPOSED ACTION				
PRS NUMBER	HSWA[a]	RADIONUCLIDE COMPONENT[b]	NFA CRITERION	FURTHER ACTION[c]	ADD TO HSWA MODULE[d]	RATIONALE	SECTION NUMBER
19-001	X	X	5			Risk levels for recreational and residential scenarios are within ranges considered acceptable by EPA .	5.1.9.1
19-003	X	X	5			Risk levels for recreational and residential scenarios are within ranges considered acceptable by EPA .	5.1.9.3
C-19-001	X	X	5			RCRA and radionuclide contamination are below SALs.	5.2.8

[a] An X in this column indicates that the site is listed on the Hazardous and Solid Waste Amendments (HSWA) Module (Module VIII) of the Laboratory's RCRA operating permit.
[b] An X in this column indicates that the site has a radionuclide component.
[c] VCA, EC, further investigation, or CMS.
[d] An X in this column indicates that hazardous constituents were confirmed at a site not already listed on the HSWA Module. The site requires further action; therefore, the site needs to be added to the Module.

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1.0 INTRODUCTION

This report presents results of the Phase I Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) at former Technical Area (TA) 19 at Los Alamos National Laboratory (LANL) (Fig. 1.1-1). Included in this report are the data assessment and analysis approach used in this investigation, and the site-specific results, conclusions, and recommendations for potential release sites (PRSs) 19-001, 19-003 (collectively known as Aggregate 19-A), and C-19-001. Although radionuclides are regulated by the Department of Energy (DOE) and not under RCRA, it is more efficient and cost-effective to investigate all types of potential contamination during a single site characterization. Therefore, it is a LANL/DOE policy to address radiochemical concerns in this report.

PRS 19-001 is a septic system consisting of a tank, piping, and outfall which reportedly handled sanitary waste from the retreat building. PRS 19-003 is a sewer drainline and outfall which reportedly handled sanitary waste from the laboratory. PRS C-19-001 is associated with possibly contaminated soil beneath the former laboratory, battery building, guard house, latrine, retreat building, and shelter building.

1.1 General Site History

The former TA-19 (East Gate Laboratory) is now part of TA-72 and is located in Santa Fe County east of the Los Alamos Airport and East Gate Industrial Park (Figure 1.1-2). The site is situated on Los Alamos Mesa and is bounded by Pueblo Canyon on the north and by a small branch of Pueblo Canyon on the south at an elevation of approximately 6 910 ft above sea level (LANL 1992, 0781).

The East Gate Laboratory was constructed in 1944 for Dr. Emilio Segre, "who needed an isolated spot for exacting experimental work on small sources" (DOE 1987, 0264). In 1947 the site consisted of a storage hutment and laboratory building, which was used for a variety of experiments, some of which used radioactive sources and chemicals. More buildings were added until the site consisted of a laboratory building, battery building, guard building, latrine, retreat building, septic tank, and shelter building. The retreat building was used by East Gate Laboratory personnel for breaks and meals. Engineering records indicate that the battery building, guard building, and latrine were removed in 1956. In 1962, the laboratory building, retreat building, and shelter building were transferred to the Zia Company and assigned to the Municipal Activities Branch of the DOE Los Alamos Area Office (LAAO) for Civil Defense purposes. LAAO later authorized the Los Alamos Radio Club to use the site. In 1974 the site was abandoned and all buildings were removed (LANL 1992, 0781).

Early work at the former TA-19 included spontaneous fission experiments and storage of radioactive source material. In 1952, two scintillation studies involving the use of aromatic compounds were documented, including the use of trimethyl borate mixed with toluene and other materials. A 1957 memo states, "Radioactive source material is now stored, or has been stored, in the old East Gate Laboratory Building". In 1958, H-4 reported that an employee was exposed to radioactivity while working in the East Gate Laboratory calibration building. Irradiation experiments using sealed radioactive lanthanum sources were also conducted on monkeys at the East Gate Laboratory. In 1960, activity at East Gate resulted in an incident of external radiation off-site, and in 1961 a 300-Curie cobalt-60 source was reportedly used at East Gate (DOE 1987, 0264).

The site is potentially contaminated by radioactive, hazardous, sanitary, and solid waste. Radioactive materials handled at the site were of at least three types: (1) actinides, used in microgram quantities for spontaneous fission experiments; (2) a 300-Curie cobalt-60 source used for irradiation as late as 1961; and (3) a radioactive lanthanum source used in irradiation experiments on monkeys. Cobalt-60 has a 5.27-year half-life. The lanthanum source was probably lanthanum-140 derived from barium-140, which have half-lives of 40 hours and 12 days, respectively. Sanitary waste may have been discharged from the guard house, retreat building, the septic system, and the drainline from the laboratory building. Solid waste consisted of the building and battery debris previously located on PRS 19-002, which was remediated in 1995 (LANL 1996, 05-0269). Chemicals, such as trimethyl borate, toluene, 2-1(1-napthyl)-5-phyenyloxozale, and terphehyl in triethylbenzene may also be present (LANL 1992, 0787).

1.2 RFI Overview

The objective of the Phase I RCRA RFI at former TA-19 was to determine whether any residual contamination is present as a result of historical operations. This determination would be based on analytical results of soil and crushed tuff samples collected from drainages, septic tank excavation, and drainline trenches in accordance with the sampling and analysis plan (SAP) presented in the Operable Unit (OU) 1071 work plan (LANL 1992, 0781). Removal of subsurface structures, including the septic system and laboratory drain line, was also performed.

In addition, the septic system and laboratory drainline were found to still be in place. Therefore, in accordance with Chapter 2.3.4.1 of the RFI Work Plan for OU 1071, the subsurface structures were removed and confirmation samples were collected from the septic tank excavation and pipeline trenches (LANL 1992, 0781).

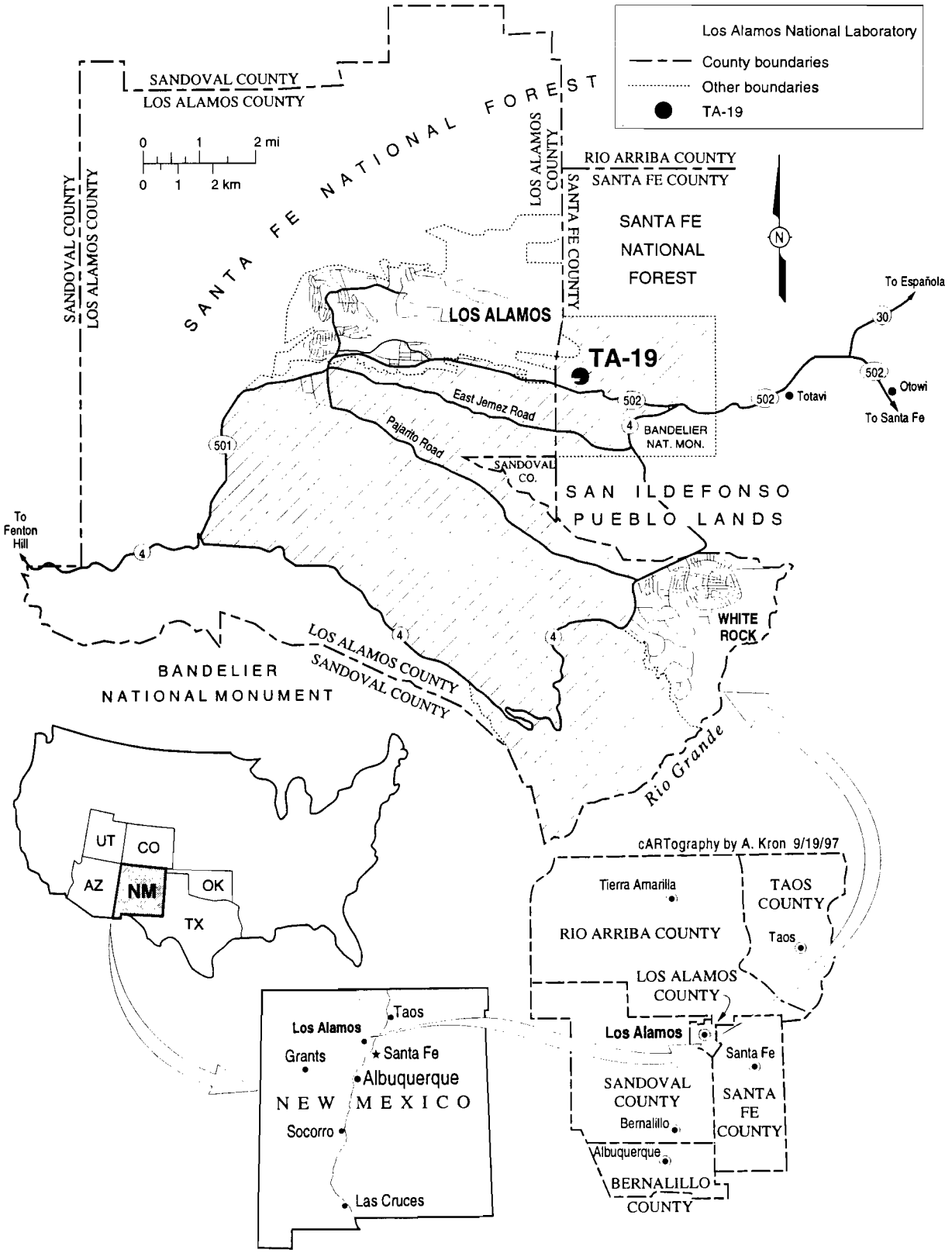

Figure 1.1-1 Location of TA-19 within LANL, Los Alamos County, New Mexico

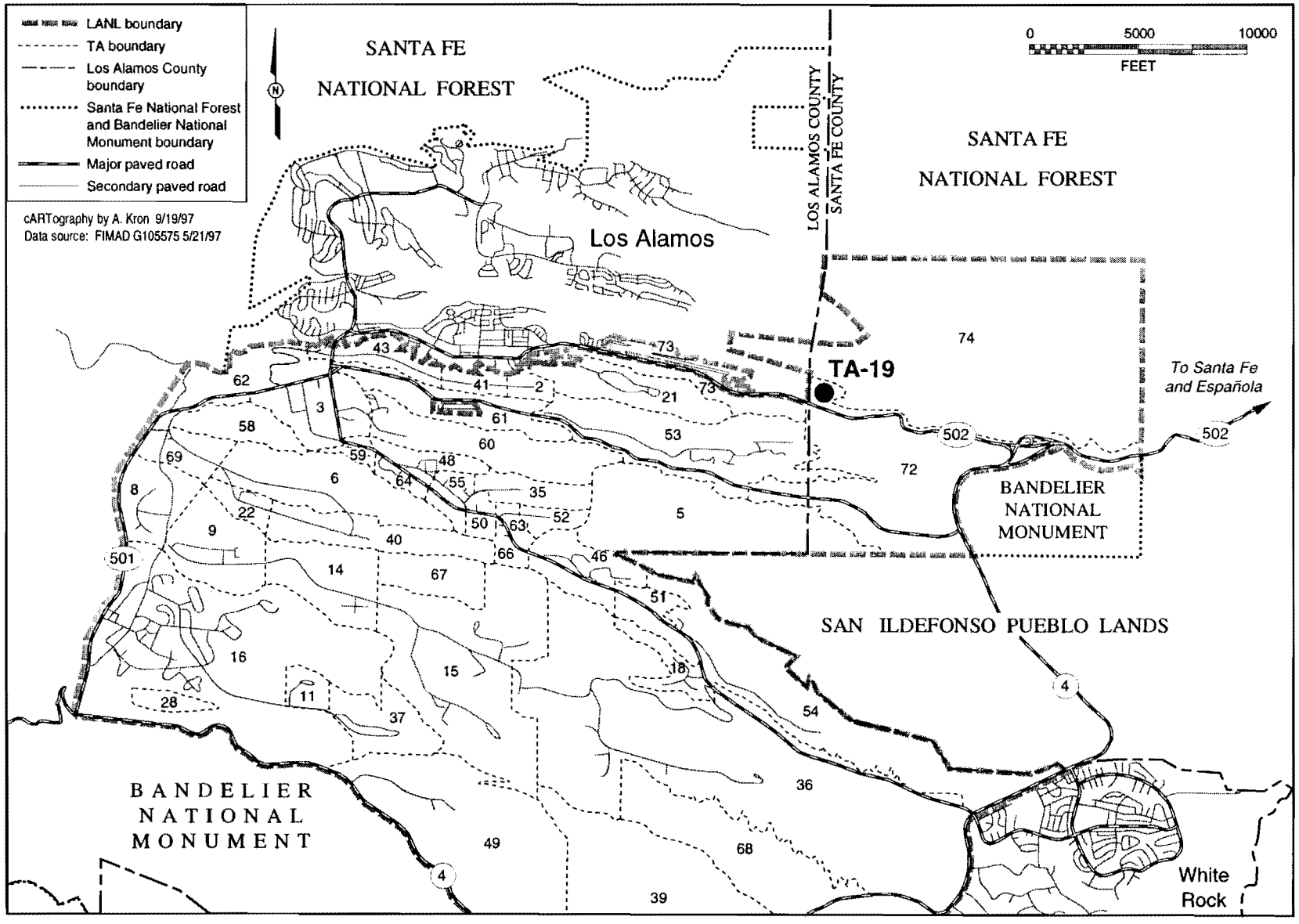

Figure 1.1-2 Location of TA-19 with respect to Laboratory and surrounding land holdings

The conceptual model for former TA-19 is presented in the OU 1071 work plan (LANL 1992, 0781). Sources of potential contamination include the septic tank system and laboratory drainline. Potential contaminants may have been released to the environment via leaks and discharges from the septic tank system and laboratory drainline. As a result, contaminants may be present in the soil or tuff. Contaminants in soil or tuff may leach through the vadose zone, be entrained by surface water, and transported downstream by run-off, or be entrained and transported off-site by wind. Contaminants present in the tuff may leach or disperse through the vadose zone.

Human or terrestrial animal exposure to possible site contaminants may occur through inhalation of suspended particulates or incidental ingestion of soil or dermal contact with soil.

1.3 Field Activities

All applicable LANL Environmental Restoration (ER) standard operating procedures (SOPs) (LANL 1997, 0875) were followed while completing field work.

1.3.1 Geodetic Surveying

A geodetic survey was performed in March 1997 to establish the original locations of the septic tank, drainlines, outfalls, and corners of buildings and fences. The survey was based on structure coordinates provided in both the Los Alamos Scientific Laboratory (LASL) Grid System and the New Mexico State Plane (NMSP) Coordinate System. After sampling and removing structures, each sample location was surveyed in July 1997.

1.3.2 Surface Sampling

On June 16, 1997, two samples were collected from each of three major south-draining channels downgradient of the former laboratory building area. One surface sample was collected from each drainage at the mesa top, approximately 6 ft from the mesa edge. One surface sample was then collected from each drainage on a shelf below the mesa edge.

Surface samples were collected from sediment catchments downslope of the drainline outfalls on July 15, 1997. Two surface samples were collected from each catchment: one below the septic tank outfall and one below the laboratory sewer drainline outfall.

1.3.3 Structure Removal and Subsurface Sampling

The septic system inlet and outlet lines and laboratory sewer drainline were located and removed in accordance with Chapter 2.3.4.1 of the RFI Work Plan (LANL 1992, 0781) on July 14 and 15, 1997. Each of the two drainlines ended approximately 20 ft short of the mesa edge. Gravel-filled trenches were present from the end of the pipes to the tuff boulders lining the mesa edge.

The septic tank was uncovered on July 15, 1997. Approximately 300 gal. of water were pumped out the tank and into 55-gal. drums. The tank was too large to be removed with the backhoe that was on-site; therefore, on July 17, 1997, the septic tank was removed using a larger tracked excavator.

Subsurface samples were collected from the pipeline trenches on July 15, 1997. One sample was collected from each of the drainline trenches at the end of each pipe. An additional sample was collected at the end of the laboratory drainline approximately 1 ft below the depth of the initial sample. Other subsurface samples were collected from the septic tank inlet and outlet pipe trenches, the laboratory drainline trench, and the septic tank excavation, as shown on Table 1.3.3-1.

TABLE 1.3.3-1

SUBSURFACE SAMPLE LOCATIONS

Septic tank inlet pipe trench	Septic tank outlet pipe trench	Septic tank excavation	Laboratory drainline trench
Beginning of pipe where floor drain left retreat building	Beginning of pipe where connected to septic tank	North end of excavation at depth of 10 ft below ground surface (bgs)	Beginning of pipe where drain left laboratory building
End of pipe where connected to septic tank	Midway from septic tank to end of pipe	South end of excavation at depth of 10 ft bgs	Midway from former building location to end of pipe
	End of pipe approximately 20 ft from mesa edge		End of pipe approximately 20 ft from mesa edge (two samples)

No soil or tuff staining or other visible evidence of contamination was observed during the removal of the septic system and laboratory drainline. No volatile organics nor radiography at levels greater than background were detected by field screening of removed pipe, septic tank sludge, and sample material. No additional excavation of soil or crushed tuff was conducted from the tank excavation or drainline trenches after removing the subsurface structures.

2.0 ENVIRONMENTAL SETTING

The environmental setting of the Laboratory is described in Section 2.4 of the Installation Work Plan (IWP) for Environmental Restoration (LANL 1995, 1275). A detailed discussion of the environmental setting of the former TA-19, including climate, geology, and hydrology, as well as a conceptual hydrogeologic model for the area and its surroundings, is presented in the RFI Work Plan for OU 1071 (LANL 1992, 0781). A summary is presented in the following sections.

2.1 Climate

Los Alamos County has a semiarid, temperate, mountain climate. Summers are generally sunny with moderate, warm days and cool nights. High altitude, light winds, clear skies, and dry atmosphere allow summer afternoon temperatures to range from the 70s to the 80s, and nighttime temperatures are typically in the 50s. Typical winter temperatures are from 30 to 50 °F in the daytime to 15 to 25 °F at night. The average annual precipitation (both rain and snow) in the area of former TA-19 averages about 18 in. Of this total, approximately 40% occurs as brief intense thunderstorms during July and August (LANL 1992, 0781).

2.2 Geology

2.2.1 Geologic Setting

A detailed discussion of the geology of the entire Los Alamos area can be found in Section 2.5.1 of the IWP (LANL 1995, 1275) and in Section 4.1.3 of the RFI work plan for OU 1071 (LANL 1992, 0781). A summary of geological information specific to former TA-19 is presented below.

Former TA-19 is situated on the Tshirege Member of the Bandelier Tuff. Within the Tshirege, from top to bottom, are Units 3, 2, 1v, and 1g. A transition zone, known as the vapor phase notch, is present between Units 1v and 1g. The vapor phase notch typically has a higher moisture content than the other units. Other members below the Tshirege include (from top to bottom) the Cerro Toledo, Otowi, and Guaje members (Figure 2.2.1-1). These units are volcanic ash flows and ash falls. Depending on the nature of the deposit, the rock varies from loose pumice to hard, highly welded tuff. Degrees of welding vary within the individual units depending on the conditions of deposit and cooling.

Former TA-19 is located at the contact between the Units 3 and 2 of the Tshirege Member. The tuff is moderately welded at the surface and shallow subsurface away from the mesa edges but is welded at the edges where it forms 20-ft cliffs. The tuff removed while excavating the septic tank and drainlines, which was moderately welded and weathered to a pale pink color, had the appearance of Unit 3 tuff. The moderately welded tuff thinned close to the mesa edges where the highly welded, dark brown-to-orange Unit 2 formed the cliffs.

2.2.2 Soils

A discussion of the soils in the Los Alamos area can be found in Section 2.5.1.3 of the IWP (LANL 1995, 1275) and in Section 4.1.3.3.2 of the RFI work plan for OU 1071 (LANL 1992, 0781). A summary of that material specific to PRSs 19-001, 19-003, and C-19-001 is presented below.

According to the RFI Work Plan for OU 1071, moderately to well-developed soils that occur in former OU 1071 are present on the gently sloping surfaces of the mesa tops. These soils have formed primarily at elevations between 6 900 and 7 500 ft and in volcanic bedrock, such as the Bandelier Tuff. Such soils possess one or more Bt subhorizons, which are horizons that have significant accumulations of layer lattice clay when compared with the materials from which the horizons apparently formed. The Bt horizons of these soils have relatively large amounts of clay, which exhibit reddish hues and chromas. The reddish colors of these well-developed soils reflect the chemical weathering of iron-bearing aluminosilicate minerals and glass in the volcanic parent materials to pedogenic ferric iron oxyhydroxides under well-drained, oxidizing conditions. Such soils usually occur on relatively stable land forms. Accordingly, these soils occur on the most shallowly sloping areas of mesas, which are typically underlain by the Bandelier Tuff or other similar tuffaceous lithologies (LANL 1992, 0781).

The soil-tuff interface was found to be at a depth of less than 12 in. bgs. However, a detailed geomorphological survey was not conducted at the site to investigate the specific type of soil, the rate of soil accumulation, or the depth of the soil across the site.

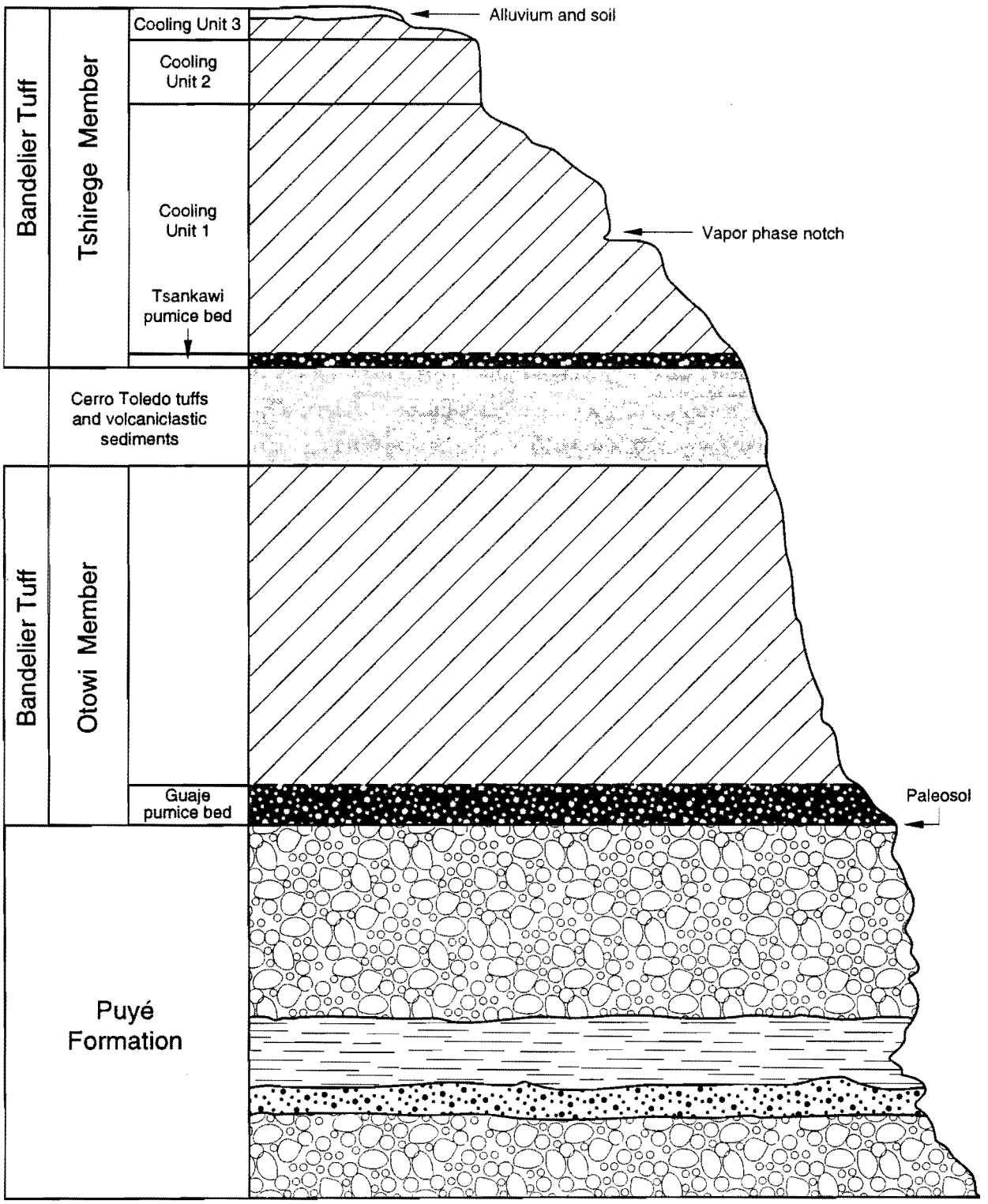

Figure 2.2.1-1 Generalized stratigraphy of TA-19

2.3 Hydrology

The hydrology of the Pajarito Plateau is summarized in Section 2.5.2 of the IWP (LANL 1995, 1275) and in Section 4.1.4 of the RFI work plan for OU 1071 (LANL 1992, 0781). Site-specific conditions are summarized below.

2.3.1 Surface Water

Most of the surface water runoff from the former TA-19 drains southward through numerous drainages toward the branch of Pueblo Canyon. Some runoff from the northern part of the site may drain northward toward Pueblo Canyon where an intermittent stream is located (Figure 2.3.1-1). Pueblo Canyon drains most of the Los Alamos townsite and also receives sewage effluent from the Bayo Canyon treatment plant. During periods of heavy storm runoff or snowmelt, surface discharge from Pueblo Canyon may reach the Rio Grande via Los Alamos Canyon. Infiltration of canyon surface flow recharges underlying alluvial and perched bedrock aquifers beneath the mid- and lower reaches of the canyon.

2.3.2 Groundwater

Groundwater occurs under former TA-19 in the main aquifer of the Pajarito Plateau, which is located at an elevation of approximately 6 000 ft above mean sea level as determined in Test Well 2 in Pueblo Canyon and in Otowi 4 in Los Alamos Canyon. The main aquifer is found in the sediments of Puye and Tesuque Formations (Purtymun 1995, 1293; Broxton and Eller 1995, 1162). Depth to this aquifer is approximately 980 ft bgs from the mesa top surface of TA-19. Shallow alluvial and perched aquifers are present in DP, Los Alamos, and Pueblo Canyons. No migration pathway from the PRS surface to the main aquifer is currently recognized.

2.4 Biological Surveys

Biological resource field surveys have been conducted in the area of PRSs 19-001, 19-003, and C-19-001 for compliance with the Federal Endangered Species Act of 1973; the New Mexico Wildlife Conservation Act; the New Mexico Endangered Species Act; Executive Order 11990, "Protection of Wetlands"; Executive Order 11988, "Floodplain Management"; 10 CFR 1022; Floodplain/Wetlands Environmental Review Requirements DOE 1979,0633); and DOE Order 5400.1, General Environmental Protection Program (DOE 1988, 0075).

The results of these surveys and the habitat description for PRSs 19-001, 19-003, and C-19-001 described in this report will be included in the ecological RFI report prepared by the Ecological Risk Assessment Team for the ecological exposure unit in which these PRSs are located.

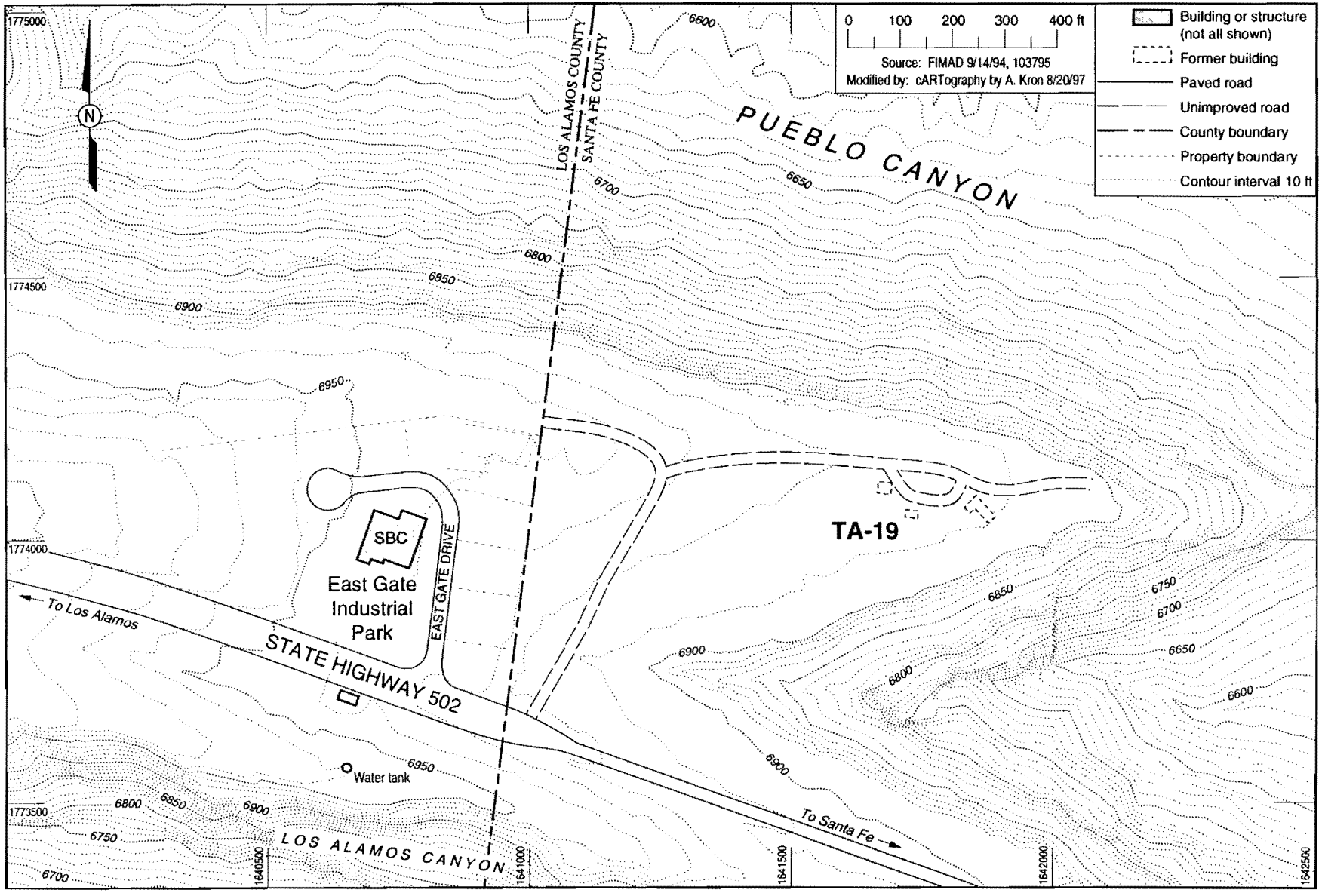

Figure 2.3.1-1 Topography of TA-19

2.5 Cultural Surveys

A cultural resource survey was conducted in 1991 in the area of former TA-19, as required by the National Historic Preservation Act of 1966 (as amended). The methods and techniques used for this survey conformed to those specified in the Secretary of the Interior's standards and guidelines for archaeology and historic preservation. A cultural resource survey report covering this area has been sent to the State Historic Preservation Office and concurrence has been received. No known intact archaeological sites remain in the subject area (LANL 1996, Ecol-96-1279).

3.0 APPROACH TO SAMPLE ANALYSES AND DATA ASSESSMENT

The approach to data assessment used by the ER Project is described in the policy document Risk-Based Corrective Action Process (Dorries 1996, 1297). The approach includes

- sampling and analysis design,
- field investigation and collection of field and QA samples,
- chemical and radiochemical analyses of samples and reporting of analytical data,
- baseline verification and validation of analytical data,
- organization of field and analytical data into PRS-specific data packages,
- exploratory data analysis,
- focused validation when necessary to further assess questionable data,
- comparison of validated analytical results with LANL background data,
- comparison of validated analytical results with LANL screening action levels (SALs),
- sufficiency of data set to support site decisions, and
- assessment of human health risk.

The following subsections provide overviews of the methods used to complete the steps listed above for the PRSs discussed in this RFI report.

3.1 Sample Analysis

Samples were collected in accordance with sample design specified in the RFI Work Plan for OU 1071 (LANL 1992, 0781). All samples requiring chemical and radiochemical analyses and chain-of-custody documentation were submitted to the LANL sample management office (SMO) for shipment to off-site fixed laboratories for analyses.

3.1.1 Analytical Methods

The following analytical suites were used for the sample analyses in this RFI report: target analyte list (TAL) metals (inorganic chemicals), volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and gamma-emitting radionuclides. A list of the target analytes for which analyses were performed for the purpose of this report can be found in Appendix A.

All samples were analyzed by contract analytical laboratories using methods specified in ER SMO analytical subcontracts (LANL 1995, 1278). The allowed methods are current EPA SW-846 and Contract Laboratory Program (CLP) methods or equivalent for inorganic chemicals, VOCs, SVOCs, and gamma emitting radionuclides. All metal samples were digested using EPA's 3050 digestion procedure and all organics were digested using EPA's digestion procedure (EPA 1992, 1207). The subcontracts specify LANL-approved methods for radiochemical analyses according to the technologies identified in the subcontract (americium-241 by alpha spectroscopy, tritium by liquid scintillation, or multiple isotopes by gamma spectroscopy). Analytical method selection is described in Appendix I of the ER Project "Quality Assurance Project Plan Requirements for Sampling and Analysis" (QAPP) (LANL 1996, 1292). For each analyte, quantitation or detection limits are specified as contract required estimated quantitation limits (EQLs) for organic chemicals and radionuclides and estimated detection limits (EDLs) for inorganic chemicals. These limits are included in Appendix III of the ER Project QAPP along with the target analytes for each analytical suite.

3.1.2 Data Validation

Data verification and baseline validation procedures were used to determine whether data packages received from the analytical laboratory were generated according to specifications and contain the information necessary to determine data sufficiency for decision-making. For analytical data used for decisions discussed in this RFI report, baseline data validation under the ER protocol was performed as described in the QAPP (LANL 1996, 1292).

This process produced validation reports, with data qualifiers designating potential deficiencies for affected results. Each data qualifier is accompanied by a reason code that provides

information about the deficiency that led to qualification of the data. The validation reports were used in the decision-making process and to direct the focused validations required to evaluate the usability of the data for this report.

Data were qualified (a marker was attached to the data results) for a variety of reasons during the baseline validation process. The baseline validation procedure used for routine analytical services provides information about the reason the qualifier was applied and its potential impact on the affected data. The purpose is not to reject data but rather to ensure that the relative quality of the data is understood so that the data may be used appropriately.

Data qualifiers used in the LANL ER Project baseline validation process are as follows.

- "A" signifies that the data required for data review and evaluation are not available.
- "U" signifies that the analyte was not positively identified in the sample, and the associated value is the sample-specific EQL/EDL.
- "J" signifies that the analyte was positively identified, and the associated numerical value is estimated to be more uncertain than would normally be expected for that analysis.
- "J+" signifies that the analyte was positively identified, and the result is likely to be biased high.
- "J-" signifies that the analyte was positively identified, and the result is likely to be biased low.
- "UJ" signifies that the analyte was not positively identified in the sample, and the associated value is an estimate of the sample-specific EQL/EDL.
- "RPM" signifies that without further review of the raw data, the sample results are unusable due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. Presence or absence cannot be verified. Any results qualified as RPM must be evaluated for relevance to data use.
- "P" signifies that professional judgment should be applied to using the data in decision-making.

- "PM" signifies that professional judgment should be applied to using the data in decision-making. A manual review of raw data is recommended to determine if the defect impacts data use for decision-making.
- "R" signifies that the data are rejected as a result of major problems with quality assurance/quality control (QA/QC) parameters.

A focused data validation may be required as a follow-up to the baseline validation. The purpose of a focused validation is to determine the technical adequacy of measurement data when:

- The data are qualified as deficient or as requiring professional judgment during the verification/baseline validation process. For example, when holding times are exceeded or interferences are present, a focused validation may be required to assist in determining data adequacy for the intended use.
- The data quality assessment process requires additional information about (1) the variability or uncertainty of the reported data, or (2) data quality before making a data-use decision because of anomalies detected in a data set.

Details of quality assurance/quality control activities are presented in Section 4 of this RFI report. Qualifiers resulting from baseline and focused validation are shown in the analytical results tables included in Section 5 of this report. Summaries of data quality evaluations and focused validation of analytical data relevant to this report are given in Appendix B. The RPM, P, and PM qualifiers do not appear in Section 5 data tables, nor in Appendix B, because they are replaced during focused validation according to the data use.

Laboratory contaminants are sometimes found in method blanks used by the analytical laboratories during organic analyses. When this occurs, there is a potential for samples to also be contaminated. To account for method blank contamination in samples, the "ten times" and "five times" rules are applied as described in the EPA document "Contract Laboratory Program National Functional Guidelines for Organic Data Review" (EPA 1994, 1205). The "ten times" rule states that when a common laboratory contaminant is found in the method blank, any values of that analyte detected in the samples at levels less than ten times the method blank concentration should be considered nondetected and a "U" qualifier should be added to the data. Common laboratory contaminants for VOC analysis include acetone, methylene chloride,

and 2-butanone; common laboratory contaminants for SVOC analysis include the common phthalates. The "five times" rule states that when an analyte that is not a common laboratory contaminant is found in the method blank, any values of that analyte detected in the samples at levels less than five times the method blank concentration should be considered nondetected and a "U" qualifier should be added to the data. These rules were used in addressing the data for TA-19 as discussed in Section 4.0 of this report.

3.2 Process for the Identification of COPCs

3.2.1 Inorganic Chemicals

Detected inorganic chemicals are compared with natural background distributions to determine whether they should be retained as chemicals of potential concern (COPCs) or eliminated from further consideration. The inorganic background data used in this RFI report are from the following sources:

- soil, sediment, and/or tuff samples collected throughout Los Alamos County for which chemical analyses were performed for certain inorganic (metal) chemicals (Longmire et al. 1995, 1142; Longmire et al. 1995, 1266). PRS samples were collected from fill material, and the all-soil-horizons background data set was used because the soil master horizon cannot be identified in disturbed material.

Comparisons between site data and background data are initially performed by comparing each observed concentration datum with a chemical-specific background screening value that is the upper tolerance limit (UTL), the maximum reported concentration, or, in the case of nondetected chemicals, the detection limit. These background screening values are derived from LANL-wide soil, sediment, and/or tuff background data, and details on the calculation of these values are presented in Longmire et al. (1995, 1266). Certain inorganic chemicals in certain media have no LANL-wide background data. For these exceptions, PRS sample-specific detection limits are used as nominal background screening values. In this report, silver is the only chemical that lacks background data.

Further statistical tests are used for background comparisons when sufficient data are available. When site data contain several nondetects and/or do not appear to satisfy normality assumptions, nonparametric tests are used for further background comparisons. The Gehan modification to the Wilcoxon Rank Sum test and the Quantile test, both of which account for nondetects, are used for these evaluations. The Gehan test is best suited for assessing

complete shifts in distribution in a statistically robust manner, whereas the Quantile test is better suited for assessing shifts of a subset of the data. Between the two tests, most types of differences between distributions can be captured. Detailed information on selecting statistical tests is presented in the guidance document Application of LANL Background Data to ER Project Decision-Making, Part I: Inorganics, EM/ER:96-PCT-010 (Project Consistency Team 1996, 1210; Ryti et al. 1996, 1298). Observed significance levels (p-values) for these tests are presented in Sections 5.1.5.2, 5.1.5.3, and 5.1.5.4 of this report. If a p-value is less than a specified probability, typically 0.05 or 5%, then there is some reason to suspect that there is a difference between the background and site distributions; otherwise, no difference is indicated. The results of these statistical tests, when available, are used in addition to the results of the comparison with background screening values to determine whether a chemical is considered greater than background.

3.2.2 Radionuclides

Comparing reported radiochemical results with minimum detectable activities and background data is necessary to determine the presence of radionuclides and to distinguish concentrations of radionuclides associated with Laboratory operations from those attributable to global fallout and/or to naturally occurring radionuclides.

The LANL ER Project requires that radiochemical data be reported by a laboratory on the basis of a detection test. Therefore, as part of the data validation/data assessment, reported results must be evaluated to ensure that only those results that represent detections be used to classify a radionuclide as a COPC. This is typically done by comparing the reported value with the associated minimum detectable activity if one is reported. When the minimum detectable activity is not available or does not meet the data quality needs of the ER Project, the reported value will be tested against an estimated minimum detectable activity. This estimated value is based on instrument counting error. The counting error is typically reported as the analytical uncertainty at a value of 1-sigma (one standard deviation), and the estimated minimum detectable activity is computed as 3-sigma.

Detected radionuclides are retained as COPCs or eliminated from further consideration based on a comparison with natural or anthropogenic background distributions. The radionuclide background data used in this RFI report are from the following sources:

- soil, sediment, and/or tuff samples collected throughout Los Alamos County for which chemical analyses were performed for certain naturally occurring

radioactive chemicals (Longmire et al. 1995, 1142; Longmire et al. 1995, 1266).

- background concentrations of radioactive chemicals associated with global fallout from atmospheric nuclear testing (plutonium, cesium, strontium, and tritium) reported in LANL Environmental Surveillance reports (Purtymun et al. 1987, 0211; ESG 1988, 0408; ESG 1989, 0308; Environmental Protection Group 1990, 0497; Environmental Protection Group 1992, 0740).

Comparisons between site data and background data are initially performed by comparing each observed concentration datum with a radionuclide-specific background screening value that is either the UTL or the maximum reported activity. These background screening values are derived from LANL-wide soil, sediment, and/or tuff background data, and details on the calculation of these values are presented in Longmire et al. (1995, 1266). Certain radionuclides in certain media have no LANL-wide background data. For these exceptions, PRS sample-specific minimum detectable activities are used as nominal background screening values. In this report, radionuclides that lack background data include americium-241, plutonium-238, plutonium-239/240, tritium, uranium-234, uranium-235, and uranium-238 that were detected but do not have a background screening value .

3.2.3 Organic Chemicals

Background data are not available for organic chemicals. Organic chemicals positively identified in one or more samples have been carried forward in the screening assessment process for the PRSs in this RFI report. Chemicals not detected in any sample have been removed from further consideration.

3.2.4 Risk-Based Screening Assessment

Inorganic chemicals and radionuclides that exceed background and organic chemicals positively identified in one or more samples require further evaluation if they also exceed SALs. SALs for nonradioactive chemicals are based on EPA Region 9 preliminary remediation goals (PRGs) for residential soil. In general, SALs represent a concentration that, given the Region 9 residential exposure assumptions, is associated with a one in one million lifetime excess cancer risk or a hazard quotient of one for carcinogens and noncarcinogens, respectively. SALs for radionuclides are calculated using the RESRAD computer code (Version 5.61) and a target dose level of 10 mrem/year. The decision to identify a chemical as a COPC when a SAL

is not available is made on a case-by-case basis, taking into account the availability of process knowledge and toxicological information.

If more than one COPC is present at the site, a multiple chemical evaluation (MCE) is performed to determine if the potentially additive effect of chemicals detected below SALs warrants additional investigation. The method for performing an MCE is summarized in the policy document "Risk-Based Corrective Action Process" (Dorries 1996, 1297). These comparisons are the last quantitative steps in the screening assessment process for human health concerns. If COPCs remain after this step, then further evaluation is required. If no COPCs remain after this step and the data set is sufficient to support the decision, an NFA recommendation may be proposed based on human health concerns.

If COPCs remain after the screening assessment, several options exist for the PRS. A further site-specific evaluation may lead to eliminating a COPC without going into a formal risk assessment. The site may be proposed for further sampling to more completely characterize the site or for remediation if it is cost effective to proceed without a risk assessment. A risk assessment may be conducted to determine if the remaining COPCs present an unacceptable human health risk.

3.3 Human Health Assessment

3.3.1 Risk Due to Naturally Occurring Inorganic Chemicals in Soils (Background)

Risk is associated with exposure to inorganic chemicals naturally occurring in soil. Calculation of background risks using the same methodology as site risk estimates provides a frame of reference for risk levels calculated at a site. This information provides a basis for determining risk-based remediation goals, which in some circumstances may be set at target risks comparable to background rather than default values, i.e., a cancer risk of 10^{-6} or a hazard index of 1. Background risks can also affect decisions at sites that have chemicals for which there is a toxicity threshold. For some inorganic chemicals, background intakes may be near a toxicity threshold such that incremental intakes associated with contamination may be unacceptable.

Background risk estimates provided in Table 3.3.1-1 were calculated using the same exposure assumptions by which SALs are calculated. SALs are based on health-protective assumptions for a residential scenario (EPA 1995, 1307). For soil exposure, the pathways include incidental soil ingestion, inhalation of resuspended dust, and dermal contact with soil. The background soil data used for these calculations were collected from several soil horizons at geographically

diverse locations. Background risks are estimated for two statistics. One statistic is the median, which represents the midpoint in the concentration range (technically, the median is the concentration value that divides the results into two equal groups or where half of the data are above and half are below this value). The second statistic represents the upper range on background concentration values, and is either a calculated UTL or a maximum concentration value. (UTLs and maximum concentration values are identical to those described in Section 3.2.1, Inorganic Chemicals.)

The background risks based on the LANL SAL residential exposure model are provided in Table 3.3.1-1. Risks due to background concentrations are presented for both noncarcinogenic and carcinogenic outcomes. The potential for adverse noncarcinogenic health effects is estimated by a hazard quotient. A chemical intake leading to a hazard quotient of up to 1 is not associated with adverse health effects. None of the median background concentrations result in hazard quotients greater than 1. The hazard quotient of the UTL concentration for manganese exceeds 1 (1.9). However, exposure to naturally occurring manganese is not expected to have significant health consequences because of the unlikely occurrence of the UTL concentration over an entire exposure area, the conservative assumptions used in the exposure assessment, and the margin of safety incorporated into the reference dose.

Three of the background inorganic chemicals provided in Table 3.3.1-1 are also carcinogens. Applying the default exposure assumptions used for SALs, the lifetime cancer risks due to residential soil exposure to background concentrations (UTL column) are estimated at approximately 1 excess case of cancer in 100 000 people for beryllium, 2 in 100 000 for arsenic, and 2 in 1 000 000 000 for cadmium (carcinogenic only by inhalation). EPA uses a range of 1 excess case of cancer in 10 000 people to 1 in 1 000 000 as a guidance for an acceptable range of cancer risk (EPA 1990, 0559).

These background risk estimates provide a frame of reference for a risk-based screening assessment and site decisions. If a site-specific risk assessment is necessary to further evaluate risks, background risks can also be calculated using site/scenario-specific assumptions to assist in any remedial action decisions for the site.

TABLE 3.3.1-1

RISK DUE TO BACKGROUND CONCENTRATIONS OF INORGANIC CHEMICALS IN SOIL ASSUMING A RESIDENTIAL SCENARIO[a]

INORGANIC CHEMICAL	BACKGROUND SOIL CONCENTRATION[b] (mg/kg)		HAZARD QUOTIENT		LIFETIME CANCER RISK	
	MEDIAN	UTL	MEDIAN	UTL	MEDIAN	UTL
Aluminum	10 000	38 700	0.1	0.5	NC[c]	NC
Antimony	0.6	1[d]	0.02	0.03	NC	NC
Arsenic	4	7.82	0.2	0.4	1×10^{-5}	1×10^{-5}
Barium	130	315	0.03	0.06	NC	NC
Beryllium	0.895	1.95	0.003	0.006	6×10^{-6}	1×10^{-5}
Cadmium[e]	0.2	2.6[d]	0.005	0.07	1×10^{-10}	2×10^{-9}
Chromium[f]	8.6	19.3	9.0×10^{-5}	0.0002	NC	NC
Cobalt	6	19.2	0.001	0.004	NC	NC
Copper	5.75	15.5	0.002	0.01	NC	NC
Lead[g]	12	23.3	0.03	0.06	NC	NC
Manganese	320	714	0.8	1.9	NC	NC
Mercury	0.05	0.1[d]	0.002	0.004	NC	NC
Nickel	7	15.2	0.005	0.01	NC	NC
Selenium	0.3	1.7[d]	0.0008	0.005	NC	NC
Thallium	0.2	1[d]	0.03	0.2	NC	NC
Uranium	0.9	1.87	0.004	0.008	NC	NC
Vanadium	21	41.9	0.04	0.08	NC	NC
Zinc	30.7	50.8	0.001	0.002	NC	NC

[a] Risk estimates are based on reference doses, slope factors, and EPA Region 9 default exposure assumptions effective August 1996.
[b] Background concentrations taken from the Longmire et al. all-soil-horizons data set (1995, 1142).
[c] NC = noncarcinogen
[d] Maximum detected background value.
[e] Cancer risks for cadmium are based solely on inhalation of resuspended dust.
[f] Naturally occurring chromium is assumed to exist in a trivalent state.
[g] Hazard quotient based on biokinetic uptake model.

3.3.2 Risk Assessment

The human health risk assessments presented in Section 5.1.9 follow the process outlined in the policy document Risk-Based Corrective Action Process (Dorries 1996, 1297). This process consists of the following steps:

- data evaluation,
- exposure assessment,

- toxicity assessment, and
- risk characterization.

3.4 Ecological Assessment

In cooperation with the New Mexico Environment Department and EPA Region 6, the Laboratory ER Project is developing an approach for ecological risk assessment. Further discussion of ecological risk assessment methodology will be deferred until the ecological exposure unit methodology being developed has been approved.

4.0 RESULTS OF QUALITY ASSURANCE/QUALITY CONTROL ACTIVITIES

4.1 Inorganic Analyses

Six soil samples collected from PRS C-19-001 were analyzed for TAL metals in request 3254R. There was one quality control (QC) problem which affected the data in this request. It was that antimony (38%), arsenic (55%), manganese (65%), selenium (51%) and thallium (70%) had low recoveries in the matrix spike sample. Matrix spike samples are used to assess the quality of the sample digestion, extraction, and analysis procedures. A low recovery suggests that either there was incomplete recovery of an analyte in these procedures or sample heterogeneity. To address this problem, post-digestion spikes, which are used to assess the sample extraction and analysis procedures, were performed for antimony, arsenic, manganese, selenium and thallium. The recoveries for the post-digestion spikes were within the limits allowed in USEPA SW846 guidelines. As required in LANL data validation guidelines, UJ or J- qualifiers were added to all antimony, arsenic, manganese, selenium, and thallium data in this request. All data are valid and usable as qualified.

Thirteen soil samples collected from PRSs 19-001 and 19-003 were analyzed for TAL metals in request 3386R. There were two QC problems with this request. The first was that manganese (68%) had a low recovery and lead (395%) a high recovery in the matrix spike sample. Matrix spike samples are used to assess the quality of the sample digestion, extraction, and analysis procedures. A low recovery suggests that either there was incomplete recovery of an analyte in these procedures or sample heterogeneity. A high recovery indicates either sample heterogeneity or a matrix interference. To address this problem, a post-digestion spike, which is used to assess the sample extraction and analysis procedures, was performed for manganese. The recovery for the post-digestion spike was within the limits allowed in USEPA SW846

guidelines. A post-digestion spike was not required for lead, however, because sample heterogeneity was confirmed in the results from the duplicate analysis, which had results similar to the matrix spike. As required in LANL data validation guidelines, UJ and J- qualifiers were added to all manganese data and J+ qualifiers to all lead data in this request. Another problem was that aluminum (74%) and iron (78%) had low recoveries in the laboratory control sample. These low recoveries indicate that the data for these elements may be biased low. Therefore, all aluminum and iron data are qualified J-. All data are valid and usable as qualified.

Four soil samples collected from PRSs 19-001 and 19-003 were analyzed for TAL metals in request 3424R. There were no QC problems with this request which affected the data, therefore, all data are valid and usable without added qualifiers.

4.2 Organic Analyses

4.2.1 Volatile Organic Compounds

Six soil samples collected from PRS C-19-001 were analyzed for volatile compounds in request 3253R. There were several QC deficiencies with this request. One was that the surrogate 4-bromofluorobenzene had high recoveries (126-164%) in samples 0119-97-0052, 0119-97-0053, 0119-97-0054, 0119-97-0055 and 0119-97-0056 and dibromofluoromethane had a high recovery (127%) and toluene-d8 had low recovery in sample 0119-97-0055. Surrogates are added to the samples before extraction and are a measure of the efficiency of the extraction process. Surrogate recoveries can be affected by sample matrix interferences, and high analyte concentrations. All of the samples above were reanalyzed with similar results, indicating matrix interferences were causing the surrogate problems. As required in LANL data validation guidelines, J+ qualifiers were added to all analytes detected in the samples with high surrogate recoveries and UJ or J- qualifiers were added to all analytes in the sample with a low recovery. Another deficiency was that the last internal standard for all samples and all internal standards for sample 0119-97-0055 were outside ranges allowed by USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (EPA 1994, 1205). Internal standards are used to assess instrument performance during the analytical procedure and standards outside the range indicate an interference from a sample or a change in the response of the instrument. All of the samples above were reanalyzed with similar results, indicating matrix interferences were causing the internal standard problems as well as the surrogate problems mentioned above. A UJ or J qualifier was added to all analytes associated with the internal standards. Associated analytes are those analytes which are in close proximity to the internal standard on the chromatogram. The last QC deficiency was that acetone (11 ug/kg)

was found in the method blank. Because acetone is a common laboratory contaminant, the "ten times" rule was applied as described in Section 3.1.2 of this report. Based on this rule, U qualifiers were added to all acetone values detected at less than 10 times the blank value, for all samples in this request. All data are valid and usable as qualified.

Thirteen soil samples collected from PRSs 19-001 and 19-003 were analyzed for volatile compounds in request 3385R. There were several QC deficiencies with this request. One was that the surrogate 4-bromofluorobenzene had low recoveries (59–62%) in samples 0119-97-0065, 0119-97-0067, and 0119-97-0068. Surrogates are added to the samples before extraction and are a measure of the efficiency of the extraction process. Surrogate recoveries can be affected by sample matrix interferences, and high analyte concentrations. All of the samples above were reanalyzed with similar results, indicating matrix interferences were causing the surrogate problems. As required in LANL data validation guidelines, UJ or J- qualifiers were added to all analytes in the sample with low recoveries. Another deficiency was that all of the internal standards for samples 0119-97-0065, 0119-97-0067 and 0119-97-0068 were outside ranges allowed by USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (EPA 1994, 1205). Internal standards are used to assess instrument performance during the analytical procedure and standards outside the range indicate an interference from a sample or a change in the response of the instrument. All of the samples above were reanalyzed with similar results, indicating matrix interferences were causing the internal standard problems as well as the surrogate problems mentioned above. A UJ or J qualifier was added to all analytes associated with the internal standards. Associated analytes are those analytes which are in close proximity to the internal standard on the chromatogram. The last QC deficiency was that acetone (4 ug/kg) was found in the method blank. Because acetone is a common laboratory contaminant, the "ten times" rule was applied as described in Section 3.1.2 of this report. Based on this rule, U qualifiers were added to all acetone values detected at less than 10 times the blank value, for all samples in this request. All data are valid and usable as qualified.

Four soil samples collected from PRSs 19-001 and 19-003 were analyzed for volatile compounds in request 3423R. There were no QC problems with this request, therefore, all data are valid and usable without added qualifiers.

4.2.2. Semivolatile Organic Compounds

Five soil samples collected from PRS C-19-001 were analyzed in request 3253R for semivolatile compounds. There were no QC problems with this request; therefore, all data are valid and usable without added qualifiers.

One soil sample collected from PRS C-19-001 was analyzed in request 3256R for semivolatile compounds. There were no QC problems with this request; therefore, all data are valid and usable without added qualifiers.

Thirteen soil samples collected from PRSs 19-001 and 19-003 were analyzed for semivolatile compounds in request 3385R. There were several QC deficiencies with this request. One was that the surrogate 2,4,6-tribromophenol had high recoveries (132-158%) in samples 0119-97-0067 and 0119-97-0068 and no recovery (0%) in sample 0119-97-0061. Surrogates are added to the samples before extraction and are a measure of the efficiency of the extraction process. Surrogate recoveries can be affected by sample matrix interferences, and high analyte concentrations. All of the samples above were reanalyzed with similar results, indicating matrix interferences were causing the surrogate problems. As required in LANL data validation guidelines, J+ qualifiers were added to all detected analytes in the samples with high recoveries. In the case of no recovery, this indicates that analytes associated with the surrogate could not be qualitated, therefore, all analytes associated with this surrogate are qualified R, rejected. Another deficiency was that the last internal standards for samples 0119-97-0066 and 0119-97-0068 and the fourth internal standard for sample 0119-97-0064 were outside ranges allowed by USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (EPA 1994, 1205). Internal standards are used to assess instrument performance during the analytical procedure and standards outside the range indicate an interference from a sample or a change in the response of the instrument. All of the samples above were reanalyzed with similar results, indicating matrix interferences were causing the internal standard. A UJ or J qualifier was added to all analytes associated with the internal standards. Associated analytes are those analytes which are in close proximity to the internal standard on the chromatogram. All data, except those qualified R, are valid and usable as qualified.

Four soil samples collected from PRSs 19-001 and 19-003 were analyzed in request 3423R for semivolatile compounds. There were no QC problems with this request; therefore, all data are valid and usable without added qualifiers.

4.3 Radiochemistry Analyses

Six soil samples collected from PRS C-19-001 were analyzed in request 3255R for gamma activity by gamma spectroscopy. There were no QC problems with this request; therefore, all data are valid and usable without added qualifiers.

Thirteen soil samples collected from PRSs 19-001 and 19-003 were analyzed in request 3387R for gamma activity by gamma spectroscopy. There were no QC problems with this request; therefore, all data are valid and usable without added qualifiers.

Four soil samples collected from PRSs 19-001 and 19-003 were analyzed in request 3425R for gamma activity by gamma spectroscopy. There were no QC problems with this request; therefore, all data are valid and usable without added qualifiers.

5.0 SPECIFIC RESULTS, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Aggregate 19-A (PRSs 19-001 and 19-003)

The septic system (PRS 19-001) served the TA-19 retreat building (TA-19-5) and consisted of a septic tank (TA-19-6), outfall, and associated piping (Figure 5.1-1). COPCs were carried through to separate risk assessments on the mesa tops and slopes of PRSs 19-001 and on the mesa top of PRS 19-003. The risk levels were found to be within the ranges considered acceptable by EPA. A risk assessment was not conducted on the mesa slope of PRS 19-003 because samples collected there were collocated with PRS 19-002, the surface disposal area. COPCs detected in the two mesa slope samples were determined to be associated with battery debris from PRS 19-002. PRS 19-002 was recommended for no further action (NFA) based on human health concerns after a VCA was conducted at the site in 1995.

An NFA recommendation for PRS Aggregate 19-A is made based on NFA Criterion 5, which states that the PRS has been characterized or remediated in accordance with current applicable state or federal regulations, and the available data indicate that contaminants pose an acceptable level of risk under current and projected future land use.

5.1.1 History of Aggregate 19-A

PRSs 19-001 and 19-003 are discussed in detail in Sections 3.2 and 5.14 of the RFI work plan (LANL 1992, 0781). The septic system (PRS 19-001) was in operation from about 1957 until about 1974 and is thought to have handled only sanitary waste from the retreat building.

The laboratory sewer drainline and outfall (PRS 19-003) reportedly handled sanitary waste from the laboratory building. Wastes were discharged through the sewer drainline to an outfall in Pueblo Canyon. The system was probably used from 1944 until the laboratory building was decommissioned in 1974. The laboratory was in operation from 1944 to 1962, at which time it was transferred to the Zia Company and assigned to the Municipal Activities Branch of DOE-LAAO for Civil Defense purposes. LAAO later authorized the Los Alamos Radio Club to use the site. The radio club used the site until 1974, at which time the former East Gate Laboratory was abandoned (LANL 1992, 0781).

5.1.2 Description

All information regarding TA-19 (site description, geology, hydrology, soils, wildlife habitat, etc.) is provided in Section 2.0

5.1.3 Previous Investigation(s) of Aggregate 19-A

Memoranda dated November and December 1974, indicated that the radio shack and related property located at the East Gate Laboratory was free of radioactive contamination, high explosives contamination, toxic contamination, and/or environmental hazards (Garde 1974, 05-0041). No radioactive material was found in the outfall areas, which was consistent with the half-lives of the radionuclides used. In July and November 1974, various H-Division groups (H-1, H-3, H-5, and H-8) conducted building and property surveys at TA-19 to identify any potential contamination. The results of the surveys indicated that the structures were free of HE and radioactive, chemical, and toxic contamination. Laboratory analysis of soil samples collected in August 1974, in the vicinity of two effluent discharge points, indicated that "no radioactive contamination was released from the building during early operations" (LANL 1992, 0781).

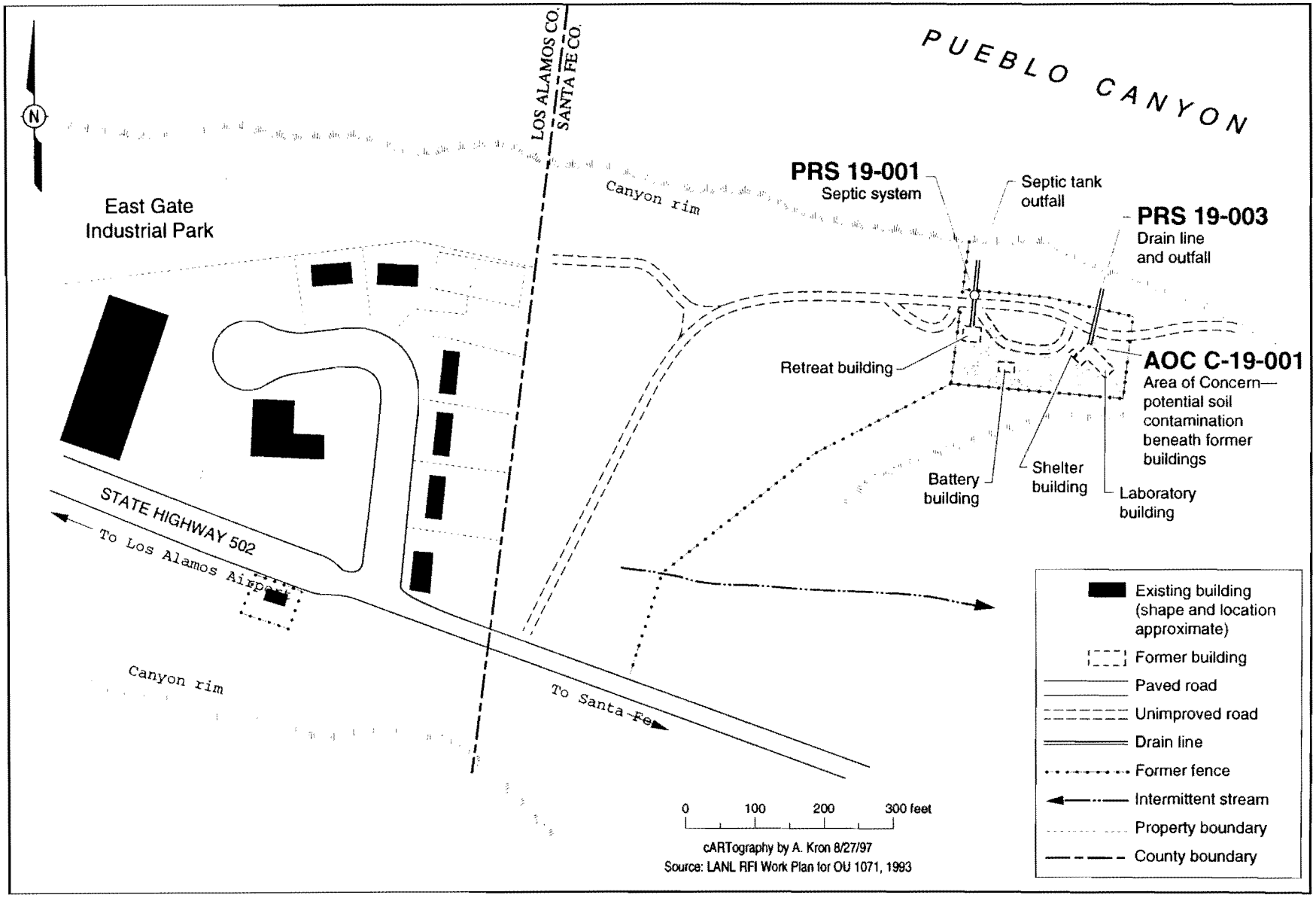

Figure 5.1-1 PRSs in this RFI Report

In August 1995, a VCA was conducted at PRS 19-002, which was a surface disposal area located on the north-facing mesa slopes beneath the laboratory sewer drainline outfall (LANL 1996, 05-0269). Surface sampling was conducted in drainages and catchment basins within and downslope of the disposal area, which is also below the laboratory drainline outfall. Results indicated that no residual chemical or radiological contaminants were present at PRS 19-002 at concentrations above SALs and an NFA recommendation was made based on human health concerns. The NFA recommendation included removing the PRS from the Hazardous and Solid Waste Amendments (HSWA) module of the RCRA Part B Permit for LANL.

5.1.4 Field Investigation of Aggregate 19-A

The objective of the Phase I RFI at PRS Aggregate 19-A was to determine whether residual contamination is present in the surface or subsurface along the drainlines, at the outfalls, or in drainages beneath the outfalls. Contaminants may have been released to the environment via leaks in the drainlines and discharges at the outfalls. If contaminants were released, they may be present in, or migrate to, soil, tuff, and/or air. Contaminants in the soil or tuff, if present, may have leached into the vadose zone, while contaminants in the soil may also have become entrained in the air and/or water and transported off-site by wind or run-off. A determination of the presence of residual contamination would be based on analytical results of soil and crushed tuff samples collected from the drainline trenches, the outfalls, the septic tank excavation, and catchments beneath the outfalls.

5.1.4.1 Field Activities

Geodetic Survey. A geodetic survey was performed by in March 1997, to establish the original locations of the septic tank, drainlines, outfalls, and corners of buildings and fences. The survey was based on structure coordinates provided in both the LASL Grid System and the NMSP Coordinate System. Following completion of the sampling and structure removal activities, each sample location was surveyed in July 1997.

Structure Removal. Field work was conducted on July 14, 15, and 17, 1997, at which time the septic tank, associated inlet and outlet lines (PRS 19-001), and the laboratory drainline (PRS 19-003) were removed using a backhoe and tracked excavator (trackhoe) in accordance with Section 2.3.4.1. of the RFI Work Plan. The two 6-in. diameter drainlines were found to end approximately 20 ft short of the mesa edge and did not daylight. Gravel-filled trenches were present from the end of each pipe to the tuff boulders lining the mesa edge.

The septic tank drainline was made of an asphaltic composition fiber material, known as orangeburg pipe, and was perforated with two rows of holes running along the length of the pipe. After removing the drainline, a sump pump was lowered into the septic tank through a vertical corrugated metal pipe, and approximately 300 gallons of liquid was pumped into 55-gal. drums. The inlet line, made of the same material as the drainline but unperforated, was then located and removed. A vertical metal standpipe set in concrete was found approximately 20 to 25 ft south of the septic tank and was removed. The standpipe was believed to be the former floor drain from the retreat building.

The top of the septic tank, which was approximately 5 ft bgs, was uncovered and the vertical corrugated metal pipe was removed. Removal of the inlet and outlet lines and excavation of the septic tank was conducted with a backhoe. However, the septic tank, which measured approximately 7 ft long by 4 ft wide by 5 ft deep and was constructed with 6-in. reinforced concrete walls, was too heavy to be removed by the backhoe. Therefore, after a day's delay, the septic tank was removed with a larger trackhoe, or tracked excavator.

The laboratory sewer drainline was also made of non-perforated asphaltic composition fiber material. The drainline was found to be approximately 90 ft long and was removed using the backhoe.

Sampling. Subsurface and surface samples were collected on July 15, 17, and 18, 1997. Sample locations are shown on Figure 5.1.4.1-1. A summary of samples collected is shown in Table 5.1.4.1-1.

Crushed tuff samples were collected from the bottom of the septic tank inlet and outlet line trenches. Samples were collected at the end of the drainline, at a point in the trench approximately midway from the septic tank to the pipe's end, and at a location near the outlet of the tank. All of these samples were collected from a depth of approximately 5 ft bgs. Samples were collected from the inlet line trench at the tank and below the stand pipe. Inlet trench samples were collected from a depth of approximately 4.5 ft bgs. The trenches were backfilled, but not compacted, after the samples were collected.

Two crushed tuff samples were collected from the bottom of the septic tank excavation from a depth of approximately 10 ft bgs. One sample was collected from the north end and one from the south end of the 12-ft long excavation. The excavation was backfilled, but not compacted, after the samples were collected.

Crushed tuff samples were collected from the laboratory drainline trench at the end of the pipe, at the beginning of the pipe where the laboratory was formerly located, and at a location approximately midway between the two ends. These samples were collected from a depth of approximately 3 ft bgs. The trench was then backfilled but not compacted.

On July 18, 1997 an additional subsurface crushed tuff sample (0119-97-0073) was collected at the end of the laboratory drainline from a depth of approximately 4 ft bgs. This extra sample, which was not planned for in the OU 1071 work plan, was collected approximately 1 ft deeper than the initial sample (0119-97-0063) collected at the end of the drainline from a depth of 3 ft bgs. Sample -0073 was collected and analyzed in an effort to evaluate the presence of any chemicals at a deeper depth beneath the end of the drainline in case chemical or radiological contamination was detected in sample -0063 collected at the end of the pipe.

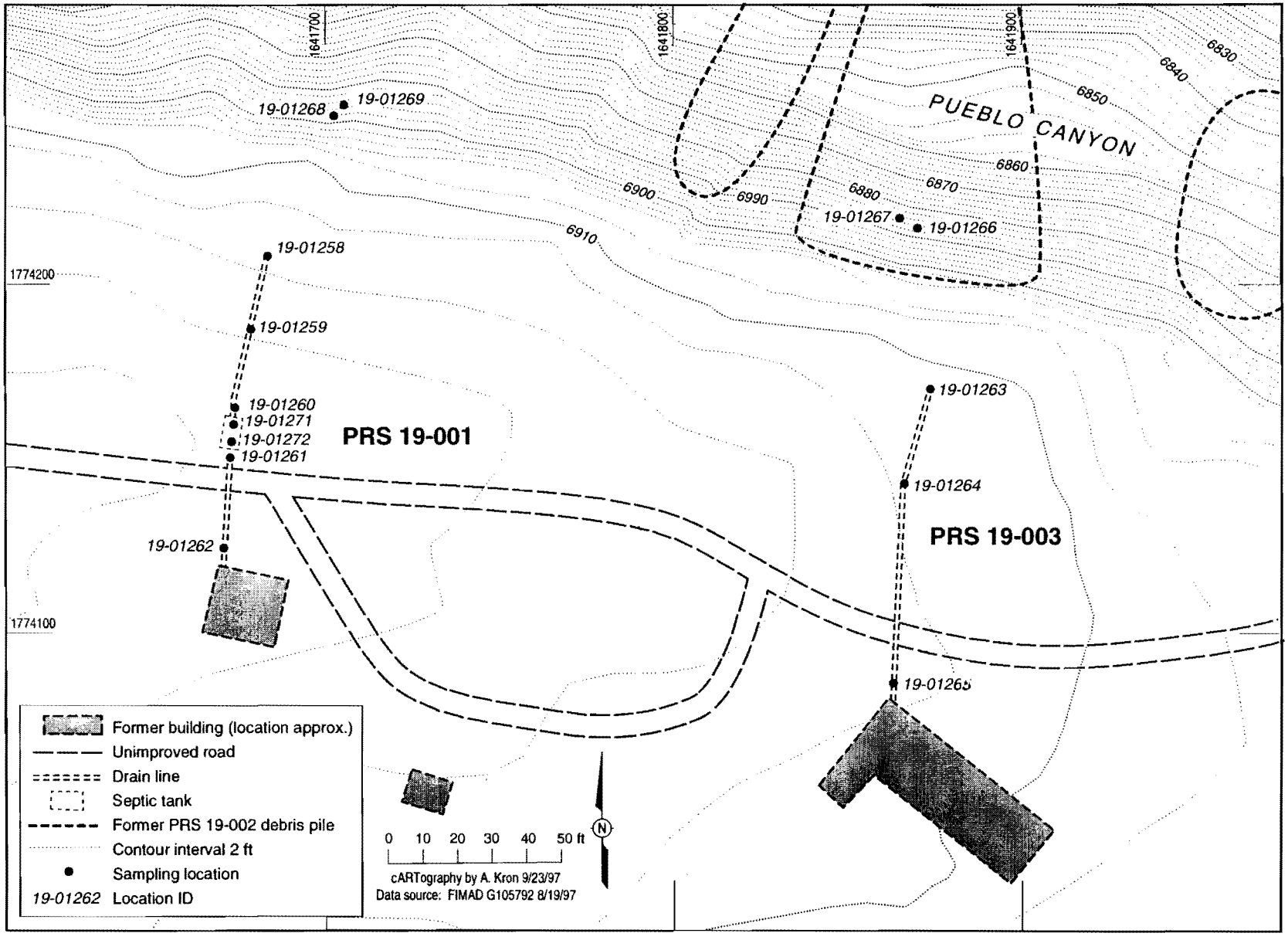

Fig. 5.1.4.1-1 Locations of PRS 19-001, 19-003, and C-19-001 Samples

TABLE 5.1.4.1-1

SUMMARY OF SAMPLES COLLECTED at PRSs 19-001 and 19-003

LOCATION ID	PRS 19-XXX	SAMPLE ID 0119-97-XXXX	DEPTH (ft)	MEDIA	OVM (ppm)[a]	GROSS ALPHA (cpm)[b]	GROSS BETA/GAMMA (cpm)	VOCs	SVOCs	INORGANIC CHEMICALS	GAMMA SPEC
19-01258	001	0058	5–5.3	Qbt 3	0.0	NDA[c]	NDA	3385R	3385R	3386R	3387R
19-01259	001	0059	5–5.3	Qbt 3	0.0	NDA	NDA	3385R	3385R	3386R	3387R
19-01260	001	0060	5–5.3	Qbt 3	0.0	NDA	NDA	3385R	3385R	3386R	3387R
19-01261	001	0061	4.5–4.8	Qbt 3	0.0	NDA	NDA	3385R	3385R	3386R	3387R
19-01262	001	0062	4.5–4.8	Qbt 3	0.0	NDA	NDA	3385R	3385R	3386R	3387R
19-01263	003	0063	3–3.3	Qbt 2	0.0	NDA	NDA	3385R	3385R	3386R	3387R
19-01264	003	0064	3–3.3	Qbt 2	0.0	NDA	NDA	3385R	3385R	3386R	3387R
19-01265	003	0065	3–3.3	Qbt 2	0.0	NDA	NDA	3385R	3385R	3386R	3387R
19-01266	002/003	0066	0–0.25	Soil	0.0	NDA	NDA	3385R	3385R	3386R	3387R
19-01267	002/003	0067	0–0.25	Soil	0.0	NDA	NDA	3385R	3385R	3386R	3387R
19-01268	001	0068	0–0.25	Soil	0.0	NDA	NDA	3385R	3385R	3386R	3387R
19-01269	001	0069	0–0.25	Soil	0.0	NDA	NDA	3385R	3385R	3386R	3387R
19-01271	001	0071	10–10.5	Qbt 3	0.0	NDA	NDA	3423R	3423R	3424R	3425R
19-01272	001	0072	10–10.5	Qbt 3	0.0	NDA	NDA	3423R	3423R	3424R	3425R
19-01263	003	0073	4–4.3	Qbt 2	0.0	NDA	NDA	3423R	3423R	3424R	3425R
19-01272	001	0076 (Replicate)	10–10.5	Qbt 3	0.0	NDA	NDA	3423R	3423R	3424R	3425R
19-01263	003	0077 (Replicate)	3–3.3	Qbt 2	0.0	NDA	NDA	3385R	3385R	3386R	3387R

[a]Organic Vapor Monitor. Units in parts per million
[b]counts per minute
[c]No detectable activity above background

Surface samples were collected from catchments in drainages beneath the septic tank and laboratory drainline outfalls. Two samples (0119—97-0068 and -0069) were collected from a catchment beneath the septic tank drainline outfall and two samples (0119-97-0066 and -0067) were collected from a catchment beneath the laboratory drainline line outfall. Samples 0119-97-0066 and -0067 were collected from a catchment in which battery debris from the PRS 19-002 disposal area was located (Fig. 5.1.4-2). PRS 19-002 was recommended for no further action after the 1995 VCA.

One sample of the pipe material (0119-97-0001) was collected for SVOC analysis to compare the SVOC results with the SVOCs detected in soil and crushed samples collected from the pipe trenches and catchments. Analytical results revealed that similar SVOCs and polynuclear aromatic hydrocarbons (PAHs) were present in the pipe material as were found in some of the crushed tuff samples collected from the pipe trenches. This similarity indicates that SVOCs and PAHs detected in the site characterization samples originated from the pipe itself and not from waste discharged through the pipe.

Field Screening. All samples and sample material were screened in the field for volatile organic vapors using a Thermo Environmental Instruments, Inc. (TEI), Model 580B OVM, gross alpha radiation using a Ludlum Model 139 with an air proportional probe, and gross beta/gamma radiation using a Ludlum Model 12 with a 44-40 Geiger-Mueller (GM) pancake probe. Results of organic vapor screening indicated that no volatile organic vapors were detected in the samples or sample material. Gross radioactivity screening detected no radioactivity at levels greater than background.

5.1.4.2 Deviations

In accordance with the approved RFI work plan, if the site survey did not reveal the location of all buried structures in sufficient detail, geophysical surveys would be conducted to more precisely locate the septic tank and drainlines. The septic tank and drainlines were located by the site and geodetic surveys; therefore, a geophysical survey was not conducted.

In accordance with the approved RFI work plan, first-order drainage channels within the PRS domain and originating at the outfall points on the north-facing mesa wall would be located and mapped to determine sites for sampling channel deposits. This activity would locate all catchments in the relevant drainages. Mapping would be completed on a scale of 1:2000. Mapping of the channels was not necessary and, therefore, not conducted because drainage channels and catchments were identified for sampling purposes as part of the site survey.

In accordance with the approved RFI work plan, three surface samples would be collected from catchments in first-order drainages below each of the drainline outfalls. Because the drainlines stopped short of the mesa top and did not daylight, one sample was collected from each drainline trench at the end of each pipe and two samples were collected from catchments in the drainages below the outfalls. Thus, the same number of samples were collected as required by the approved work plan.

On July 18, 1997, an additional subsurface crushed tuff sample (0119-97-0073) was collected at the end of the laboratory drainline from a depth of approximately 4 ft bgs. This extra sample was collected approximately 1 ft deeper than the initial sample (0119-97-0063) collected at the end of the drainline from a depth of 3 ft bgs. Sample -0073 was collected and analyzed in an effort to evaluate the presence of any chemicals at a deeper depth beneath the end of the drainline in case chemical or radiological contamination was detected in sample -0063 collected at the end of the pipe.

5.1.5 Evaluation of Inorganic Chemicals at Aggregate 19-A

The evaluation of Aggregate 19-A chemicals and radionuclides was divided into three separate evaluations: (1) at PRS 19-001, (2) on the PRS 19-003 mesa slope, and (3) on the PRS 19-003 mesa top. Data evaluations for the 19-003 mesa top were separated from the data evaluations for the mesa slope because the PRS 19-003 mesa slope samples were collocated with the PRS 19-002 battery debris pile (Fig 5.4.1.1-1). Metals concentrations detected in the two soil samples collected from the mesa slope as part of this RFI originated from the battery debris. The concentrations are very similar to the metal concentrations detected in soil samples collected as part of the 1995 PRS 19-002 VCA, which concluded with an NFA recommendation for PRS 19-002.

5.1.5.1 Evaluation of Inorganic Chemicals at PRS 19-001

Ten samples collected at PRS 19-001 were analyzed for TAL metals. Two soil samples were collected in the outfall area on the mesa slope. Eight samples were collected in Unit 3 of the Tshirege Member of the Bandelier Tuff on the mesa top. Each inorganic result was compared to the appropriate background screening value (Longmire et al. 1995, 1142 and 1266).

Many of the TAL metals data were qualified as discussed in Section 4.1.1. A discussion of the effects of these qualifiers for particular analytes follows.

- Manganese data for seven samples were qualified J- because of a low recovery in the matrix spike sample. A low recovery suggests that either

there was incomplete recovery of an analyte during chemical extraction or that the sample is hetergeneous. A post-digestion spike was performed for manganese and the recovery was within the limits allowed in USEPA SW846 guidelines. The maximum concentration reported for the two soil samples qualified J- is 177 mg/kg, which is much lower than the all soil data UTL of 714 mg/kg. The maximum concentration reported for the five J- qualified samples in Unit 3 is 109 mg/kg. The maximum value for the remaining three Unit 3 samples for which there were no QC problems is 113 mg/kg, which is still approximately one-fourth of the Unit 3 UTL of 426 mg/kg. This information indicates that manganese does not appear be above background. Manganese will not be evaluated further in the human health screening assessment.

- Iron was qualified J- in seven samples because of a slightly low recovery in the laboratory control sample. The J- qualifier indicates that the data is possibly biased low. Similar to manganese, the maximum concentration reported for the two soil samples qualified J- is 6250 mg/kg, which is much lower than the all soil data UTL of 21300 mg/kg. The maximum concentration reported for the five J- qualified samples in Unit 3 is 3900 mg/kg. The maximum value for the remaining three Unit 3 samples for which there were no QC problems is 4320 mg/kg, which is still approximately one-half of the Unit 3 UTL of 9040 mg/kg. This information indicates that iron does not appear be above background. Iron will not be evaluated further in the human health screening assessment.

Eleven inorganics (aluminum, barium, calcium, chromium, cobalt, copper, lead, magnesium, nickel, vanadium, zinc) were detected above background screening values in at least one geologic unit. Further background comparisons were not performed for these eleven metals because the number of site samples for these metals in each geologic unit are inadequate to support other statistical tests. Therefore, these eleven metals are carried forward to the screening assessment. Of these eleven metals, lead was detected above the background screening value in only one outfall sample. Copper was detected above its background screening values in one outfall sample as well as three Unit 3 samples. The other nine metals (aluminum, barium, calcium, chromium, cobalt, magnesium, nickel, vanadium, and zinc) were

only detected above background screening values in the Unit 3 samples. The data for each sample that had at least one concentration above the background screening value in at least one geologic unit for these eleven inorganics are shown in Tables 5.1.5.1-1 and 5.1.5.1-2 and Figure 5.1.5-1.

The qualifiers shown in Table 5.1.5.1-1 and 5.1.5.1-2 have been assigned during data validation. However, the data are usable for site-specific decisions, as stated in the rationale below.

- Lead data for seven samples were qualified J+ because of a high recovery in the matrix spike sample. A high recoverv indicates either sample heterogeneity or a matrix interference. Sample heterogeneity was confirmed by the duplicate analysis. Because a J+ indicates a possible high bias, and the lead data are already above the UTL in the surface soil samples, lead will be further evaluated in the human health screening assessment.

- Aluminum data were qualified J- because of slightly low recoveries in the laboratory control sample. Two out of five Unit 3 samples qualified J- for aluminum were above the Unit 3 UTL of 3700 mg/kg. Because these two samples were the only aluminum concentrations above the Unit 3 UTL and may be biased low, aluminum will be carried forward to the human health screening assessment for further evaluation.

TABLE 5.1.5.1-1

INORGANIC CHEMICALS WITH CONCENTRATIONS EXCEEDING BACKGROUND SCREENING VALUES IN OUTFALL SAMPLES AT PRS 19-001

Location ID			19-01268
Depth (ft)			0-0.25
Sample ID	SAL	All soil data UTL	0119-97-0068
Copper	2800	15.5	17.8
Lead	400	23.3	32.9J+

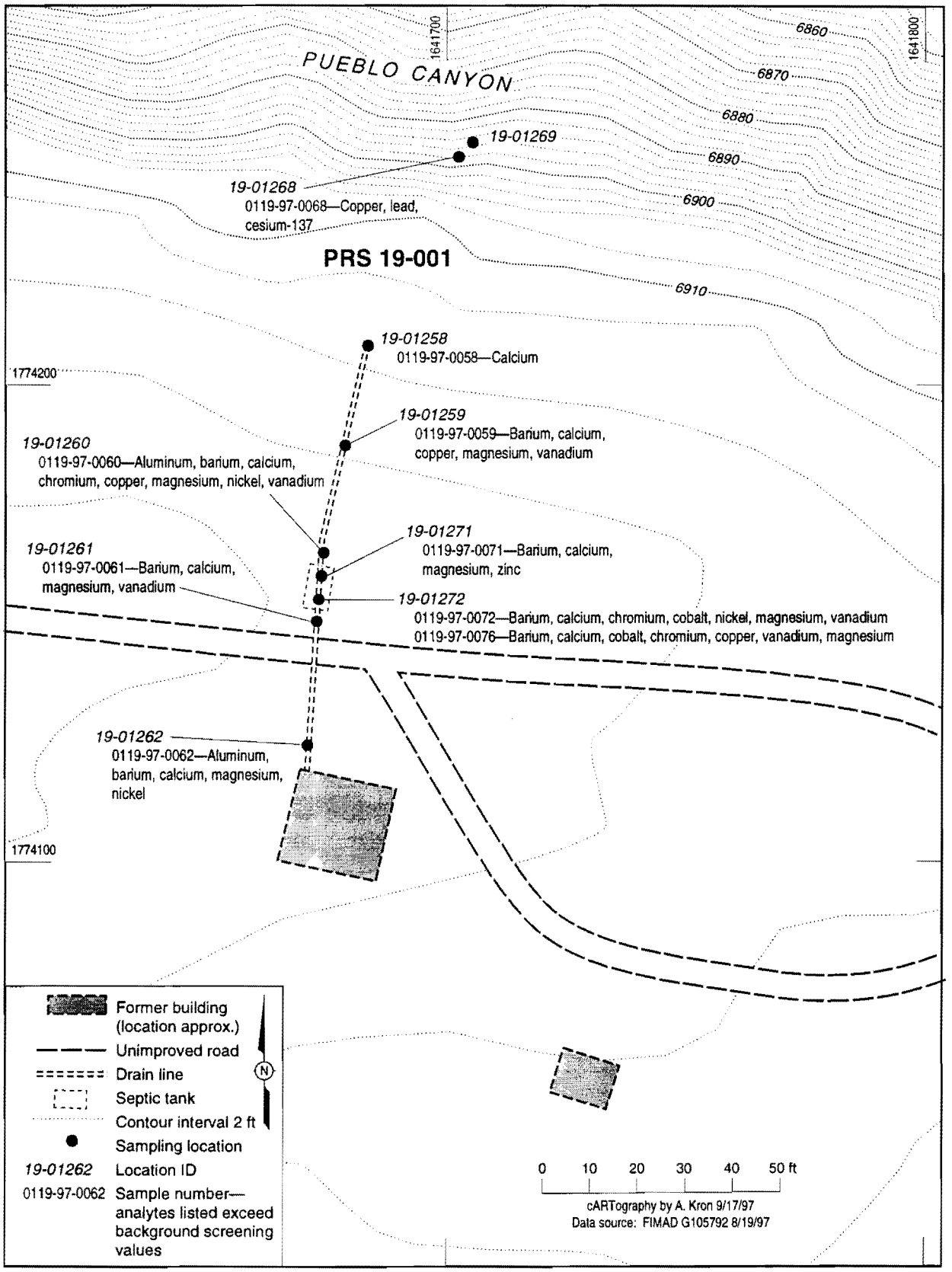

Figure 5.1.5-1. Inorganics and radionuclides above background screening values at PRS 19-001.

TABLE 5.1.5.1-2

INORGANIC CHEMICALS WITH CONCENTRATIONS IN MG/KG EXCEEDING BACKGROUND SCREENING VALUES IN UNIT 3 SAMPLES AT PRS 19-001

Location ID			19-01258	19-01259	19-01260	19-01261	19-01262	19-01271	19-01272	19-01272
Depth (ft)			5–5.3	5–5.3	5–5.3	4.5–4.8	4.5–4.8	10–10.5	10–10.5	10–10.5
Sample ID	SAL	Unit 3 UTL	0119-97-0058	0119-97-0059	0119-97-0060	0119-97-0061	0119-97-0062	0119-97-0071	0119-97-0072	0119-97-0076
Aluminum	77000	3700	—	—	4990J-	—	3780 J-	2360	—	—
Barium	5300	28	—	30.9	59.7	34.5	28.9	31.1	46.5	40.5
Calcium	n/a	1520	4760	4610	0	2040	1830	5190	3520	2630
Chromium	210	2.1	—	—	2.5	—	—	—	2.2	2.3
Cobalt	4600	1.39	—	—	—	—	—	—	1.4	1.5
Copper	2800	2	—	2.9	2.7	—	—	—	—	2.3
Magnesium	n/a	628	—	746	1690	640	1310	659	872	664
Nickel	1500	2.6	—	—	3.8	—	2.7	—	2.7	—
Vanadium	540	4.01	—	4.1	6.1	5.3	—	—	6.3	6.3
Zinc	23000	59	—	—	—	—	—	102	—	—

5.1.5.2 Evaluation of Inorganics at the PRS 19-003 Mesa Slope

Two soil samples collected at the PRS 19-003 outfall were analyzed for TAL metals. These sample locations are within the boundaries of PRS 19-002. Each inorganic result was compared to the all soil data background screening value (Longmire et al. 1995, 1142 and 1266).

Many of the TAL metals data were qualified as discussed in Section 4.1.1. A discussion of the effects of these qualifiers for particular analytes follows.

- Aluminum data were qualified J- in these two samples because of slightly low recoveries in the laboratory control sample. Both samples qualified J- for aluminum were below the UTL of 38 700 mg/kg. The maximum concentration reported for aluminum in these two samples is 4 370 mg/kg, which is well below the UTL. Thus, this low bias does not change the conclusion that aluminum concentrations are within the range of background. Therefore, aluminum will not be carried forward to the human health screening assessment.

- Iron was qualified J- in these two samples because of a slightly low recovery in the laboratory control sample. The J- qualifier indicates that the data is possibly biased low. Similar to aluminum, the maximum concentration reported for these two J- qualified iron samples is 4070 mg/kg compared to

a UTL of 21300 mg/kg. Even with a low bias, the data does not indicate that iron may be above background. Iron will not be evaluated further in the human health screening assessment.

Seven inorganics (cadmium, calcium, copper, lead, manganese, mercury, and zinc) were detected above background screening values in these samples. Further background comparisons were not performed for these seven metals because the number of site samples for these metals are inadequate to support other statistical tests. Therefore, these seven metals are carried forward to the human health screening assessment. The data for each sample that had at least one concentration above the background screening value for these seven inorganics are shown in Table 5.1.5.2-1 and Figure 5.1.5-2.

TABLE 5.1.5.2-1

INORGANIC CHEMICALS WITH CONCENTRATIONS IN MG/KG EXCEEDING BACKGROUND SCREENING VALUES IN OUTFALL SAMPLES AT PRS 19-003

Location ID			19-01266	19-01267
Depth (ft)			0-0.25	0-0.25
Sample ID	SAL	All Soil Data UTL	0119-97-0066	0119-97-0067
Cadmium	38	2.6	10.3	—
Calcium	n/a[a]	6120	—	6980
Copper	2800	15.5	128	20.5
Lead	400	23.3	173J+	68.6J+
Manganese	3200	714	6210J-	1790J-
Mercury	23	0.1	3.3	0.46
Zinc	23000	50.8	6380	2540

[a]not applicable

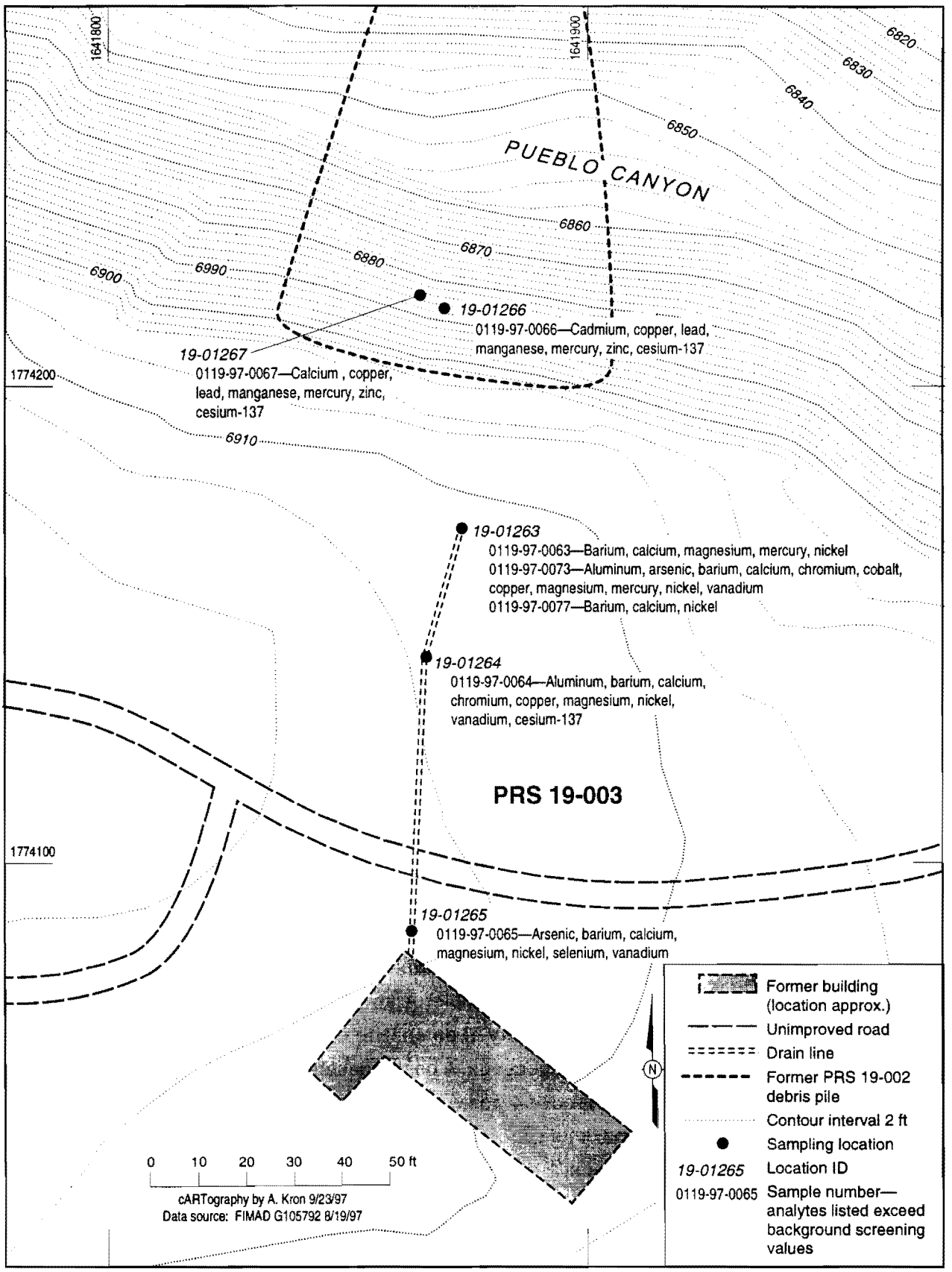

Fig. 5.1.5-2 Inorganics and radionuclides above background screening values at PRS 19-003.

The qualifiers shown in Table 5.1.5.2-1 have been assigned during data validation. However, the data are usable for site-specific decisions, as stated in the rationale below.

- Lead data for these two samples were qualified J+ because of a high recovery in the matrix spike sample. A high recovery indicates either sample heterogeneity or a matrix interference. Sample heterogeneity was confirmed by the duplicate analysis. Because a J+ indicates a possible high bias, and the lead data are already above the UTL in the surface soil samples, lead will be further evaluated in the human health screening assessment.

- Manganese data for these two samples were qualified J- because of a low recovery in the matrix spike sample. A low recovery suggests that either there was incomplete recovery of an analyte during chemical extraction or that the sample is heterogeneous. A post-digestion spike was performed for manganese and the recovery was within the limits allowed in USEPA SW846 guidelines. Because the J- qualifier indicates a possible low bias, and these two surface soil samples are well above the UTL, there is reason to believe that manganese is above background in these samples, and it will be further evaluated in the human health screening assessment.

5.1.5.3 Evaluation of Inorganics at PRS 19-003 Mesa Top

Five samples collected at the PRS 19-003 mesa top were analyzed for TAL metals. These five samples were collected in Unit 2 of the Tshirege Member of the Bandelier Tuff. Each inorganic result was compared to the Unit 2 background screening value (Longmire et al. 1995, 1142 and 1266).

Many of the TAL metals data were qualified as discussed in Section 4.1.1. A discussion of the effects of these qualifiers for particular analytes follows.

- Manganese data for four samples were qualified J- because of a low recovery in the matrix spike sample. A low recovery suggests that either there was incomplete recovery of an analyte during chemical extraction or that the sample is heterogeneous. A post-digestion spike was performed for manganese and the recovery was within the limits allowed in USEPA SW846 guidelines. The maximum concentration reported for these four J- qualified manganese samples is 108 mg/kg compared to a Unit 2 UTL of 533 mg/kg. The one sample in this data set that was not qualified was greater than the maximum of the qualified data and is still approximately one-third of the UTL. This information indicates that manganese does not appear be above

background. Manganese will not be evaluated further in the human health screening assessment.

- Iron was qualified J- in four samples because of a slightly low recovery in the laboratory control sample. The J- qualifier indicates that the data is possibly biased low. Similar to manganese, the maximum concentration reported for these four J- qualified iron samples is 3740 mg/kg compared to a Unit 2 UTL of 9040 mg/kg. The one sample in this data set that was not qualified was greater than the maximum of the qualified data and is still approximately one-half of the UTL. This information indicates that iron does not appear be above background. Iron will not be evaluated further in the human health screening assessment.

Twelve inorganics (aluminum, arsenic, barium, calcium, chromium, cobalt, copper, magnesium, mercury, nickel, selenium, and vanadium) were detected above background screening values in these Unit 2 samples. Further background comparisons were not performed for these twelve metals because the number of site samples for these metals in Unit 2 are inadequate to support other statistical tests. Therefore, these twelve metals are carried forward to the screening assessment. The data for each sample that had at least one concentration above the background screening value in Unit 2 for these twelve inorganics are shown in Table 5.1.5.3-1 and Figure 5.1.5-2.

TABLE 5.1.5.3-1

INORGANIC CHEMICALS WITH CONCENTRATIONS IN MG/KG EXCEEDING BACKGROUND SCREENING VALUES IN UNIT 2 AT PRS 19-003 MESA TOP

Location ID			19-01263	19-01264	19-01265	19-01273	19-01263
Depth (ft)			3-3.3	3-3.3	3-3.3	4-4.25	3-3.3
Sample ID	SAL	Unit 2 UTL	0119-97-0063	0119-97-0064	0119-97-0065	0119-97-0073	0119-97-0077
Aluminum	**38700**	3700	—	3750J-	—	4400	—
Arsenic	**n/a[a]**	2	—	—	3.3	3.1	—
Barium	**5300**	28	48.5	55	70.8	82	32.2
Calcium	**n/a**	1520	14300	7560	27400	11400	10400
Chromium	**210**	1.6	—	2	—	2.5	—
Cobalt	**4600**	1.34	—	—	—	1.7	—
Copper	**2800**	2	—	2.2	—	2.8	—
Magnesium	**n/a**	548	1120	1190	4390	1070	—
Mercury	**23**	n/a	0.063	—	—	0.03	—
Nickel	**1500**	<2	3.2	3.2	3.4	4	2.5
Selenium	**380**	n/a	—	—	0.39	—	—
Vanadium	**540**	4.01	—	6	5.6	7.3	—

[a]not applicable

The qualifiers shown in Table 5.1.5.3-1 have been assigned during data validation. However, the data are usable for site-specific decisions, as stated in the rationale below.

- Aluminum data presented in Table 5.1.5.3-1 were qualified J- because of slightly low recoveries in the laboratory control sample. One out of four samples qualified J- for aluminum was above the Unit 2 UTL of 3700 mg/kg. The fifth sample analyzed for aluminum was the maximum concentration of these five samples and was not associated with any QC problems. Therefore, aluminum will be carried forward to the human health screening assessment based on the unqualified data.

5.1.6.1 Evaluation of Radionuclides at PRS 19-001

Ten samples collected at PRS 19-001 were analyzed by gamma spectroscopy. Two soil samples were collected in the outfall area. Eight samples were collected in Unit 3 of the Tshirege Member of the Bandelier Tuff. Each soil sample was compared to the appropriate background screening value. Because background screening values are not available for most radionuclides in Unit 3, the minimum detectable activity was used as a background screening value for these samples.

Analyses of radionuclides by gamma spectroscopy often leads to the reporting of concentrations for certain radionuclides that are inappropriate to evaluate as potential site contaminants. Radiological indicators are used by the laboratory for evaluation of analytical laboratory data packages. Thus, it is not appropriate to compare radiological indicators to background, dose- or risk-based health protection standards. Seven radiological indicators (potassium-40, cadmium-109, cerium-139, mercury-203, tin-113, strontium-85, and yttrium-88) were reported as part of the gamma spectroscopy data for PRS 19-001. These radionuclides will be not be carried forward to the human health screening assessment.

When minimum detectable activities (MDAs) are not reported, a value of three times the measurement uncertainty (3 sigma or three standard deviations) is used to calculate a sample-specific MDA, which is then employed in the same manner as a detection limit. This methodology is similar to Currie's method of determining radionuclide maximum detectable activity (Currie 1988, 0792). Fourteen radionuclides (americium-241, barium-140, cerium-144,

cobalt-57, cobalt-60, cesium-134, europium-152, lanthanum-140, protactinium-233, ruthenium-106, selenium-75, sodium-22, uranium-235, zinc-65) were eliminated from further consideration because they were not detected in any sample.

The following radionuclides are all daughters of uranium and thorium: bismuth-211, bismuth-214, lead-212, lead-214, thorium-227, thorium-234, and thallium-208. They were reported at levels consistent with background levels expected from local uranium and thorium concentrations. These seven radionuclides will not be carried forward to the human health screening assessment.

Cesium-137 and manganese-54 were the only radionuclides that were detected and compared to their background screening values. Cesium-137 was above its background screening value of 1.65 pCi/g in at least one soil sample. Therefore, cesium-137 and manganese-54 are carried forward to the human health screening assessment. The data for each sample that had at least one concentration above the background screening value for cesium-137 and manganese-54 are shown in Table 5.1.6.1-1 and Figure 5.1.5-1.

TABLE 5.1.6.1-1

RADIONUCLIDES WITH CONCENTRATIONS EXCEEDING BACKGROUND SCREENING VALUES AT PRS 19-001

Location ID	Depth (ft)	Sample ID	Cs-137	Mn-54
		SAL	5.1	3.5
		All Soil Data UTL	1.65	n/a[a]
19-01268	0-0.25	0119-97-0068	5.85	-0.02U
19-01272	10-10.5	0119-97-0072	0.03U	0.15

[a] n/a = Not available: minimum detectable activity used as a background screening value.

5.1.6.2 Evaluation of Radionuclides at PRS 19-003 Mesa Slope

Two soil samples collected at the PRS 19-003 Mes Slope were analyzed by gamma spectroscopy. These sample locations are within the boundaries of PRS 19-002. Each soil sample was compared to the appropriate background screening value.

Analyses of radionuclides by gamma spectroscopy often leads to the reporting of concentrations for certain radionuclides that are inappropriate to evaluate as potential site contaminants. Radiological indicators are used by the lab for QA/QC evaluation of analytical laboratory data packages. Thus it is not appropriate to compare radiological indicators to background, dose- or risk-based health protection standards. Seven radiological indicators (potassium-40, cadmium-109, cerium-139, mercury-203, tin-113, strontium-85, and yttrium-88) were reported as part of the gamma spectroscopy data for the PRS 19-003 outfall. These radionuclides will be not be carried forward to the human health screening assessment.

When MDAs are not reported, a value of three times the measurement uncertainty (3 sigma or three standard deviations) is used to calculate a sample-specific MDA, which is then employed in the same manner as a detection limit. This methodology is similar to Currie's method of determining radionuclide maximum detectable activity (Currie 1988, 0792). Fourteen radionuclides (americium-241, barium-140, cerium-144, cobalt-57, cobalt-60, cesium-134, europium-152, lanthanum-140, protactinium-233, ruthenium-106, selenium-75, sodium-22, uranium-235, zinc-65) were eliminated from further consideration because they were not detected in any sample.

The following radionuclides are all daughters of uranium and thorium: bismuth-211, bismuth-214, lead-212, lead-214, thorium-227, thorium-234, and thallium-208. They were reported at levels consistant with background levels expected from local uranium and thorium concentrations. These seven radionuclides will not be carried forward to the human health screening assessment.

Cesium-137 was the only radionuclide that was detected and compared to its background screening value. Cesium-137 was above its background screening value of 1.65 pCi/g in both soil samples. Therefore, cesium-137 is carried forward to the human health screening assessment. The cesium-137 data for these two samples are shown in Table 5.1.6.2-1 and Figure 5.1.5-2.

TABLE 5.1.6.2-1

RADIONUCLIDES WITH CONCENTRATIONS in pCi/ g EXCEEDING BACKGROUND SCREENING VALUES AT PRS 19-003 OUTFALL

Location ID	Depth (ft)	Sample ID	Cs-137
		All Soil Data UTL	1.65
		SAL	5.1
19-01266	0-0.25	0119-97-0066	2.49
19-01267	0-0.25	0119-97-0067	2.08

5.1.6.3 Evaluation of Radionuclides at PRS 19-003 Mesa Top

Five samples collected at the PRS 19-003 mesa top were analyzed by gamma spectroscopy. These five samples were collected in Unit 2 of the Tshirege Member of the Bandelier Tuff. Because background screening values are not available for most radionuclides in Unit 2, the minimum detectable activity was used as a background screening value for these samples.

Analyses of radionuclides by gamma spectroscopy often leads to the reporting of concentrations for certain radionuclides that are inappropriate to evaluate as potential site contaminants. Radiological indicators are used for quality control and quality assurance evaluation of analytical laboratory data packages. Thus it is not appropriate to compare radiological indicators to background, dose- or risk-based health protection standards. Seven radiological indicators (potassium-40, cadmium-109, cerium-139, mercury-203, tin-113, strontium-85, and yttrium-88) were reported as part of the gamma spectroscopy data for PRS 19-003. These radionuclides will be not be carried forward to the human health screening assessment.

When MDAs are not reported, a value of three times the measurement uncertainty (3 sigma or three standard deviations) is used to calculate a sample-specific MDA, which is then employed in the same manner as a detection limit. This methodology is similar to Currie's method of determining radionuclide maximum detectable activity (Currie 1988, 0792). Fourteen radionuclides (americium-241, barium-140, cerium-144, cobalt-57, cobalt-60, cesium-134, europium-152, lanthanum-140, protactinium-233, ruthenium-106, selenium-75, sodium-22, uranium-235, zinc-65) were eliminated from further consideration because they were not detected in any sample.

The following radionuclides are all daughters of uranium and thorium: bismuth-211, bismuth-214, lead-212, lead-214, thorium-227, thorium-234, and thallium-208. They were reported at levels consistant with background levels expected from local uranium and thorium concentrations. These seven radionuclides will not be carried forward to the human health screening assessment.

Cesium-137 was the only radionuclide that was detected and compared to its background screening value. Cesium-137 was MDA in one Unit 2 sample. Therefore, cesium-137 is carried forward to the human health screening assessment. The data for the sample that had a concentration above the background screening value for cesium-137 are shown in Table 5.1.6.3-1 and Figure 5.1.5-2.

TABLE 5.1.6.3-1

RADIONUCLIDES WITH CONCENTRATIONS in pCi/g EXCEEDING BACKGROUND SCREENING VALUES AT PRS 19-003

Location ID	Depth (ft)	Sample ID	Cs-137
		SAL	5.1
		UNIT 2 UTL	n/a[a]
19-01264	3-3.3	0119-97-0064	0.14J

[a] Not available. Minimum detectable activity used as background screening value.

5.1.7 Evaluation of Organic Chemicals at Aggregate 19-A

5.1.7.1 Evaluation of Organic Chemicals at PRS 19-001

Ten samples collected at PRS 19-001 were analyzed for a suite of semivolatile organic chemicals and volatile organic chemicals. Two soil samples were collected in the outfall area. Eight samples were collected in Unit 3 of the Tshirege Member of the Bandelier Tuff.

Twenty-two organic compounds were detected in at least one soil sample. The data for each sample that had at least one detected concentration of these twenty-two organic chemicals are presented below in Table 5.1.7.1-1. The J qualifiers in Table 5.1.7.1-1 were assigned by the laboratory. These J qualifiers indicate that the concentrations are estimated because they are reported between the method detection limit and the EQL. These chemicals are still considered detected and will be further evaluated in the human health screening assessment. These twenty-two organic chemicals are carried forward to the human health screening assessment.

TABLE 5.1.7.1-1

DETECTED ORGANIC CONCENTRATIONS in mg/kg AT PRS 19-001

Location ID	Depth (ft)	Sample ID	Acetone	Methylene Chloride	Toluene	Naphthalene (PAH)
		SAL	2100	7.8	790	1000
19-01268	0-0.25	0119-97-0068	—	0.007	0.004J	1.4
19-01269	0-0.25	0119-97-0069	—	0.006	0.005J	—
19-01258	5-5.3	0119-97-0058	—	0.003J	—	2
19-01259	5-5.3	0119-97-0059	—	0.003J	—	—
19-01260	5-5.3	0119-97-0060	—	0.004J	—	—
19-01261	4.5-4.8	0119-97-0061	—	0.003J	–	0.1J
19-01262	4.5-4.8	0119-97-0062	—	0.009	—	—
19-01271	10-10.5	0119-97-0071	0.034	0.0061	—	—
19-01272	10-10.5	0119-97-0072	0.041	—	—	—
19-01272	10-10.5	0119-97-0076	0.044	—	—	—

TABLE 5.1.7.1-1 (continued)

DETECTED ORGANIC CONCENTRATIONS in mg/kg AT PRS 19-001

Location ID	Depth (ft)	Sample ID	2-Methyl naphthalene		Dibenzofuran		Phenanthrene		Fluoranthene (PAH)		Pyrene (PAH)		Benzo (a) anthracene (PAH)	
		SAL	n/a		250		n/a		2600		1900		0.61	
19-01268	0-0.25	0119-97-0068	0.34	J	0.34	J	3.2		2.8		2		0.21	J
19-01269	0-0.25	0119-97-0069			0.04	J	0.58		0.63		0.5			
19-01258	5-5.3	0119-97-0058	0.98	J	2.1		23		23		24		13	
19-01259	5-5.3	0119-97-0059					0.12	J	0.13	J	0.13	J	0.07	J
19-01260	5-5.3	0119-97-0060					0.05	J	0.06	J	0.06	J		
19-01261	4.5-4.8	0119-97-0061	0.04	J	0.02	J	3.3		3.8		3.1		1.8	
19-01262	4.5-4.8	0119-97-0062					0.06	J	0.07	J	0.06	J		
19-01272	10-10.5	0119-97-0072					0.39		0.53		0.39		0.25	

TABLE 5.1.7.1-1 (continued)

DETECTED ORGANIC CONCENTRATIONS in mg/kg AT PRS 19-001

Location ID	Depth (ft)	Sample ID	bis (2-Ethylhexyl) phthalate		Chrysene (PAH)		Benzo (b) fluoranthene (PAH)		Benzo (k) fluoranthene (PAH)		Benzo (a) pyrene (PAH)		Acenaphthene (PAH)	
		SAL	32		61		0.61		6.1		0.061		2200	
19-01268	0-0.25	0119-97-0068			0.74		0.55	J	0.22	J	0.13	J	0.14	J
19-01269	0-0.25	0119-97-0069			0.2	J	0.17	J						
19-01258	5-5.3	0119-97-0058	0.4	J	13		16		6		13		5.7	
19-01259	5-5.3	0119-97-0059			0.08	J	0.09	J			0.07	J		
19-01261	4.5-4.8	0119-97-0061	0.2	J	1.8		1.9		0.82		1.4		0.34	
19-01272	10-10.5	0119-97-0072			0.26		0.19		0.18		0.19			

TABLE 5.1.7.1-1 (continued)

DETECTED ORGANIC CONCENTRATIONS in mg/kg AT PRS 19-001

Location ID	Depth (ft)	Sample ID	Anthracene		Benzo (g,h,i) perylene		Carbazole		Dibenzo (a,h) Anthracene (PAH)		Fluorene (PAH)		Indeno (1,2,3-cd) Pyrene (PAH)	
			18000		1900		61		0.061		2300		0.61	
19-01268	0-0.25	0119-97-0068					0.22	J			0.18	J		
19-01269	0-0.25	0119-97-0069					0.05	J						
19-01258	5-5.3	0119-97-0058	7.9		3.2		3		1.2	J	3.2		3.8	
19-01259	5-5.3	0119-97-0059	0.038	J										
19-01261	4.5-4.8	0119-97-0061	0.99		0.53		0.84		0.21	J	0.35		0.6	

5.1.7.2 Evaluation of Organic Chemicals at PRS 19-003 Mesa Slope

Two samples collected at the PRS 19-003 mesa slope were analyzed for a suite of SVOCs and VOCs. These sample locations are within the boundaries of PRS 19-002.

Five organic compounds (acetone, fluoranthene, methylene chloride, pyrene, and toluene) were detected in at least one soil sample. The data for each sample that had at least one detected concentration of these five organic chemicals are presented below in Table 5.1.7.2-1. These five organic chemicals are carried forward to the human health screening assessment.

TABLE 5.1.7.2-1

DETECTED ORGANIC CONCENTRATIONS in mg/kg AT THE PRS 19-003 MESA SLOPE

Location ID		19-01266	19-01267
Depth (ft)		0-0.25	0-0.25
Sample ID	SAL	0119-97-0066	0119-97-0067
Acetone	2100	0.041	0.046J
Fluoranthene (PAH)	2600		0.099J
Methylene Chloride	7.8	0.009	0.008J
Pyrene (PAH)	1900		0.13J
Toluene	790	0.004 J	0.007J

The qualifiers in Table 5.1.7.2-1 have been assigned during data validation. However, the data are usable for site-specific decisions, as stated in the rationale below.

- Sample 0119-97-0067 has J qualifiers assigned for acetone, methylene chloride, and toluene because the internal standards were outside allowed ranges. This sample was reanalyzed with similar results, indicating that matrix interferences were causing the internal standard problems. A J qualifier indicates that the result is estimated. Because this result is estimated and the other sampole also has acetone, methylene chloride, and toluene detected, acetone, methylene chloride, and toluene will be further evaluated in the human health screening assessment.

- For sample 0119-97-0064, pyrene is qualified J because the internal standards were outside allowed ranges. This sample was reanalyzed with similar results, indicating that matrix interferences were causing the internal standard problems. A J qualifier indicates that these results are estimated. Because these results are estimated and the other sample was a non-detect, pyrene will be further evaluated in the human health screening assessment.

The remaining J qualifiers in Table 5.1.7.3-1 that have not yet been addressed were assigned by the laboratory. These J qualifiers indicate that the concentrations are estimated because they are reported between the method detection limit and the EQL. These chemicals are still considered detected and will be further evaluated in the human health screening assessment.

5.1.7.3 Evaluation of Organic Chemicals at the PRS 19-003 Mesa Top

Five samples collected at the PRS 19-003 mesa top were analyzed for a suite of SVOCs and VOCs. These five samples were collected in Unit 2 of the Tshirege Member of the Bandelier Tuff.

Twenty organic compounds were detected in at least one soil sample. The data for each sample that had at least one detected concentration of these twenty organic chemicals are presented below in Table 5.1.7.3-1. These twenty organic chemicals are carried forward to the human health screening assessment.

TABLE 5.1.7.3-1

DETECTED ORGANIC CONCENTRATIONS in mg/kg AT PRS 19-003

Location ID	Depth (ft)	Sample ID	Acetone	Methylene Chloride	Naphthalene (PAH)
		SAL	2100	7.8	1000
19-01263	3-3.3	0119-97-0063		0.007	
19-01264	3-3.3	0119-97-0064		0.008	1.8 J
19-01265	3-3.3	0119-97-0065		0.005 J	
19-01273	4-4.3	0119-97-0073	0.044		
19-01263	3-3.3	0119-97-0077		0.006	

TABLE 5.1.7.3-1 (continued)

DETECTED ORGANIC CONCENTRATIONS in mg/kg AT PRS 19-003

Location ID	Depth (ft)	Sample ID	2-Methylnaphthalene	Dibenzofuran	Phenanthrene	Fluoranthene (PAH)	Pyrene (PAH)	Benzo (a) anthracene (PAH)
		SAL	n/a	250	n/a	2600	1900	0.61
19-01263	3-3.3	0119-97-0063			0.04 J	0.05 J	0.04 J	
19-01264	3-3.3	0119-97-0064	1.1 J	2.3 J	26	27	25 J	15 J
19-01265	3-3.3	0119-97-0065					0.06 J	
19-01273	4-4.3	0119-97-0073			0.32	0.43	0.31	0.2

TABLE 5.1.7.3-1 (continued)

DETECTED ORGANIC CONCENTRATIONS in mg/kg AT PRS 19-003

Location ID	Depth (ft)	Sample ID	Chrysene (PAH)	Benzo (b) fluoranthene (PAH)	Benzo (k) fluoranthene (PAH)	Benzo (a) pyrene (PAH)	Acenaphthene (PAH)
		SAL	61	0.61	6.1	0.061	2200
19-01264	3-3.3	0119-97-0064	14 J	14	6	13	6.6

TABLE 5.1.7.3-1 (continued)

DETECTED ORGANIC CONCENTRATIONS in mg/kg AT PRS 19-003

Location ID	Depth (ft)	Sample ID	Anthracene (PAH)	Benzo (g,h,i) perylene	Carbazole	Dibenzo (a,h) Anthracene (PAH)	Fluorene (PAH)	Indeno (1,2,3-cd) Pyrene (PAH)
		SAL	18000	1900	61	0.061	2300	0.61
19-01264	3-3.3	0119-97-0064	8.9	6.2	3.6	2.1 J	3.6	6.2

The qualifiers in Table 5.1.7.3-1 have been assigned during data validation. However, the data are usable for site-specific decisions, as stated in the rationale below.

- One sample for methylene chloride is qualified J because the internal standards were outside allowed ranges. This sample was reanalyzed with similar results, indicating that matrix interferences were causing the internal standard problems. A J qualifier indicates that the result is estimated. Because this result is estimated and there were three other samples in which methylene chloride was detected at concentrations higher than the estimated concentration and these concentrations were not associated with QC problems, methylene chloride will be further evaluated in the human health screening assessment.

- For sample 0119-97-0064, seven semivolatiles are qualified J because the fourth internal standard was outside allowed ranges. This sample was reanalyzed with similar results, indicating that matrix interferences were causing the internal standard problems. A J qualifier indicates that these results are estimated. Because these results are estimated and there were other detects reported for these chemicals which were not associated with QC problems, these seven semivolatiles will be further evaluated in the human health screening assessment.

The remaining J qualifiers in Table 5.1.7.3-1 that have not yet been addressed were assigned by the laboratory. These J qualifiers indicate that the concentrations are estimated because they are reported between the method detection limit and the EQL. These chemicals are still considered detected and will be further evaluated in the human health screening assessment.

5.1.8 Risk-Based Screening and Assessment

5.1.8.1 Risk-Based Screening and Assessment for PRS 19-001

This subsection discusses the comparison with SALs for COPCs detected at levels greater than background screening levels in the investigation at PRS 19-001. A screening assessment was conducted on the RFI data for this PRS following methodology discussed in Chapter 3.0 of this report (Dorries 1996, 1297).

Acetone, aluminum, barium, bis(2-ethylhexyl)phthalate, calcium, carbazole, chromium, cobalt, copper, dibenzofuran, lead, magnesium, methylene chloride, nickel, toluene, vanadium, zinc, 16 PAHs, manganese-54, and cesium-137 were carried forward from the background evaluation and compared to their respective SALs.

Greater than SAL. Cesium-137 and the five PAHs shown in Table 5.1.8.1-1 were detected at concentrations greater than SAL. The locations of the samples with COPCs greater than SALs are shown on Figure 5.1.8.1-1.

TABLE 5.1.8.1-1
COPCs GREATER THAN SAL FOR PRS 19-001

CHEMICAL	LOCATION ID	SAMPLE ID	CONCENTRATION (mg/kg)	SAL (mg/kg)
Benzo(a)anthracene (PAH)	19-01258	0119-97-0058	13	0.61
	19-01261	0119-97-0061	1.8	
Benzo(b)fluoranthene (PAH)	19-01258	0119-97-0058	16	0.61
	19-01261	0119-97-0061	1.9	
Benzo(a)pyrene (PAH)	19-01258	0119-97-0058	13	0.061
	19-01268	0119-97-0068	0.13 J	
	19-01259	0119-97-0059	0.07 J	
	19-01261	0119-97-0061	1.4	
	19-01272	0119-97-0072	0.19	
Dibenzo(a,h)anthracene (PAH)	19-01258	0119-97-0058	1.2 J	0.061
	19-01261	0119-97-0061	0.21 J	
Indeno(1,2,3-cd)pyrene (PAH)	19-01258	0119-97-0058	3.8	0.61
RADIONUCLIDES			**Activity (pCi/g)**	**SAL (pCi/g)**
Cesium-137	19-01268	0119-97-0068	5.85	5.1

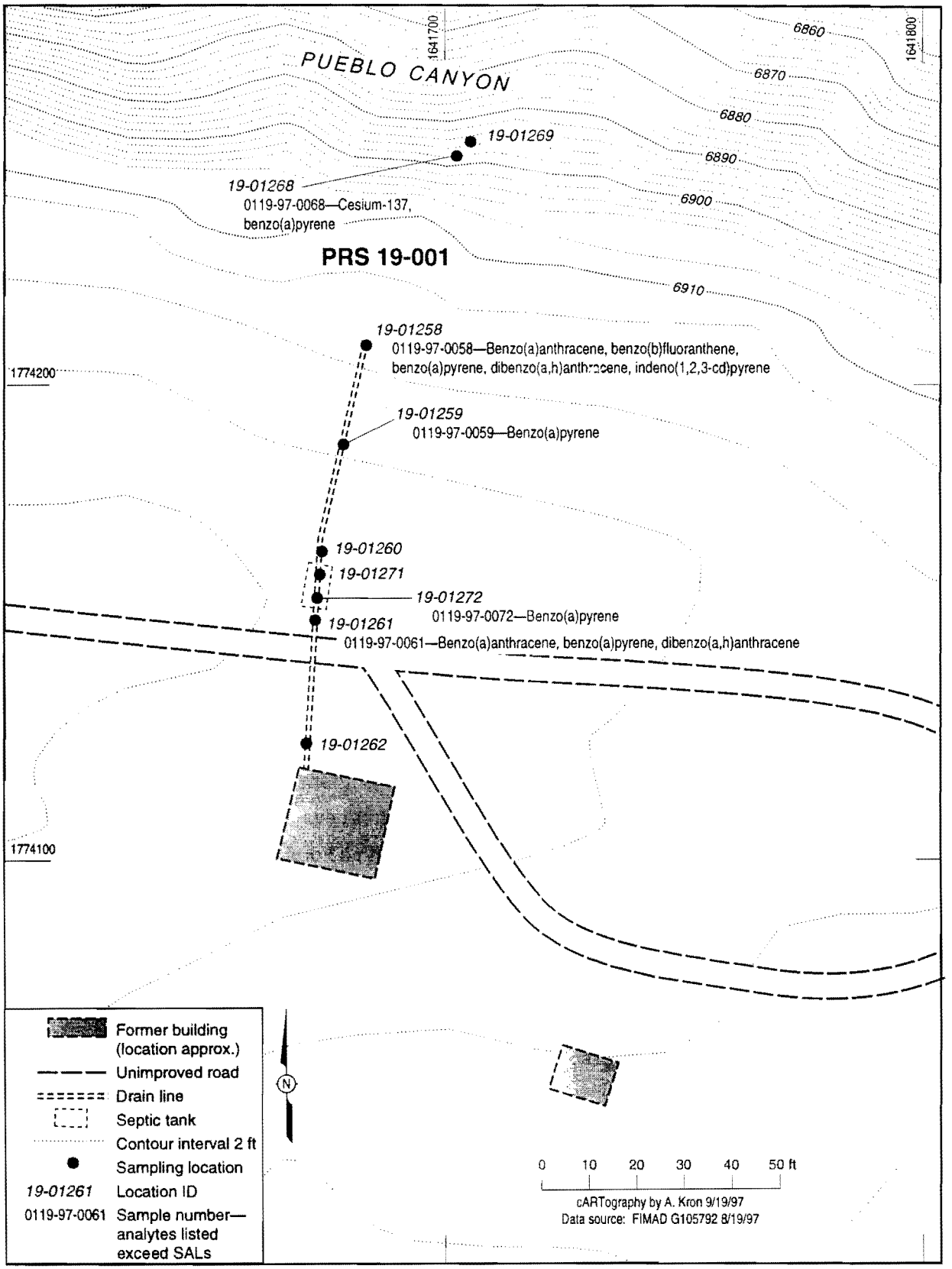

Fig. 5.1.8.1-1 Locations of samples with COPCs greater than SAL at PRS 19-001.

No SAL. Calcium and magnesium are essential nutrients and have no SALs. However, a comparison may be made to the recommended daily allowance (RDA) for these nutrients. The calcium and magnesium intakes associated with incidental soil ingestion would be considerably less than nutritional intakes, i.e., RDAs. Therefore, calcium and magnesium are eliminated as COPCs.

Several PAHs also have no SALs. Surrogate toxicity values were used for these PAHs based on similar chemical structure to other PAHs. These are included in the discussion below.

Less than SAL. Acetone, aluminum, barium, bis(2-ethylhexyl)phthalate, carbazole, chromium, cobalt, copper, dibenzofuran, lead, manganese-54, methylene chloride, nickel, toluene, vanadium, zinc, and 11 PAHs were all detected at concentrations less than their respective SALs. To evaluate multiple chemical effects for this data set, COPCs detected at concentrations less than their respective SALs were grouped according to their toxicological effects (carcinogenic or noncarcinogenic effects of chemicals). Because manganese-54 is the only remaining radionuclide detected above background, and the detected activity (0.15 pCi/g) is less than its SAL (3.5 pCi/g), manganese-54 is not included in the MCE and is not carried forward to as a COPC.

The maximum concentration for each chemical is divided by its respective SAL to produce a normalized value. The sum of those normalized values yields a normalized sum which is compared to one. If the normalized sum is equal to or less than one, this indicates that adverse health effects are unlikely to occur from exposure to these chemicals at the maximum concentrations detected and all chemicals require no further evaluation as COPCs. In the event the normalized sum is greater than one, any chemical with a normalized value of 0.1 or greater is retained as a COPC for further evaluation. This process is described in the policy document "Risk-Based Corrective Action Process" (Dorries 1996, 1297). The results of the analysis are shown in Table 5.1.8.1-2.

The result of the multiple chemical evaluation is less than one for noncarcinogenic effects indicating that potential adverse human health effects resulting from exposures to noncarcinogens are unlikely. Therefore, all noncarcinogenic chemicals detected at concentrations less than their respective SALs are eliminated as COPCs.

The results of the multiple chemical evaluation is greater than one for carcinogens. Additionally, five chemical carcinogens were detected at values greater than SAL. Because of potential additivity of effects, all COPCs that contribute at least 0.1 to the carcinogenic MCE will also be carried forward as COPCs.

TABLE 5.1.8.1-2

MULTIPLE CHEMICAL EVALUATION FOR PRS 19-001

BASED ON NONCARCINOGENIC EFFECTS				
CHEMICAL	SAMPLE ID	CONCENTRATION (mg/kg)	SAL (mg/kg)	NORMALIZED VALUE
Acenaphthene (PAH)	0119-97-0058	5.7	2200	0.003
Acetone	0119-97-0076	0.044	2 100	0.00002
Aluminum	0119-97-0068	5770	77000	0.07
Anthracene (PAH)	0119-97-0058	7.9	18000	0.0004
Barium	0119-97-0058	62.5	5300	0.01
Benzo(g,h,i)perylene	0119-97-0058	3.2	1900	0.02
Cobalt	0119-97-0068	2	4600	0.0004
Copper	0119-97-0068	17.8	2800	0.006
Dibenzofuran	0119-97-0058	2.1	250	0.008
Fluoranthene (PAH)	0119-97-0058	23	2 600	0.009
Fluorene (PAH)	0119-97-0058	3.2	2300	0.001
Lead	0119-97-0068	32.9	400	0.08
2-Methylnaphthalene	0119-97-0058	0.98 J	1 000[a]	0.001
Naphthalene (PAH)	0119-97-0058	2	1000	0.002
Nickel	0119-97-0068	3.9	1500	0.003
Phenanthrene	0119-97-0058	23	18 000[b]	0.001
Pyrene (PAH)	0119-97-0058	24	1 900	0.01
Toluene	0119-97-0068	0.004 J	790	0.000005
Vanadium	0119-97-0068	9.9	540	0.02
Zinc	0119-97-0071	102	23 000	0.004
NORMALIZED SUM				0.2
BASED ON CARCINOGENIC EFFECTS				
CHEMICAL	SAMPLE ID	CONCENTRATION (mg/kg)	SAL (mg/kg)	NORMALIZED VALUE
Benzo(k)fluoranthene (PAH)		6	6.1	0.98
Bis(2-ethylhexyl)phthalate	0119-97-0058	0.4 J	32	0.01
Carbazole	0119-97-0058	3	61	0.05
Chromium	0119-97-0058	2.5	250	0.01
Chrysene (PAH)	0119-97-0058	13	61	0.21
Methylene Chloride	0119-97-0062	0.009	7.8	0.001
NORMALIZED SUM				1.3

a No toxicity value was available for 2-methylnaphthalene, therefore, the toxicity criteria for naphthalene was used as a surrogate based on similarity in chemical structure.

b No toxicity value was available for phenanthrene, therefore, the toxicity criteria for anthracene was used as a surrogate based on similarity in chemical structure.

At the conclusion of this human health screening assessment for PRS 19-001, seven carcinogenic PAHs, benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, benzo(k)fluoranthene, chrysene dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, and radionuclide cesium-137 are retained as COPCs.

5.1.8.2 Risk-Based Screening and Assessment for PRS 19-003 Mesa Slope

This subsection discusses the comparison with SALs for COPCs detected at levels greater than background screening levels in the investigation at the PRS 19-003. A screening assessment was conducted on the RFI data for this PRS following methodology discussed in Section 3.0 of this report (Dorries 1996, 1297).

Acetone, cadmium, calcium, copper, fluoranthene, lead, manganese, mercury, methylene chloride, pyrene, toluene, zinc, and cesium-137 were carried forward from the background evaluation and compared to their respective SALs.

Greater than SAL. Manganese was detected at concentrations greater than SAL as shown in Table 5.1.8.2-1.

TABLE 5.1.8.2-1

COPCs GREATER THAN SAL FOR PRS 19-003 MESA SLOPE

CHEMICAL	SAMPLE ID	CONCENTRATION (mg/kg)	SAL (mg/kg)
Manganese	0119-97-0066	6210J-	3200

No SAL. Calcium is an essential nutrient and has no SAL. However, a comparison may be made to the RDA for these nutrients. The calcium intake associated with incidental soil ingestion would be considerably less than nutritional intake level, i.e., RDAs. Therefore, calcium is eliminated as a COPC.

Less than SAL. The chemicals acetone, cadmium, cesium-137, copper, fluoranthene, lead, mercury, methylene chloride, pyrene, toluene, and zinc were all detected at concentrations less than their respective SALs. To evaluate multiple chemical effects for this data set, COPCs detected at concentrations less than their SALs were grouped according to their toxicological effects (carcinogenic or noncarcinogenic effects of chemicals). Because cesium-137 is the only radionuclide detected above background and the maximum detected activity (2.49(J) pCi/g) is less than its SAL (5.1 pCi/g), cesium-137 is not included in the MCE and is not carried forward as a COPC.

The maximum concentration for each chemical is divided by its respective SAL to produce a normalized value. The sum of those normalized values yields a normalized sum which is compared to one. If the normalized sum is equal to or less than one, this indicates that adverse health effects are unlikely to occur from exposure to these chemicals at the maximum concentrations detected and all chemicals require no further evaluation as COPCs. If the normalized sum is greater than one, then any chemical with a normalized value of 0.1 or greater is retained as a COPC for further evaluation. This process is described in the policy document "Risk-Based Corrective Action Process" (Dorries, 1996, 1297). The results of the analysis are shown in Table 5.1.8.2-2.

The results of the multiple chemical evaluation is 1.2 for noncarcinogenic effects indicating that further evaluation is required. Therefore, all noncarcinogenic chemicals detected at greater than 0.1 times their SAL, i.e., cadmium, lead, mercury, and zinc, will be retained as COPCs. Noncarcinogenic chemicals detected at less than 0.1 times SAL are eliminated as COPCs.

The results of the multiple chemical evaluation is less than one for carcinogens. Additionally, there were no carcinogenic COPCs in the greater than SAL category. Therefore, methylene chloride is eliminated as a COPC.

TABLE 5.1.8.2-2

MULTIPLE CHEMICAL EVALUATION FOR PRS 19-003 MESA SLOPE

BASED ON NONCARCINOGENIC EFFECTS				
CHEMICAL	**SAMPLE ID**	**CONCENTRATION (mg/kg)**	**SAL (mg/kg)**	**NORMALIZED VALUE**
Acetone	0119-97-0067	0.046	2 100	0.00002
Cadmium	0119-97-0066	10.3	38	0.27
Copper	0119-97-0066	128	2800	0.05
Fluoranthene (PAH)	0119-97-0067	0.046J	2 600	0.00002
Lead	0119-97-0066	173 J+	400	0.43
Mercury	0119-97-0066	3.3	23	0.14
Pyrene (PAH)	0119-97-0067	0.13J	1 900	0.00007
Toluene	0119-97-0067	0.007 J	790	0.000009
Zinc	0119-97-0066	6380	23 000	0.28
NORMALIZED SUM				1.2
BASED ON CARCINOGENIC EFFECTS				
CHEMICAL	**SAMPLE ID**	**CONCENTRATION (mg/kg)**	**SAL (mg/kg)**	**NORMALIZED VALUE**
Methylene Chloride	0119-97-0066	0.009	7.8	0.001
NORMALIZED SUM				0.001

At the conclusion of this human health screening assessment for the PRS 19-003 mesa slope, inorganics cadmium, lead, manganese, mercury and zinc are retained as COPCs.

5.1.8.3 Risk-Based Screening and Assessment for PRS 19-003 Mesa Top

This subsection discusses the comparison with SALs for COPCs detected at levels greater than background screening levels in the investigation at the PRS 19-003 mesa top. A screening assessment was conducted on the RFI data for this PRS following methodology discussed in Chapter 3.0 of this report (Dorries 1996, 1297).

Aluminum, arsenic, barium, calcium, carbazole, chromium, cobalt, copper, dibenzofuran, magnesium, mercury, methylene chloride, nickel, selenium, vanadium, 16 PAHs, and cesium-137 were carried forward from the background evaluation and compared to their respective SALs.

Greater than SAL. The five carcinogenic PAHs shown in Table 5.1.8.3-1 were detected at concentrations greater than SAL. The background value for arsenic is greater than its risk-based SAL. Therefore, whenever arsenic is detected above background, it is also greater than SAL. The locations of the samples with COPCs greater than SALs are shown on Figure 5.1.8.3-1.

TABLE 5.1.8.3-1

COPCs GREATER THAN SAL FOR PRS 19-003 MESA TOP

CHEMICAL	SAMPLE ID	CONCENTRATION (mg/kg)	SAL (mg/kg)
Arsenic	0119-97-0065 0119-97-0073	3.3 J- 3.1	0.38
Benzo(a)anthracene (PAH)	0119-97-0064	15	0.61
Benzo(b)fluoranthene (PAH)	0119-97-0064	14	0.61
Benzo(a)pyrene (PAH)	0119-97-0064	13	0.061
Dibenzo(a,h)anthracene (PAH)	0119-97-0064	2.1J	0.061
Indeno(1,2,3-cd)pyrene (PAH)	0119-97-0064	6.2	0.61

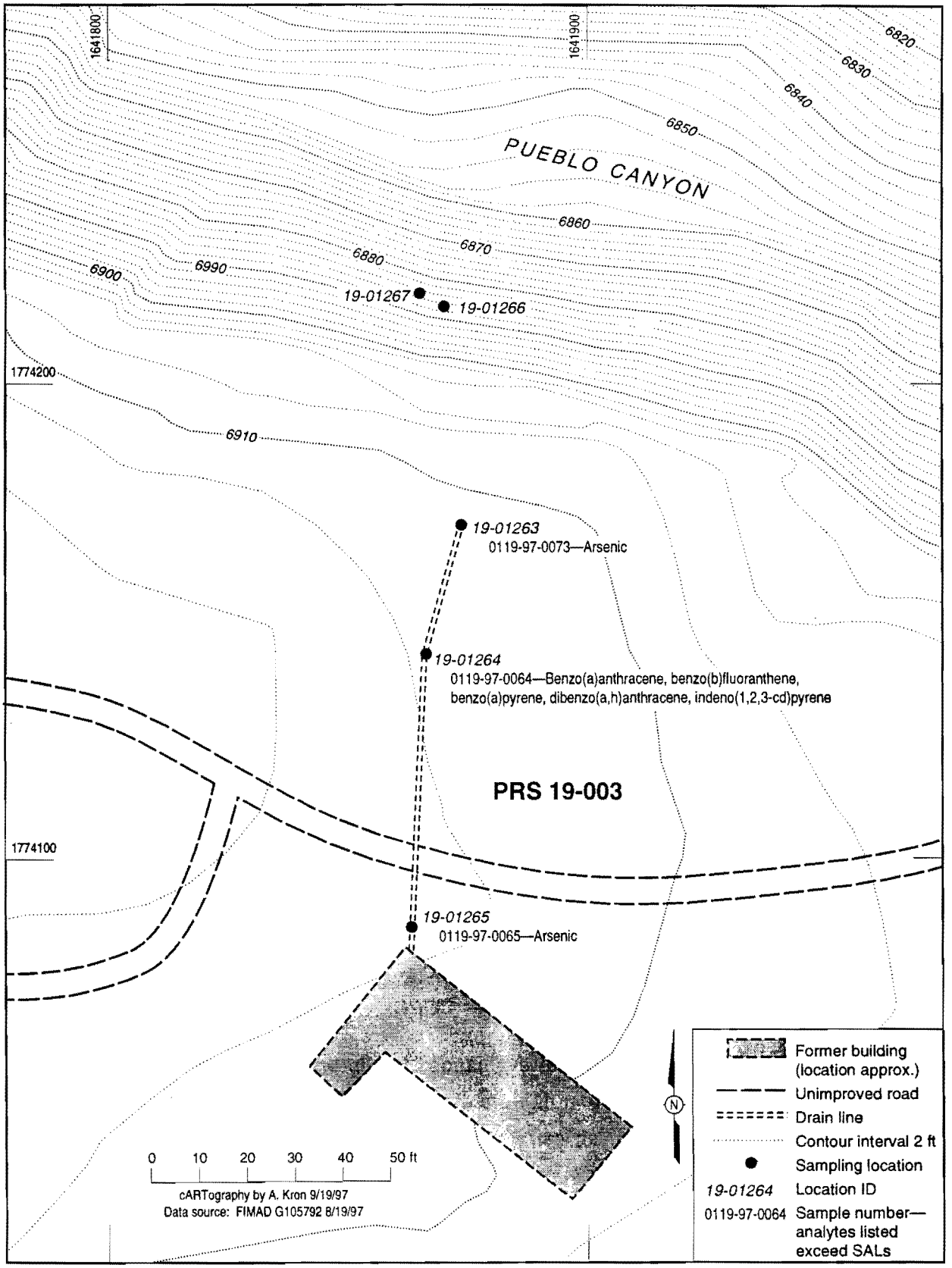

Fig. 5.1.8.3-1 Locations of samples with COPCs greater than SAL at PRS 19-003.

No SAL. Calcium and magnesium are essential nutrients and have no SALs. However, a comparison may be made to the RDA for these nutrients. The calcium and magnesium intakes associated with incidental soil ingestion would be considerably less than nutritional intakes, i.e., RDAs. Therefore, calcium and magnesium are eliminated as COPCs.

Several PAHs also have no SALs. Surrogate toxicity values were used for these PAHs based on similar chemical structure to other PAHs. These are included in the discussion below.

Less than SAL. The chemicals aluminum, barium, carbazole, cesium-137, chromium, cobalt, copper, dibenzofuran, mercury, methylene chloride, nickel, selenium, vanadium, and 11 PAHs were all detected at concentrations less than their respective SALs. To evaluate multiple chemical effects for this data set, COPCs detected at concentrations less than their SALs were grouped according to their toxicological effects (carcinogenic or noncarcinogenic effects of chemicals). Because cesium-137 is the only radionuclide detected above background and the detected activity (0.14(J) pCi/g) is considerably less than its SAL (5.1 pCi/g), cesium-137 is not included in the MCE and is not carried forward as a COPC.

The maximum concentration for each chemical is divided by its respective SAL to produce a normalized value. The sum of those normalized values yields a normalized sum which is compared to one. If the normalized sum is equal to or less than one, this indicates that adverse health effects are unlikely to occur from exposure to these chemicals at the maximum concentrations detected and all chemicals require no further evaluation as COPCs. If the normalized sum is greater than one, then any chemical with a normalized value of 0.1 or greater is retained as a COPC for further evaluation. This process is described in the policy document "Risk-Based Corrective Action Process" (Dorries 1996, 1297). The results of the analysis are shown in Table 5.1.8.3-2.

The results of the multiple chemical evaluation is 0.3 for noncarcinogenic effects indicating that no adverse health effects would be associated with these concentrations. Therefore, all noncarcinogenic chemicals are eliminated as COPCs.

The results of the multiple chemical evaluation, 1.2, is greater than one for carcinogens. Additionally, six chemical carcinogens were detected at values greater than SAL. Because of potential additivity of effects, all carcinogenic COPCs that contribute at least 0.1 to the carcinogenic MCE, i.e., benzo(k)fluoranthene and chrysene, will also be carried forward as COPCs.

TABLE 5.1.8.3-2

MULTIPLE CHEMICAL EVALUATION FOR PRS 19-003 MESA TOP

BASED ON NONCARCINOGENIC EFFECTS				
CHEMICAL	SAMPLE ID	CONCENTRATION (mg/kg)	SAL (mg/kg)	NORMALIZED VALUE
Acenaphthene (PAH)	0119-97-0064	6.6	2200	0.003
Aluminum	0119-97-0073	4400	77000	0.06
Anthracene (PAH)	0119-97-0064	8.9	18000	0.0005
Barium	0119-97-0073	82	5300	0.02
Benzo(g,h,i)perylene	0119-97-0064	6.2	1900	0.003
Cobalt	0119-97-0073	1.7	4600	0.0004
Copper	0119-97-0073	2.8	2800	0.001
Dibenzofuran	0119-97-0064	2.3	250	0.009
Fluoranthene (PAH)	0119-97-0064	27	2 600	0.01
Fluorene (PAH)	0119-97-0064	3.6	2300	0.002
Mercury	0119-97-0066	3.3	23	0.14
2-Methylnaphthalene	0119-97-0064	1.1 J	1 000[a]	0.001
Naphthalene (PAH)	0119-97-0064	1.8	1000	0.002
Nickel	0119-97-0073	4	1500	0.003
Phenanthrene	0119-97-0064	26	18 000[b]	0.001
Pyrene (PAH)	0119-97-0064	25	1 900	0.01
Selenium	0119-97-0065	0.39	380	0.001
Vanadium	0119-97-0073	7.3	540	0.01
NORMALIZED SUM				0.3
BASED ON CARCINOGENIC EFFECTS				
CHEMICAL	SAMPLE ID	CONCENTRATION (mg/kg)	SAL (mg/kg)	NORMALIZED VALUE
Benzo(k)fluoranthene (PAH)	0119-97-0064	6	6.1	0.98
Carbazole	0119-97-0064	3.6	61	0.06
Chromium	0119-97-0073	2.5	250	0.01
Chrysene (PAH)	0119-97-0064	6.2	61	0.1
Methylene Chloride	0119-97-0064	0.008	7.8	0.001
NORMALIZED SUM				1.2

[a] No toxicity value was available for 2-methylnaphthalene, therefore, the toxicity criteria for naphthalene was used as a surrogate based on similarity in chemical structure.

[b] No toxicity value was available for phenanthrene, therefore, the toxicity criteria for anthracene was used as a surrogate based on similarity in chemical structure.

At the conclusion of this human health screening assessment for PRS 19-003 mesa top, seven carcinogenic PAHs, benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, benzo(k)fluoranthene, chrysene dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, and arsenic, are retained as COPCs.

5.1.9 Human Health Risk Assessment

The human health risk assessment has been divided into mesa top and outfall slope exposure areas for PRS 19-001 and PRS 19-003.

5.1.9.1 PRS 19-001

A land transfer is planned for the site; therefore, future land use on the mesa top is assumed to be residential. The area of the outfall drainage is too steeply sloped to support development; therefore, recreational land use is assumed for this area.

Review of COPCs and Extent of Contamination at PRS 19-001

The results of the screening assessment indicated that PAHs were present at concentrations greater than SALs in samples 0119-97-0058 (collected from the end of the drainline), 0119-97-0061 (collected from the inlet line trench at the septic tank), and 0119-97-0068 (collected from the outfall area). Cesium-137 was also detected at a level greater than SAL in one of the outfall samples.

PRS 19-001 was characterized following the removal of the septic tank and associated piping by collecting seven samples from the inlet and outlet line trenches and the septic tank excavation. These samples were collected beneath the former pipe and tank, and span a distance of approximately 80 ft. Because the source of the PAHs is the pipe material, PAHs would not be expected at upgradient locations where there is no pipe. However, PAHs may have been carried by effluent to the edge of the mesa an additional 20 ft beyond the end of the drainline. Lateral flow of PAHs away from the pipe would be minimal and is conservatively assumed to be less than 5 ft in either direction away from the pipe because the vertical flow component would be stronger than the horizontal flow component. Based on these assumptions, the lateral extent of PAH contamination is defined for the mesa top as shown on Figure 5.1.9.1-1.

The depth to the main aquifer at this site is 980 ft bgs. Migration of these pipe-related PAHs to the main aquifer is not likely.

Soil samples were collected in a catchment area beneath PRS 19-001 where outfall drainage would have fallen. Two surface samples were collected to evaluate this area. Sample 0119-97-0068 had cesium-137 concentrations that are greater than the background UTL and the SAL for cesium-137. Cesium-137 concentrations were not greater than background in nearby sample 0119-97-0069. The two samples also had several PAHs detected, including benzo(a)pyrene at a concentration greater than SAL, and benzo(b)fluoranthene and benzo(a)anthracene at concentrations greater than 0.1 times SAL. Because this catchment received the most direct drainage from the outfall and is the first downgradient location for sediment to collect, these samples represent the maximum concentrations for soil in the slope area.

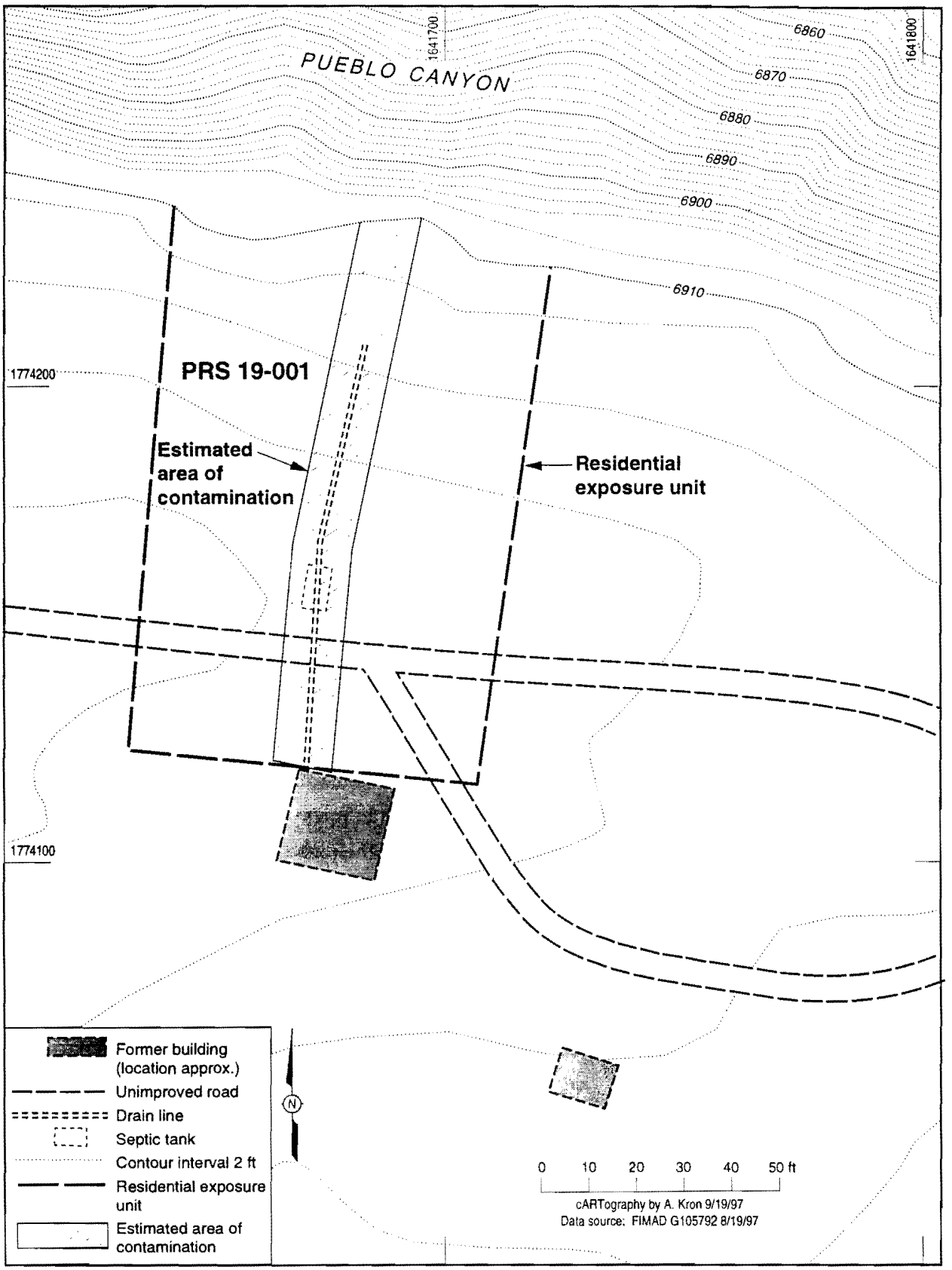

Fig. 5.1.9.1-1 Estimated PAH area of contamination and residential exposure unit at PRS 19-001.

Because this area can only be used for recreational purposes, PAHs detected greater than 0.1 times SAL (benzo(a)pyrene, benzo(b)fluoranthene and benzo(a)anthracene) and cesium-137 will be evaluated for a recreational scenario at the outfall area of PRS 19-001.

Human Health Risk Evaluation for PRS 19-001

A human health risk evaluation was conducted to determine if current or future land use at the site would be associated with unacceptable risk. The risk evaluation includes a semi-quantitative evaluation of the residential scenario for the mesa top and a recreational scenario for the outfall catchment. Residential risk estimates are calculated by ratio to EPA Region IX Preliminary Remediation Goals (PRGs) (EPA 1996 XXXX). The PRGs are based on the same exposure pathways that are relevant for this PRS including:

- Incidental ingestion of soil
- Dermal contact with soil
- Inhalation of volatilized COPCs or resuspended soil particulates.

All COPCs on the mesa top are carcinogenic PAHs. The exposure duration for carcinogens used in the Region IX PRGs is 30 years, including 6 years as a child with a higher soil ingestion rate. Region IX PRGs for carcinogens are based on a lifetime excess cancer risk of 1×10^{-6}. As such, to correlate an exposure concentration with a cancer risk, the mean concentration for the site is divided by the PRG and multiplied by 1×10^{-6}.

Although the PAHs occur at a depth of 4 to 5 ft, they are conservatively assumed to be available for exposure at the surface, e.g., if they were brought to the surface following excavation for a basement. The area potentially affected by PAHs on the mesa top is estimated as a strip 10 ft wide and 100 ft long extending from the location of the former retreat building to the edge of the mesa. This 1000 ft^2 area of contamination constitutes one fifth of a residential exposure unit (generally assumed to be 5000 ft^2). Therefore, exposure concentrations are adjusted accordingly.

The exposure concentrations estimated for the site and their associated cancer risk are shown in Table 5.1.9.1-1. The total lifetime cancer risk for residential use of the mesa top portion of PRS 19-001 is 1×10^{-5}.

TABLE 5.1.9.1-1

RISK ESTIMATES FOR RESIDENTIAL USE OF THE PRS 19-001 MESA TOP

COPC	Average Concentration[a] (mg/kg)	Area-Weighted Concentration (mg/kg)	Region IX PRG (mg/kg)	AWC[b]/PRG
Benzo(a)anthracene (PAH)	2.23	0.45	0.61	0.74
Benzo(b)fluoranthene (PAH)	2.67	0.53	0.61	0.87
Benzo(a)pyrene (PAH)	2.17	0.43	0.061	7.0
Dibenzo(a,h)anthracene (PAH)	0.323	0.065	0.061	1.1
Indeno(1,2,3-cd)pyrene (PAH)	0.750	0.15	0.61	0.25
Benzo(k)fluoranthene (PAH)	1.10	0.22	6.1	0.036
Chrysene (PAH)	2.24	0.45	61	0.0074
Ratio Sum x 10^{-6} cancer risk	—	—	—	1×10^{-5}

[a] Non-detected values were included in the average at one-half their detection limit. The higher of a duplicate value was used for the average.

[b] AWC - Area-weighted concentration

Recreational risk estimates were calculated for cesium-137 and PAHs that were detected at a level greater than 0.1 times SAL in the catchment. Radionuclide risks are calculated by the RESRAD computer code, version 5.0. (RESRAD is a microcomputer program developed by DOE to calculate dose associated with residual radioactive materials.) Default recreational exposure assumptions have been developed for LANL and are specified in the Risk-Based Corrective Action Process Document and are included in the RESRAD output in Appendix C. The recreational scenario includes routine use of the area for hiking. Exposure pathways include:

- incidental soil ingestion,
- inhalation of dust, and
- external gamma radiation.

The maximum cesium-137 activity of 5.85 pCi/gm is conservatively assumed to be the exposure concentration for the entire exposure area, although the catchment is only a fraction of the exposure area. The results of the RESRAD dose estimate for a reasonable maximum recreational exposure are 0.74 mrem/yr.

Recreational risk was evaluated for the PAHs that were detected at a level greater than 0.1 times SAL in the catchment. Default recreational exposure assumptions have been developed for LANL and are specified in the Risk-Based Corrective Action Process Document

(Dorries 1996, 1297). The exposure assumptions for reasonable maximum exposure for a trail user are used to evaluate the catchment. The recreational scenario includes routine use of the area for hiking. Exposure pathways include:

- incidental soil ingestion and
- inhalation of dust.

All PAHs carried forward for the catchment area are carcinogens. To determine the reasonable maximum exposure cancer risk, the intake from incidental ingestion of soil for a recreational scenario is estimated by the following equation:

Intake (mg/kg-day) = (CS x IR x CF x FI x EF x ED)/(BW x AT)

where:

CS - concentration in soil (mg/kg of each COPC)

IR - ingestion rate of 100 mg/day of soil

CF - conversion factor of 1×10^{-6} kg/mg

FI - fraction ingested from contaminated source assumed to be 0.25

EF - exposure frequency assumed to be 170 days/yr

ED - exposure duration assumed to be 30 yr

BW - body weight of 70 kg

AT - averaging time of 25550 days (70 yr x 365 days/yr)

Inhalation intake for a recreational scenario is estimated by the following equation:

Intake (mg/kg-day) = (CA x IhR x ET x EF x ED)/(BW x AT)

where:

CA - concentration in air (mg/m^3 of each COPC) derived by multiplying soil concentration by

a dust loading factor of 0.09 x 10^{-6} kg/m^3 i.e., the maximum 24 hour average of total suspended particulates from the Bandelier air monitoring station (EPG 1990, 0497)

IhR - inhalation rate of 3.5 m^3/hr for outdoor activities

ET - exposure time assumed to be 2 hr/day

EF - exposure frequency assumed to be 170 days/yr

ED - exposure duration assumed to be 30 yr

BW - body weight of 70 kg

AT - averaging time of 25550 days (30 yr x 365 days/yr)

Each COPC is multiplied by its slope factor. Slope factors are concentrations in $(mg/kg\text{-}day)^{-1}$ that are an upper bound estimate of the carcinogenic potential of a chemical ingested or inhaled over a lifetime as determined by EPA's evaluation of current toxicity data. The cancer risks are then summed to determine a total lifetime excess cancer. Table 5.1.9.1-2 shows the intake for each exposure route, the slope factor and cancer risk for each COPC, and the total cancer risk for all chemical COPCs. The total potential cancer risk from recreational use of the outfall area, assuming maximum concentrations are present throughout 25% of a recreational exposure unit, is 1 x 10^{-7}. This risk is below the risk range of 10^{-4} to 10^{-6} considered acceptable by EPA in the NCP and proposed in RCRA Subpart B.

TABLE 5.1.9.1-2

RISK EVALUATION OF RECREATIONAL SCENARIO AT PRS 19-001

Chemical COPC	Maximum Conc. (mg/kg)	Soil Ingestion Intake (mg/kg-day)	Ingestion Slope Factor $(mg/kg\text{-}day)^{-1}$	Soil Inhalation Intake (mg/kg-day)	Inhalation Slope Factor $(mg/kg\text{-}day)^{-1}$	Hazard Quotient Ingested	Hazard Quotient Inhaled
Benzo(a) anthracene (PAH)	0.21	1.5E-8	0.73	3.8E-10	0.73	1E-8	3E-10
Benzo(a) pyrene (PAH)	0.13	9.2E-9	7.3	2.3E-10	7.3	7E-8	2E-9
Benzo(b) fluoranthene (PAH)	0.55	3.9E-8	0.73	9.9E-10	0.73	3E-8	7E-10
Total Cancer Risk	—	—	—	—	—	1 x 10^{-7}	

Uncertainty Analysis for PRS 19-001

The risk estimates described previously are screening level for comparative decision-making purposes, i.e. for comparison to other PRSs and/or to regulatory benchmarks based on these or similar assumptions. Due to the tremendous sources of uncertainty in these calculations, these estimates are not appropriate to use as an actual anticipated risk from the site, nor do they serve a predictive value for health effects at a site. In keeping with the screening approach, exposure assumptions were made that are likely to overestimate risk, i.e., it is intended to represent a reasonable maximum exposure potential.

Sources of uncertainty in the exposure intake parameters span an order of magnitude in the soil ingestion rate and span at least 2 orders of magnitude in the dust resuspension factor and inhalation rate. Toxicity values, i.e., cancer slope factors, have at least an order of magnitude of uncertainty since they have been extrapolated from animal studies, across exposure routes and duration, and to sensitive subpopulations. However, by using the default assumptions, these results can be used to compare risks across sites and facilitate decision making.

Human Health Risk Conclusions for PRS 19-001

The results of the human health risk assessment indicate that residential use of the mesa top portion of PRS 19-001 could be associated with a lifetime excess cancer risk of 1×10^{-5} if PAHs in subsurface soil were brought to the surface. This risk level is within the range considered acceptable by EPA in the National Contingency Plan and in proposed RCRA Subpart S, i.e., lifetime excess cancer risks of 10^{-4} to 10^{-6} (EPA 1990, 0559; EPA 1990, 1358). Use of the slope area for routine recreational purposes could be associated with a dose 0.74 mrem/yr from cesium-137 and a cancer risk of 1×10^{-7} from PAHs assuming a reasonable maximum exposure scenario. The dose for cesium-137 is considerably below the 100 mrem/yr dose limit for a member of the public specified in DOE Order 5400.5, and the cancer risk from PAHs is less than EPA's acceptable risk range.

5.1.9.2 Human Health Risk Assessment for PRS 19-003 Mesa Slope

The results of the screening assessment indicated that manganese was present at a concentration greater than SAL and cadmium, lead, mercury, and zinc contributed to an MCE greater than one. These COPCs are associated with batteries and are the same COPCs that were detected in the batteries and soil in the battery disposal area for PRS 19-002. COPCs that would be associated with the drain line, namely PAHs, were not detected at levels greater than 0.1 times SAL in the outfall. Five organics, acetone, fluoranthene, methylene chloride, pyrene,

and toluene, were detected in the outfall but only at levels near their respective detection limits (four of the values are "J" qualified estimated values).

As can be seen on Figure 5.1.4.1-1, the outfall area of 19-003 is contained within the battery disposal area identified for PRS 19-002. A VCA was conducted for PRS 19-002 in 1995 which involved removal of battery debris. Soil was not removed at that time, as nothing was detected greater than SALs in use at that time (September 1995). However, based on the results of the current samples in the 19-003 outfall (0119-97-0066 and 0119-97-0067) which are located in the battery debris area, it appears that the extent of contamination may not have been adequately defined for 19-002. The new samples have battery-related COPCs cadmium, mercury, and zinc detected at higher concentrations than the maximum values previously reported (manganese and lead were detected at similar levels as previously reported). These data indicate that the source term may not have been sufficiently characterized to determine the potential for human health risk at PRS 19-002. As such, soil contamination relating to the battery disposal area of PRS 19-002 will be revisited and will include the outfall area previously identified as part of PRS 19-003 since the outfall COPCs are associated with batteries and not the drain line.

5.1.9.3 Human Health Risk Assessment for PRS 19-003 Mesa Top

A land transfer is planned for the site; therefore, future land use on the mesa top is assumed to be residential. The area of the outfall drainage is associated with PRS 19-002 as discussed in section 5.1.9.2.

Review of COPCs and Extent of Contamination at PRS 19-003 Mesa Top

The results of the screening assessment indicated that PAHs were present at concentrations greater than SALs in sample 0119-97-0064 (collected from the drainline trench approximately midway between the ends) and arsenic was detected above the Unit 2 UTL in samples 0119-97-0065 and 0119-97-0073.

PRS 19-003 was characterized following the removal of the drain line by collecting four samples from the lab drain line trench. These samples were collected beneath the former pipe and span a distance of approximately 80 ft. Because the source of the PAHs is the pipe material, PAHs would not be expected at upgradient locations where there is no pipe. However, PAHs may have been carried by effluent to the edge of the mesa an additional 20 ft beyond the pipe end at sample location 19-01263. Lateral flow of PAHs away from the pipe would be minimal and is conservatively assumed to be 5 ft in either direction away from the pipe. Based on these assumptions, the lateral extent of PAH contamination is defined for the mesa top as shown on Figure 5.1.9.2-1.

It is not clear if arsenic is actually present at concentrations above background since it slightly exceeds the Unit 2 UTL of 2 mg/kg in two samples (3.3 and 3.1 mg/kg). However, these values are lower than the arsenic UTL for all soils (7.82 mg/kg) and the arsenic UTL for Unit 3 (5.0 mg/kg). The soil horizons may not be sufficiently distinct at these sample locations to precisely identify the contact between Units 2 and 3. Nonetheless, arsenic will be evaluated as a COPC.

The depth to the main aquifer at this site is 980 ft bgs. Migration of arsenic and these pipe-related PAHs to the main aquifer is not likely.

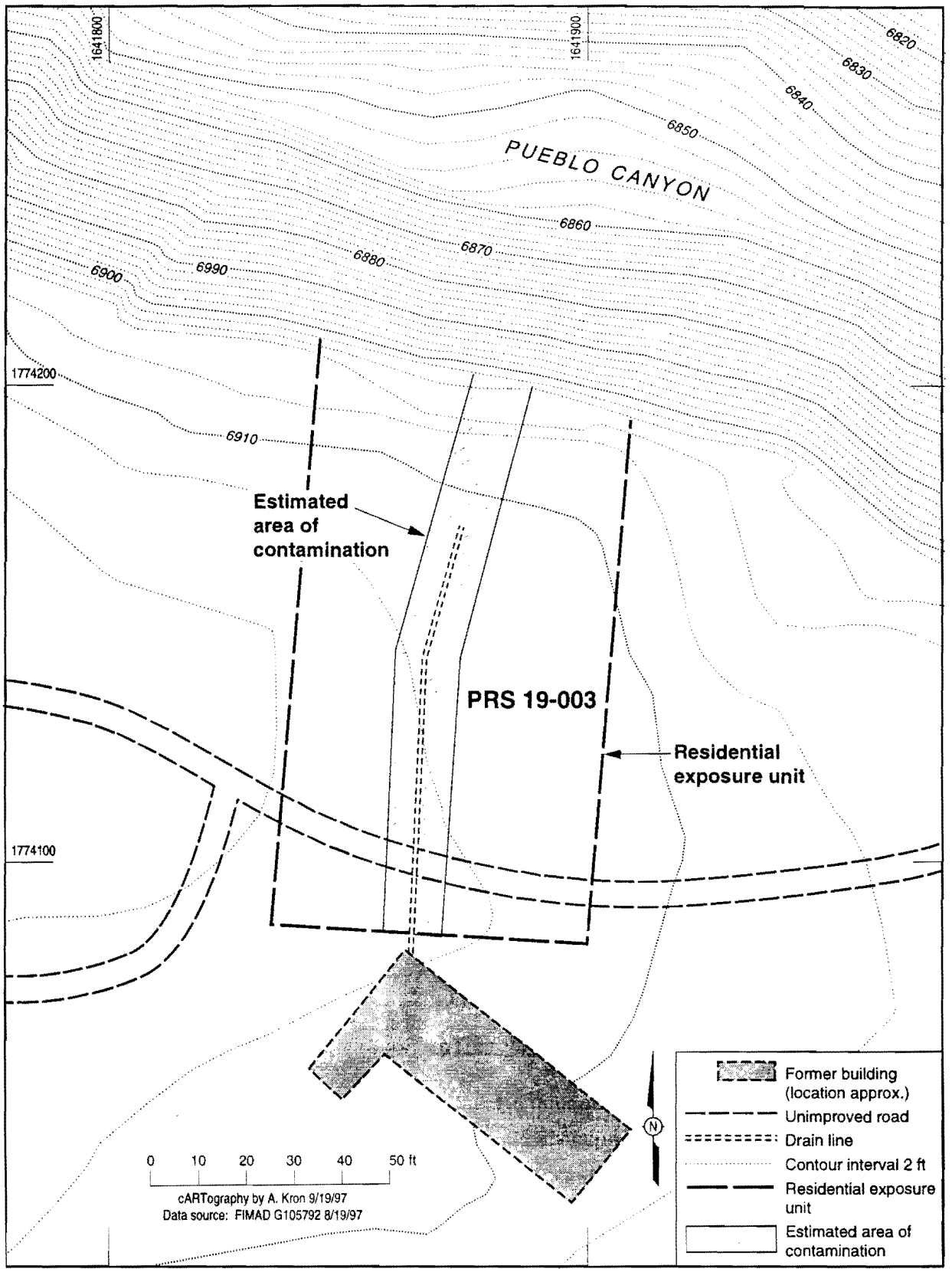

Fig. 5.1.9.2-1 Estimated PAH area of contamination and residential exposure unit at PRS 19-003.

Human Health Risk Evaluation for PRS 19-003 Mesa Top

A human health risk evaluation was conducted to determine if current or future land use at the site would be associated with unacceptable risk. The risk evaluation includes a semi-quantitative evaluation of the residential scenario for the mesa top. Residential risk estimates are calculated by ratio to EPA Region IX PRGs (EPA 1996 XXXX). The PRGs are based on the same exposure pathways that are relevant for this PRS including:

- incidental ingestion of soil,
- dermal contact with soil, and
- inhalation of volatilized COPCs or resuspended soil particulates.

All COPCs on the mesa top are carcinogens. The exposure duration for carcinogens used in the Region IX PRGs is 30 years, including 6 years as a child with a higher soil ingestion rate. Region IX PRGs for carcinogens are based on a lifetime excess cancer risk of 1×10^{-6}. As such, to correlate an exposure concentration with a cancer risk, the mean concentration for the site is divided by the PRG and multiplied by 1×10^{-6}.

Although the COPCs occur at a depth of 3 to 4 ft, they are conservatively assumed to be available for exposure at the surface, e.g., if they were brought to the surface following excavation for a basement. The area potentially affected by COPCs on the mesa top is estimated as a strip 10 ft wide and 100 ft long extending from the location of the former laboratory to the edge of the mesa. This 1000 ft^2 area of contamination constitutes one fifth of a residential exposure unit (generally assumed to be 5000 ft^2). Therefore, exposure concentrations are adjusted accordingly.

The exposure concentrations estimated for the site and their associated cancer risk are shown in Table 5.1.9.3-1. The total lifetime cancer risk for residential use of the mesa top area of PRS 19-003 is $1x\ 10^{-5}$.

Uncertainty Analysis for PRS 19-003 Mesa Top

The risk estimates described in Section 5.1.9.3 are screening level for comparative decision-making purposes, i.e. for comparison to other PRSs and/or to regulatory benchmarks based on these or similar assumptions. Due to the tremendous sources of uncertainty in these calculations, these estimates are not appropriate to use as an actual anticipated risk from the site, nor do they serve a predictive value for health effects at a site. In keeping with the screening approach, exposure assumptions were made that are likely to overestimate risk, i.e., it is intended to represent a reasonable maximum exposure potential.

TABLE 5.1.9.3-1

RISK ESTIMATES FOR RESIDENTIAL USE OF THE PRS 19-003 MESA TOP

COPC	Average Concentration[a] (mg/kg)	Area-Weighted Concentration (mg/kg)	Region IX PRG (mg/kg)	AWC[b]/PRG
Arsenic	1.90	0.38	0.38	1.0
Benzo(a)anthracene (PAH)	3.17	0.63	0.61	1.0
Benzo(b)fluoranthene (PAH)	2.97	0.59	0.61	0.97
Benzo(a)pyrene (PAH)	2.77	0.55	0.061	9.0
Dibenzo(a,h)anthracene (PAH)	0.59	0.12	0.061	2.0
Indeno(1,2,3-cd)pyrene (PAH)	1.41	0.28	0.61	0.46
Benzo(k)fluoranthene (PAH)	1.37	0.27	6.1	0.04
Chrysene (PAH)	2.98	0.60	61	0.01
Ratio Sum x 10^{-6} cancer risk	—	—	—	1×10^{-5}

[a] Non-detected values were included in the average at one-half their detection limit. The higher of a duplicate value was used for the average.
[b] AWC - Area-weighted concentration

Sources of uncertainty in the exposure intake parameters span an order of magnitude in the soil ingestion rate and span at least two orders of magnitude in the dust resuspension factor and inhalation rate. Toxicity values, i.e., cancer slope factors, have at least an order of magnitude of uncertainty since they have been extrapolated from animal studies, across exposure routes and duration, and to sensitive subpopulations. However, by using the default assumptions, these results can be used to compare risks across sites and facilitate decision making.

Human Health Risk Conclusions for PRS 19-003 Mesa Top

The results of the human health risk assessment indicate that residential use of the mesa top portion of PRS 19-003 could be associated with a lifetime excess cancer risk of 1×10^{-5} if PAHs and arsenic in subsurface soil were brought to the surface. This risk level is within the range considered acceptable by EPA in the National Contingency Plan and in proposed RCRA Subpart S, i.e., lifetime excess cancer risks of 10^{-4} to 10^{-6} (EPA 1990, 0559; EPA 1990, 1358).

5.1.10 Preliminary Ecological Assessment of Aggregate 19-A

In cooperation with the New Mexico Environment Department and EPA Region 6, the Laboratory ER Project is developing an approach for ecological risk assessment. Further ecological risk assessment at PRS 19-001 and 19-003 will be deferred until the sites can be assessed as part of the ecological exposure unit methodology currently being developed.

5.1.11 Conclusions and Recommendations for Aggregate 19-A

The results of the human health risk assessment for PRS 19-001 indicate that residential use of the mesa top portion of PRS 19-001 could be associated with a lifetime excess cancer risk of 1×10^{-5} if PAHs in subsurface soil were brought to the surface. This risk level is within the range considered acceptable by EPA in the National Contingency Plan and in the proposed RCRA Subpart S, i.e., lifetime excess cancer risks of 10^{-4} to 10^{-6} (EPA 1990, 0559; EPA 1990, 1358). Use of the slope area for routine recreational purposes could be associated with a dose 0.74 mrem/yr from cesium-137 and a cancer risk of 1 x 10-7 from PAHs assuming a reasonable maximum exposure scenario. The dose for cesium-137 is considerably below the 100 mrem/yr dose limit for a member of the public specified in DOE Order 5400.5, and the cancer risk from PAHs is less than EPA's acceptable risk range.

The results of the human health risk assessment indicate that residential use of the mesa top portion of PRS 19-003 could be associated with a lifetime excess cancer risk of 1×10^{-5} if PAHs and arsenic in subsurface soil were brought to the surface. This risk level is within the range considered acceptable by EPA in the National Contingency Plan and in the proposed RCRA Subpart S, i.e., lifetime excess cancer risks of 10^{-4} to 10^{-6} (EPA 1990, 0559; EPA 1990, 1358).

A recommendation of NFA is, therefore, made for PRSs 19-001 and 19-003. The NFA recommendation is based on LANL's NFA Criteria Policy, Criterion 5, which states that the PRS has been characterized in accordance with current applicable state or federal regulations, and that COPCs are not present in concentrations that would pose an unacceptable risk under the projected future land use.

The results of the screening assessment for the mesa slope below the PRS 19-003 outfall indicated that manganese was present at a concentration greater than SAL and cadmium, lead, mercury, and zinc contributed to an MCE greater than one. These COPCs are associated with

batteries and are the same COPCs that were detected in the batteries and soil for the battery surface disposal area PRS 19-002. There were no COPCs identified for the outfall that are related to the drain line of PRS 19-003. Because the concentrations of several battery-related COPCs were detected at higher levels than previously reported for PRS 19-002, PRS 19-002 will be revisited and will include evaluation of the battery-related COPCs detected in the outfall samples of 19-003.

5.2 PRS C-19-001

PRS C-19-001 contains potentially contaminated soil located beneath the former laboratory, battery building, guard house, latrine, retreat building, and shelter building (Figure 5.1-1). No chemicals were retained as COPCs after completion of a human health screening assessment; therefore, a recommendation of NFA is made based on NFA Criterion 5, "The PRS has been characterized or remediated in accordance with current applicable state or federal regulations, and the available data indicate that contaminants pose an acceptable level of risk under current and projected future land use".

5.2.1 History

PRS C-19-001 is discussed in detail in Sections 3.2 and 5.14 of the RFI work plan. The laboratory was constructed in 1944 and the battery building, latrine, guard shack, retreat building, septic tank, and shelter building were added by the early 50s. In December 1956, the battery building, guard building, and latrine were removed. The other structures were transferred to the Zia Company in 1957 and 1962. All LASL capital equipment remaining at East Gate Laboratory was assigned to E-Division and was used in civil defense activities by the Amateur Radio Club until late 1974, at which time the site was apparently abandoned. When DOE visited the site in 1986 as part of the Comprehensive Environmental Assessment and Response Program, the only remaining structure at TA-19 was the septic tank (LANL 1992, 0781).

5.2.2 Description

All information regarding the C-19-001 site description, geology, hydrology, soils, wildlife habitat, etc., are provided in Section 2.0.

5.2.3 Previous Investigation(s)

In July and November 1974, various H-Division groups (H-1, H-3, H-5, and H-8) conducted building and property surveys at TA-19 to identify any potential contamination. The results of

the surveys indicated that the structures were free of HE and radioactive, chemical, and toxic contamination. Laboratory analysis of soil samples collected in August 1974, in the vicinity of two effluent discharge points indicated that "no radioactive contamination was released from the building during early operations" (LANL 1992, 0781).

5.2.4 Field Investigation

The objective of the Phase I RFI at PRS C-19-001 was to determine whether residual contamination is present in the surface drainages south of the former laboratory. Contaminants may have been released to the environment via leaks and spills from the laboratory operations. If contaminants were released, they may be present in, or migrate to, soil, tuff, and/or air. Contaminants in the soil or tuff, if present, may have leached into the vadose zone, while contaminants in the soil may also have become entrained in the air and/or water and transported off-site by wind or run-off.

Based on the surface topography of the site, surface run-off from the area of the former building would flow south off the mesa. In accordance with the OU 1071 work plan, a determination of the presence of residual contamination would be based on analytical results of soil samples collected from the catchments in drainages south of the former laboratory location.

5.2.4.1 Field Activities

Geodetic Survey

A geodetic survey was performed in March 1997, to establish the original locations of the corners of buildings and fences. The survey was based on structure coordinates provided in both the LASL Grid System and the New Mexico State Plane Coordinate System. Following completion of the surface sampling, each sample location was surveyed in July 1997. A base map was generated from the resulting data.

Sampling

Surface samples were collected on June 17, 1997. In accordance with the approved RFI work plan, two soil samples were collected from the top 6 in. in catchments in each of the three major south-draining channels downgradient of the former laboratory area. A summary of samples collected is shown in Table 5.2.4-1. Sample locations are shown on Figure 5.2.4.1-1.

TABLE 5.2.4.1-1

SUMMARY OF SAMPLES COLLECTED at PRS C-19-001

Location ID	Sample ID 0119-97-xxxx	Depth (ft)	Media	OVM[a] (ppm)	Gross alpha (cpm)[b]	Gross beta/gamma (cpm)	VOCs	SVOCs	Inorganic Chemicals	Gamma Spec
19-01251	0051	0 - 0.5	Soil	0.0	NDA[c]	NDA	3253R	n/a[d]	3254R	3255R
19-01252	0052	0 - 0.5	Soil	0.0	NDA	NDA	3253R	3253R	3254R	3255R
19-01253	0053	0 - 0.5	Soil	0.0	NDA	NDA	3253R	3253R	3254R	3255R
19-01254	0054	0 - 0.5	Soil	0.0	NDA	NDA	3253R	3253R	3254R	3255R
19-01255	0055	0 - 0.5	Soil	0.0	NDA	NDA	3253R	3253R	3254R	3255R
19-01256	0056	0 - 0.5	Soil	0.0	NDA	NDA	3253R	3253R	3254R	3255R
19-01251	0057	0 - 0.5	Soil	0.0	NDA	NDA	n/a	3256R	n/a	n/a

[a] Organic Vapor Monitor. Units in parts per million
[b] counts per minute
[c] No Detectable Activity above background
[d] not analyzed

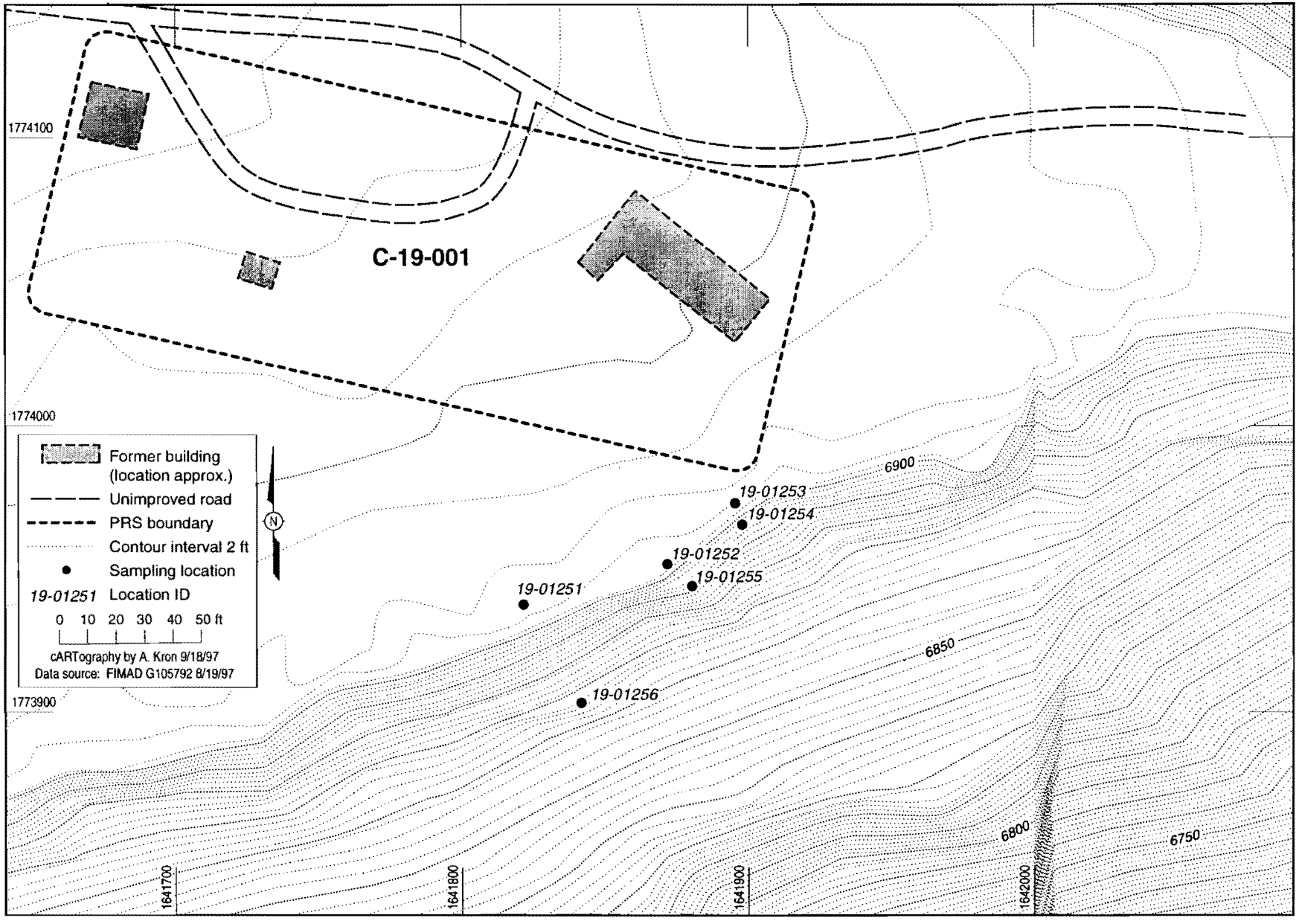

Fig. 5.2.4.1-1. Location of samples collected at PRS C-19-001.

One additional sample (0119-97-0057) for SVOC analysis was collected from sample location 19-01251 on June 20, 1997, to replace one sample container broken by SMO personnel. The sample was collected to replace the SVOC sample collected as part of the sample suite for 0119-97-0051 collected from location 19-01251.

Field Screening

All samples and sample material were screened in the field for VOCs using a TEI Model 580B OVM, gross alpha radiation using a Ludlum Model 139 with an air proportional probe, and gross beta/gamma radiation using an Ludlum Model 12 with a 44-40 GM pancake probe. Results of organic vapor screening indicated that no volatile organic vapors were detected in the samples or sample material. Gross radioactivity screening detected no radioactivity at levels greater than background.

5.2.4.2 Deviations

In accordance with the approved RFI work plan, first-order drainage channels within the PRS domain would be located and mapped to determine sites for sampling channel deposits. This activity would locate all catchment sites in the relevant drainages. Mapping would be completed on a scale of 1:2000. Mapping of the channels was not necessary and therefore, not conducted because drainage channels and catchments were identified for sampling purposed as part of the site survey.

5.2.5 Evaluation of Inorganics

Six soil samples collected at PRS C-19-001 were analyzed for TAL metals. Each inorganic soil result was compared to the all soil data background screening value (Longmire et al. 1995, 1142 and 1266).

As discussed in Section 4.1 (Inorganic Analyses), arsenic and manganese were qualified J- in all six samples because of a low recovery in the matrix spike sample. A low recovery suggests that either there was incomplete recovery of an analyte during chemical extraction or that the sample is heterogeneous. A post-digestion spike was performed for arsenic and manganese and the recoveries were within the limits allowed in USEPA SW846 guidelines. The maximum concentration of manganese is 320 mg/kg. This concentration is less than half of the background screening value of 714 mg/kg for manganese. All of the reported concentrations of manganese are consistent with the range of detects normally observed for this inorganic and a possible low

bias does not indicate that manganese is above background. Arsenic was detected at a maximum value of 6.7 mg/kg. The other five reported concentrations of arsenic were approximately 2.5 mg/kg. These data are consistent with the concentration range of background for this inorganic. Thus, a possible low bias does not affect the conclusion that PRS arsenic data are not different from background. Arsenic and manganese are not evaluated further.

Three inorganics, calcium, lead, and sodium, were detected above background screening values in at least one soil sample. Further background comparisons were not performed for calcium, lead, and sodium because the number of site samples for these metals are inadequate to support other statistical tests. Therefore, calcium, lead, and sodium are carried forward to the screening assessment. The data for each sample that had at least one concentration above the background screening value for these three inorganics are shown in Table 5.2.5-1 and Figure 5.2.5-1.

TABLE 5.2.5-1

INORGANIC CHEMICALS WITH CONCENTRATIONS EXCEEDING BACKGROUND SCREENING VALUES IN SOIL AT PRS C-19-001

			Calcium	Lead	Zinc
Location ID	Depth (ft)	UTL Sample ID	6120	23.3	50.8
19-01255	0 - 0.5	0119-97-0055	10000	27	51

5.2.6 Evaluation of Radionuclides

Six soil samples collected at PRS C-19-001 were analyzed by gamma spectroscopy.

EQLs and MDAs are often not available for radionuclides by gamma spectroscopy. A value of three times the measurement uncertainty (3 sigma or three standard deviations) is used to calculate a sample-specific MDA, which is then employed in the same manner as a detection limit. This methodology is similar to Currie's method of determining radionuclide maximum detectable activity (Currie 1988, 0792). This 3 sigma screening value takes into account variability due to counting statistics, but does not account for spectral peak identification problems. Thus, this 3 sigma screening is conservative, and may include radionuclides whose presence is spuriously reported due to spectral interferences or misidentifications. Nine radionuclides (americium-241, cerium-144, cobalt-57, cobalt-60, europium-152, iodine-129, neptunium-237, ruthenium-106, and sodium-22) were eliminated from further consideration because they were not detected in any sample.

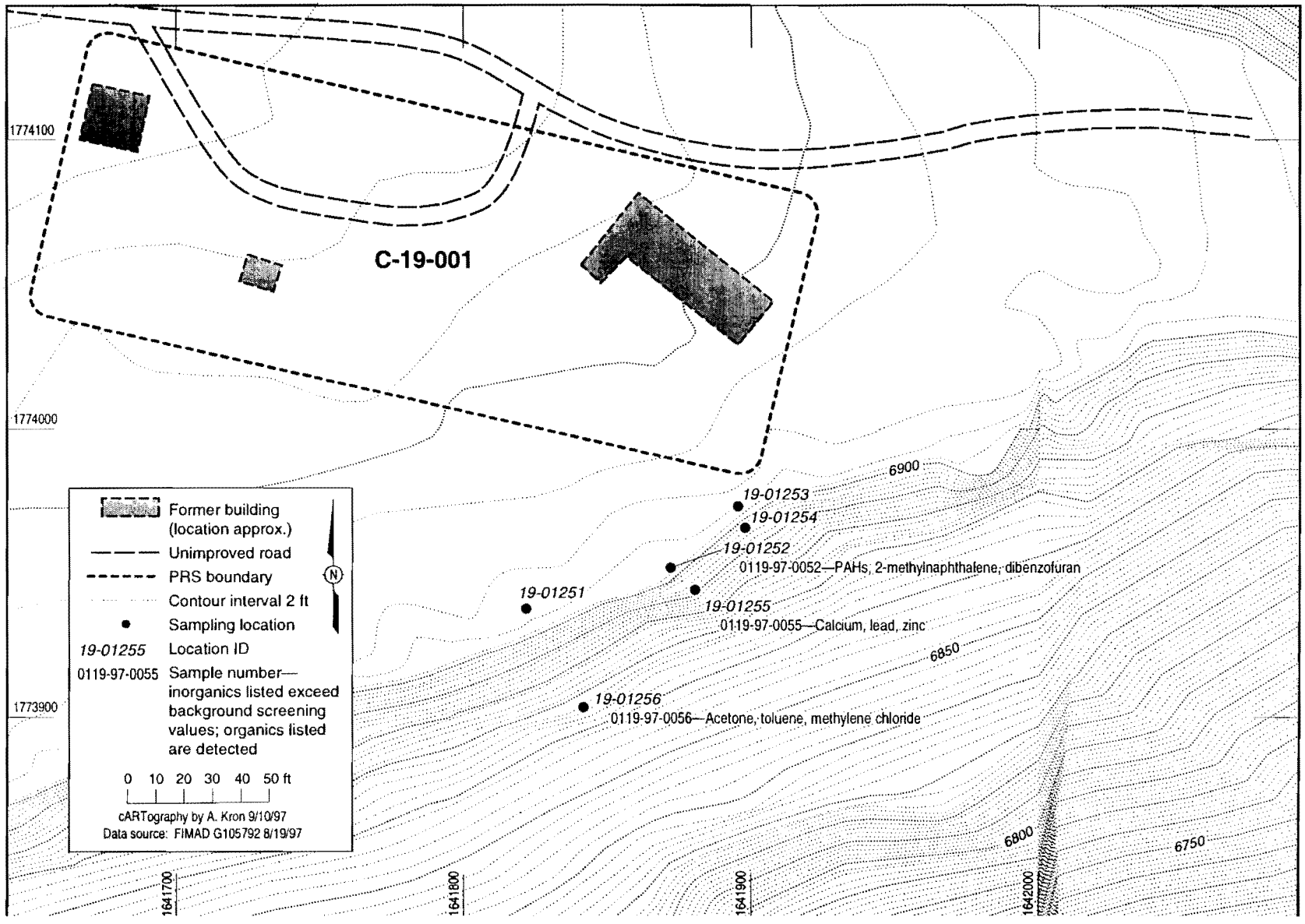

Fig. 5.2.5-1 Inorganics above background screening values and detected organics at PRS 19-001.

Potassium-40 is a naturally occurring radionuclide that is also routinely reported by the analyst because it is used as an internal standard to measure such things as equipment performance, laboratory background (or contamination), etc. There is no process knowledge of the use of potassium-40 at TA-19, and reported concentrations are generally within known background ranges for potassium-40 (Longmire et al. 1995, 1142; Longmire et al. 1995, 1266). Therefore, potassium-40 will not be carried forward to the human health screening assessment.

Cesium-137 was the only radionuclide that was detected and compared to its background screening value. All detected values of cesium-137 were below its background screening value of 1.65 pCi/g. Therefore, cesium-137 is not carried forward to the human health screening assessment. No radionuclides will be carried forward to the human health screening assessment.

5.2.7 Evaluation of Organic Chemicals

Six soil samples collected at PRS C-19-001 were analyzed for a suite of semivolatile organic chemicals and volatile organic chemicals.

Ten organic compounds (acetone, methylene chloride, toluene, naphthalene, 2-methylnaphthalene, dibenzofuran, phenanthrene, fluoranthene, pyrene, and chrysene) were detected in at least one soil sample. The data for each sample that had at least one detected concentration for these ten organic chemicals are presented below in Table 5.2.7-1 and in Figure 5.2.5-1. These ten organic chemicals are carried forward to the human health screening assessment.

TABLE 5.2.7-1

DETECTED ORGANIC CONCENTRATIONS AT PRS C-19-001

Location ID	Depth (ft)	Sample ID	Acetone	Methylene Chloride	Toluene	Naphthalene (PAH)	2-Methylnaphthalene
19-01252	0 - 0.5	0119-97-0052				1.7	0.4
19-01256	0 - 0.5	0119-97-0056	0.2J	0.011 J	0.01J		

TABLE 5.2.7-1 (continued)

DETECTED ORGANIC CONCENTRATIONS AT PRS C-19-001

Location ID	Depth (ft)	Sample ID	Dibenzofuran	Phenanthrene	Fluoranthene (PAH)	Chrysene (PAH)	Pyrene (PAH)
19-01252	0 - 0.5	0119-97-0052	0.5	3.1	2	0.56	1.8
19-01256	0 - 0.5	0119-97-0056					

The J qualifiers in Table 5.2.7.1-1 were assigned by the laboratory. These J qualifiers indicate that the concentrations are estimated because they are reported between the method detection limit and the EQL. These chemicals are still considered detected and will be further evaluated in the human health screening assessment.

5.2.8 Risk-Based Screening and Assessment for C-19-001

This subsection discusses the comparison with SALs for COPCs detected at levels greater than background screening levels in the investigation at C-19-001. A screening assessment was conducted on the RFI data for this PRS following methodology discussed in chapter three of this report (Dorries 1996, 1297).

Acetone, dibenzofuran, calcium, chrysene, fluoranthene, lead, methylene chloride, 2-methylnaphthalene, naphthalene, phenanthrene, pyrene, toluene, and zinc were carried forward from the background evaluation.

These 13 COPCs were compared to their respective SALs.

Greater than SAL. No chemical was detected at concentrations greater than its respective SAL.

No SAL. Calcium, an essential nutrient, has no SAL. However, a comparison may be made to the RDA of this nutrient for children and adults. The greatest concentration of calcium detected at C-19-001 was 10 000 mg/kg. At the standard soil ingestion rate of 200 mg/day for a child, the amount ingested per day would be approximately 2 mg. This amount is considerably less than the RDA of 800 mg/day for a child. At a standard soil ingestion rate of 100 mg/day for an adult, the amount ingested per day would be approximately 1 mg. This amount is considerably less than the RDA of 1 200 mg/day for an adult. Therefore, calcium is eliminated as a COPC.

Less than SAL. Acetone, dibenzofuran, chrysene, fluoranthene, lead, methylene chloride, 2-methylnaphthalene, naphthalene, phenanthrene, pyrene, toluene, and zinc were all detected at concentrations less than their respective SALs. To evaluate multiple chemical effects for this data set, COPCs detected at concentrations less than their SALs were grouped according to their toxicological effects (carcinogenic or noncarcinogenic effects of chemicals).

The maximum concentration for each chemical is divided by its respective SAL to produce a normalized value. The sum of those normalized values yields a normalized sum. The normalized sum is compared to one. If the normalized sum is equal to or less than one, this indicates that adverse health effects are unlikely to occur from exposure to these chemicals at the maximum

concentrations detected and all chemicals require no further evaluation as COPCs. If the normalized sum is greater than one, then any chemical with a normalized value of 0.1 or greater is retained as a COPC for further evaluation. This process is described in the policy document "Risk-Based Corrective Action Process" (Dorries, 1996, 1297). The results of the analysis are shown in Table 5.2.8-1.

The results of the multiple chemical evaluations are less than one, indicating that potential adverse human health effects resulting from these exposures are unlikely. Therefore, all chemicals detected at concentrations less than SALs are eliminated as COPCs.

TABLE 5.2.8-1

MULTIPLE CHEMICAL EVALUATION FOR C-19-001

BASED ON NONCARCINOGENIC EFFECTS				
CHEMICAL	SAMPLE ID	CONCENTRATION (mg/kg)	SAL (mg/kg)	NORMALIZED VALUE
Acetone	19-01256	0.2	2 100	0.0001
Dibenzofuran	19-01252	0.5	250	0.002
Fluoranthene (PAH)	19-01252	2	2 600	0.0008
Lead	19-01255	27	400	0.07
2-Methylnaphthalene	19-01252	0.4	1 000[a]	0.0004
Naphthalene (PAH)	19-01252	1.7	1 000	0.002
Phenanthrene	19-01252	3.1	18 000[b]	0.0002
Pyrene (PAH)	19-01252	1.8	1 900	0.0009
Toluene	19-01256	0.01	790	0.00001
Zinc	19-01255	51	23 000	0.002
NORMALIZED SUM				0.08
BASED ON CARCINOGENIC EFFECTS				
CHEMICAL	SAMPLE ID	CONCENTRATION (mg/kg)	SAL (mg/kg)	NORMALIZED VALUE
Chrysene (PAH)	19-01252	0.56	61	0.009
Methylene Chloride	19-01256	0.011	7.8	0.001
NORMALIZED SUM				0.01

a No toxicity value was available for 2-methylnaphthalene, therefore, the toxicity criteria for naphthalene was used as a surrogate based on similarity in chemical structure.
b No toxicity value was available for phenanthrene, therefore, the toxicity criteria for anthracene was used as a surrogate based on similarity in chemical structure.

At the conclusion of this human health screening assessment, no chemicals are retained as COPCs.

5.2.9 Human Health Risk Assessment

This section is not applicable to this report.

5.2.10 Preliminary Ecological Assessment

In cooperation with the New Mexico Environment Department and EPA Region 6, the Laboratory ER Project is developing an approach for ecological risk assessment. Further ecological risk assessment at PRS C-19-001 will be deferred until the site can be assessed as part of the ecological exposure unit methodology currently being developed.

5.2.11 Conclusions and Recommendations

The recommendation of NFA is based upon the soil sampling data collected from the drainage channels of PRS C-19-001. No chemicals or radionuclides were retained as COPCs by the screening process for PRS C-19-001.

The NFA recommendation is based on LANL's NFA Criteria Policy, Criterion 5, which states that the PRS has been characterized in accordance with current applicable state or federal regulations, and that COPCs are not present in concentrations that would pose an unacceptable risk under the projected future land use.

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APPENDIX A ANALYTICAL RESULTS

Analytical results for Potential Release Sites 19-001(c), C-19-001, and 19-003 can be found in the Facility for Information Management, Analysis, and Display (FIMAD). Hard copies of supporting information will be provided upon request.

Chemicals that are reported by analytical laboratories as nondetects have not been included in the tables of this report. Nonetheless, nondetected chemicals are often part of the decision-making process, and it is important to note that analyses for these chemicals were performed. This appendix provides a list of the target analytes in each analytical suite for which samples were collected.

The complete data used for the evaluations in this report are included in Tables A-1 through A-3.

Inorganic Suite (Metals)

Aluminum	Cobalt	Potassium
Antimony	Copper	Selenium
Arsenic	Iron	Silver
Barium	Lead	Sodium
Beryllium	Magnesium	Thallium
Cadmium	Manganese	Vanadium
Calcium	Mercury	Zinc
Chromium	Nickel	

Volatile Organic Suite

Acetone
Benzene
Bromobenzene
Bromochloromethane
Bromodichloromethane
Bromoform
Bromomethane
2-Butanone
n-Butylbenzene
sec-Butylbenzene
tert-Butylbenzene
Carbon disulfide
Carbon tetrachloride
Chlorobenzene
Chlorodibromomethane
Chloroethane
Chloroform
Chloromethane
2-Chlorotoluene
4-Chlorotoluene
1,2-Dibromo-3-chloropropane
1,2-Dibromoethane
Dibromomethane
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
Dichlorodifluoromethane
1,1-Dichloroethane
1,2-Dichloroethane
1,1-Dichloroethene
c-1,2-Dichloroethene
t-1,2-Dichloroethene
1,2-Dichloropropane
1,3-Dichloropropane
2,2-Dichloropropane
1,1-Dichloropropene
c-1,3 Dichloropropene
t-1,3-Dichloropropene
Ethylbenzene
2-Hexanone
Iodomethane
Isopropylbenzene
p-Isopropyltoluene
Methylene chloride
4-Methyl-2-pentanone
n-Propylbenzene
Styrene
1,1,1,2-Tetrachloroethane
1,1,2,2,-Tetrachloroethane
Tetrachloroethene
Toluene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Trichloroethene
Trichlorofluoromethane
1,2,3-Trichloropropane
Trichlorotrifluoroethane
1,2,4-Trimethylbenzene
1,3,5-Trimethylbenzene
Vinyl chloride
o,m,p-Xylene (mixed)

Semivolatile Organic Suite

Acenaphthene
Acenaphthylene 1
Aniline
Anthracene
Azobenzene
Benzo(a)anthracene
Benzo(b)fluoranthene
Benzo(k)fluoranthene
Benzoic acid
Benzo(g,h,i)perylene
Benzo(a)pyrene
Benzyl alcohol
Bis(2-chloroethoxy)methane
Bis(2-chloroethyl)ether
Bis(2-ethylhexyl)phthalate
4-Bromophenylphenyl ether
Butylbenzylphthalate
4-Chloroaniline
4-Chloro-3-methylphenol
2-Chloronaphthalene
2-Chlorophenol
4-Chlorophenylphenyl ether
2,2'-oxybis(1-Chloropropane)
Chrysene
Dibenzo(a,h)anthracene
Dibenzofuran
Di-n-butylphthalate
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
3,3'-Dichlorobenzidine
2,4-Dichlorophenol
Diethylphthalate
2,4-Dimethylphenol
Dimethyl phthalate
4,6-Dinitro-2-methylphenol
2,4-Dinitrophenol
2,4-Dinitrotoluene
2,6-Dinitrotoluene
Di-n-octylphthalate
Fluoranthene
Fluorene
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclopentadiene
Hexachloroethane 2
Indeno(1,2,3-cd)pyrene
Isophorone
2-Methylnaphthalene
2-Methylphenol
4-Methylphenol
Naphthalene
2-Nitroaniline
3-Nitroaniline
4-Nitroaniline
Nitrobenzene
2-Nitrophenol
4-Nitrophenol
N-Nitrosodimethylamine
N-Nitrosodiphenylamine
N-Nitroso-di-n-propylamine
Pentachlorophenol
Phenanthrene
Phenol
Pyrene
1,2,4-Trichlorobenzene
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol

Radiochemical Suite

Actinium-228
Americium-241
Annihilation radiation
Barium-140
Bismuth-211
Bismuth-212
Bismuth-214
Cadmium-109
Cerium-139
Cerium-144
Cesium-134
Cesium-137
Cobalt-57
Cobalt-60
Europium-152
Iodine-129
Lanthanum-140
Lead-210
Lead-211
Lead-212
Lead-214
Manganese-54
Mercury-203
Neptunium-237
Plutonium-238
Plutonium-239/240
Potassium-40
Protactinium-214m
Protactinium-231
Protactinium-233
Radium-223
Radium-224
Radium-226
Radium-228
Radon-219
Ruthenium-106
Selenium-75
Sodium-22
Strontium-85
Strontium-90
Thallium-208
Thorium-227
Thorium-228, 230, & 232
Thorium-234
Tin-113
Tritium
Uranium-234, 235, & 238
Yttrium-88
Zinc-65

TABLE A-1

ANALYTICAL RESULTS FOR DETECTED ORGANIC ANALYTES AT PRSs C-19-001, 19-001(c), AND 19-003

SAMPLE NUMBER	LOCATION ID	DEPTH (ft)	Acenaphthene (PAH)	Acetone	Anthracene (PAH)	Benzo(a) anthracene PAH)	Benzo(b) fluoranthene PAH)	Benzo(k) fluoranthene (PAH)	Benzo(g,h,i) perylene	Benzo(a) pyrene (PAH)	Bis(2-ethylhexyl) phthalate	Carbazole	Chrysene (PAH)
		SAL	2200	2100	18000	0.61	0.61	6.1	NA	0.061	32	22	61
C-19-001													
0119-97-0051	19-01251	0-0.5	NA	0.021 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
0119-97-0052	19-01252	0-0.5	0.35 U	0.021 U	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U	0.4 U	ND	0.56
0119-97-0053	19-01253	0-0.5	0.35 U	0.021 U	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U	0.4 U	ND	0.35 U
0119-97-0054	19-01254	0-0.5	0.35 U	0.021 U	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U	0.4 U	ND	0.35 U
0119-97-0055	19-01255	0-0.5	0.36 U	0.022 UJ	0.36 U	0.36 U	0.36 U	0.36 U	0.36 U	0.36 U	0.4 U	ND	0.36 U
0119-97-0056	19-01256	0-0.5	0.34 U	0.2 J	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.3 U	ND	0.34 U
0119-97-0057	19-01251	0-0.5	0.34 U	NA	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.3 U	ND	0.34 U
C-19-001(c)													
0119-97-0058	19-01258	5-5.3	5.7	0.02 U	7.9	13	16	6	3.2	13	0.4 J	3	13
0119-97-0059	19-01259	5-5.3	0.33 U	0.02 U	0.038 J	0.07 J	0.09 J	0.33 U	0.33 U	0.07 J	0.3 U	0.33 U	0.08 J
0119-97-0060	19-01260	5-5.3	0.34 U	0.02 U	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.3 U	0.34 U	0.34 U
0119-97-0061	19-01261	4.5-4.8	0.34	0.02 U	0.99	1.8	1.9	0.82	0.53	1.4	0.2 J	0.84	1.8
0119-97-0062	19-01262	4.5-4.8	0.33 U	0.02 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.3 U	0.33 U	0.33 U
0119-97-0068	19-01268	0-0.25	0.14 J	0.02 U	0.68 U	0.21 J	0.55 J	0.22 J	0.68 U	0.13 J	0.7 U	0.22 J	0.74
0119-97-0069	19-01269	0-0.25	0.33 U	0.02 U	0.33 U	0.33 U	0.17 J	0.33 U	0.33 U	0.33 U	0.3 U	0.05 J	0.2 J
0119-97-0071	19-01271	10-10.5	0.34 U	0.034	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.3 U	ND	0.34 U
0119-97-0072	19-01272	10-10.5	0.34 U	0.041	0.34 U	0.25	0.19	0.18	0.34 U	0.19	0.3 U	0.34 U	0.26
0119-97-0076	19-01272	10-10.5	0.34 U	0.044	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.3 U	0.34 U	0.34 U
19-003													
0119-97-0063	19-01263	3-3.3	0.33 U	0.02 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.3 U	0.33 U	0.33 U
0119-97-0064	19-01264	3-3.3	6.6	0.02 U	8.9	15 J-	14	6	6.2	13	3.4 UJ	3.6	14 J-
0119-97-0065	19-01265	3-3.3	0.34 U	0.02 U	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.3 U	0.34 U	0.34 U
0119-97-0066	19-01266	0-0.25	3.4 U	0.041	3.4 U	3.4 U	3.4 UJ	3.4 UJ	3.4 UJ	3.4 UJ	3.4 U	3.4 U	3.4 U
0119-97-0067	19-01267	0-0.25	0.68 U	0.046	0.68 U	0.68 UJ	0.68 UJ	0.68 UJ	0.68 UJ	0.68 UJ	0.7 UJ	0.68 U	0.68 UJ
0119-97-0073	19-01273	4-4.3	0.34 U	0.044	0.34 U	0.2	0.34 U	0.34 U	0.34 U	0.34 U	0.3 U	0.34 U	0.21
0119-97-0077	19-01263	3-3.3	0.66 U	0.02 U	0.66 U	0.66 U	0.66 U	0.66 U	0.66 U	0.66 U	0.7 U	0.66 U	0.66 U

Units are mg/kg
NA = Not applicable
ND = Not detected

TABLE A-1

ANALYTICAL RESULTS FOR DETECTED ORGANIC ANALYTES AT PRSs C-19-001, 19-001(c), AND 19-003 (CONTINUED)

SAMPLE NUMBER	LOCATION ID	DEPTH (ft)	Dibenzo(a,h) anthracene (PAH)	Dibenzo-furan	Fluoranthene (PAH)	Fluorene (PAH)	Indeno(1,2,3-cd) pyrene (PAH)	Methylene chloride	2-Methyl naphthalene	Napthalene (PAH)	Toluene	Phenanthrene	Pyrene (PAH)
		SAL	0.061	250	2600	2300	0.61	7.8	na	1000	790	na	1900
C-19-001													
0119-97-0051	19-01251	0-0.5	NA	NA	NA	NA	NA	0.005 U	NA	NA	0.005 U	NA	NA
0119-97-0052	19-01252	0-0.5	0.35 U	0.47	2	0.35 U	0.35 U	0.005 U	0.37	1.7	0.005 U	3.1	1.8
0119-97-0053	19-01253	0-0.5	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U	0.005 U	0.35 U	0.4 U	0.005 U	0.35 U	0.35 U
0119-97-0054	19-01254	0-0.5	0.35 U	0.35 U	0.35 U	0.35 U	0.35 U	0.005 U	0.35 U	0.4 U	0.005 U	0.35 U	0.35 U
0119-97-0055	19-01255	0-0.5	0.36 U	0.36 U	0.36 U	0.36 U	0.36 U	0.006 UJ	0.36 U	0.4 U	0.006 UJ	0.36 U	0.36 U
0119-97-0056	19-01256	0-0.5	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.011 J	0.34 U	0.3 U	0.01 J	0.34 U	0.34 U
0119-97-0057	19-01251	0-0.5	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	NA	0.34 U	0.3 U	NA	0.34 U	0.34 U
C-19-001(c)													
0119-97-0058	19-01258	5-5.3	1.2 J	2.1	23	3.2	3.8	0.003 J	0.98 J	2	0.005 U	23	24
0119-97-0059	19-01259	5-5.3	0.33 U	0.33 U	0.13 J	0.33 U	0.33 U	0.003 J	0.33 U	0.3 U	0.005 U	0.12 J	0.13 J
0119-97-0060	19-01260	5-5.3	0.34 U	0.34 U	0.06 J	0.34 U	0.34 U	0.004 J	0.34 U	0.3 U	0.005 U	0.05 J	0.06 J
0119-97-0061	19-01261	4.5-4.8	0.21 J	0.02 J	3.8	0.35	0.6	0.003 J	0.04 J	0.1 J	0.005 U	3.3	3.1
0119-97-0062	19-01262	4.5-4.8	0.33 U	0.33 U	0.07 J	0.33 U	0.33 U	0.009	0.33 U	0.3 U	0.005 U	0.06 J	0.06 J
0119-97-0068	19-01268	0-0.25	0.68 U	0.34 J	2.8	0.18 J	0.68 U	0.007	0.34 J	1.4	0.004 J	3.2	2
0119-97-0069	19-01269	0-0.25	0.33 U	0.04 J	0.63	0.33 U	0.33 U	0.006	0.33 U	0.3 U	0.005 J	0.58	0.5
0119-97-0071	19-01271	10-10.5	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.0061	0.34 U	0.3 U	0.005 U	0.34 U	0.34 U
0119-97-0072	19-01272	10-10.5	0.34 U	0.34 U	0.53	0.34 U	0.34 U	0.005 U	0.34 U	0.3 U	0.005 U	0.39	0.39
0119-97-0076	19-01272	10-10.5	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.005 U	0.34 U	0.3 U	0.005 U	0.34 U	0.34 U
19-003													
0119-97-0063	19-01263	3-3.3	0.33 U	0.33 U	0.05 J	0.33 U	0.33 U	0.007	0.33 U	0.3 U	0.005 U	0.04 J	0.04 J
0119-97-0064	19-01264	3-3.3	2.1 J	2.3 J	27	3.6	6.2	0.008	1.1 J	1.8 J	0.005 U	26	25 J-
0119-97-0065	19-01265	3-3.3	0.34 U	0.34 U	0.34 U	0.34 U	0.34 U	0.005 J	0.34 U	0.3 U	0.005 UJ	0.34 U	0.06 J
0119-97-0066	19-01266	0-0.25	3.4 UJ	3.4 U	3.4 U	3.4 U	3.4 UJ	0.009	3.4 U	3.4 U	0.004 J	3.4 U	3.4 U
0119-97-0067	19-01267	0-0.25	0.68 UJ	0.68 U	0.1 J	0.68 U	0.68 UJ	0.008 J	0.68 U	0.7 U	0.007 J	0.68 U	0.13 J-
0119-97-0073	19-01273	4-4.3	0.34 U	ND	0.43	0.34 U	0.34 U	0.005 U	0.34 U	0.3 U	0.005 U	0.32	0.31
0119-97-0077	19-01263	3-3.3	0.66 U	0.66 U	0.66 U	0.66 U	0.66 U	0.006	0.66 U	0.7 U	0.005 U	0.66 U	0.66 U

Units are mg/kg
NA = Not applicable
ND = Not detected

TABLE A-2

ANALYTICAL RESULTS FOR DETECTED RADIONUCLIDES AT PRSs C-19-001, 19-001(c), AND 19-003

SAMPLE NUMBER	LOCATION ID	DEPTH (ft)	Actinium-228	Bismuth-211	Bismuth-212	Bismuth-214	Cadmium-109	Cesium-137	Potassium-40	Manganese-54
		UTL	NA	NA	NA	NA	NA	NA	36.9	NA
		SAL	NA	NA	NA	NA	NA	5.1	12	3.5
C-19-001										
0119-97-0051	19-01251	0-0.5	NA	NA	NA	NA	NA	0.815	25.7	NA
0119-97-0052	19-01252	0-0.5	NA	NA	NA	NA	NA	0.684	26.3	NA
0119-97-0053	19-01253	0-0.5	NA	NA	NA	NA	NA	0.21	32.3	NA
0119-97-0054	19-01254	0-0.5	NA	NA	NA	NA	NA	0.345	28.8	NA
0119-97-0055	19-01255	0-0.5	NA	NA	NA	NA	NA	1.33	24.1	NA
0119-97-0056	19-01256	0-0.5	NA	NA	NA	NA	NA	0.248	28.4	NA
19-001(c)										
0119-97-0058	19-01258	5-5.3	1.07	2.35	1 J	0.78	3.63 U	0.01 U	23.11	0 U
0119-97-0059	19-01259	5-5.3	0.98	1.63	1.47	0.9	4.9 U	-0.01 U	19.21	-0.04 U
0119-97-0060	19-01260	5-5.3	1.35	2.88	1.33	1.02	-0.18 U	0 U	23.6	0.04 U
0119-97-0061	19-01261	4.5-4.8	1.27	2.01	1.52	0.77	5.18 U	-0.03 U	21.94	-0.02 U
0119-97-0062	19-01262	4.5-4.8	1.5	2.88	1.13	1.23	2.06 U	0.01 U	24.24	-0.02 U
0119-97-0068	19-01268	0-0.25	1.63	5.28	1.72 J	1.25	3.93	5.85	24.61	-0.02 U
0119-97-0069	19-01269	0-0.25	1.22	3.28	2.21	1.04	1.6 U	1.43	24.68	0.03 U
0119-97-0071	19-01271	10-10.5	1.37	1.97	0.69 U	1.07	1.96 U	0.05 U	24.82	-0.02 U
0119-97-0072	19-01272	10-10.5	1.22	3.18	0.93 U	0.91	5.25 U	0.03 U	23.31	0.15
0119-97-0076	19-01272	10-10.5	1.3	2.94	1.06 J	0.88	2.75 U	0.03 U	24.48	0 U
19-003										
0119-97-0063	19-01263	3-3.3	1.61	3.32	1.54 J	1.24	0.66 U	0.09 U	25.24	0.03 U
0119-97-0064	19-01264	3-3.3	1.22	2.13	2.02	1.01	2.16 U	0.14 J	23.1	0.03 U
0119-97-0065	19-01265	3-3.3	1.5	3.21	1.69 J	1.12	2.95 U	-0.02 U	26.52	-0.01 U
0119-97-0066	19-01266	0-0.25	1.53	4.03	1.22 U	1.18	1.82 U	2.49	26.27	0 U
0119-97-0067	19-01267	0-0.25	1.89	3.73	1.77 U	1.37	3.35 U	2.08	27.82	-0.03 U
0119-97-0073	19-01273	4-4.3	1.53	3.13	1.7	0.95	7.66 U	0.07 U	25.02	0.05 U
0119-97-0077	19-01263	3-3.3	1.34	2.65	1.86 J	1.02	3.5 U	0.04 U	24.6	0.01 U

Units are in pCi/g
NA = Not applicable

TABLE A-2

ANALYTICAL RESULTS FOR DETECTED RADIONUCLIDES AT PRSs C-19-001, 19-001(c), AND 19-003 (CONTINUED)

SAMPLE NUMBER	LOCATION ID	DEPTH (ft)	Protactinium-234m	Lead-210	Lead-212	Lead-214	Radium-224	Radium-226	Thorium-227	Thorium-234	Thallium-208	Neptunium-237
		UTL	NA	NA	NA	NA	NA	2.6	NA	NA	NA	NA
		SAL	NA	NA	NA	NA	NA	0.1	NA	NA	NA	1.9
C-19-001												
0119-97-0051	19-01251	0-0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.009 U
0119-97-0052	19-01252	0-0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	-0.066 U
0119-97-0053	19-01253	0-0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	-0.004 U
0119-97-0054	19-01254	0-0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	-0.017 U
0119-97-0055	19-01255	0-0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	-0.017 U
0119-97-0056	19-01256	0-0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	-0.016 U
19-001(c)												
0119-97-0058	19-01258	5-5.3	0.11 U	0.65 U	1.12	0.7	2.12	1.67 U	2.45	0.12 U	0.94	0.32 U
0119-97-0059	19-01259	5-5.3	3.63 U	2.91	0.99	0.91	10.07	1.13 U	0.16 U	1.75 J	1.01	1.4
0119-97-0060	19-01260	5-5.3	1.66 U	-0.75 U	1.42	0.96	2.89	1.78 U	1.72	0.45 U	1.24	0.53 U
0119-97-0061	19-01261	4.5-4.8	3.8 U	5.46	0.89	0.93	10.66	1.64 U	0.41 J	0.56 U	1.04	1.11 J
0119-97-0062	19-01262	4.5-4.8	5.56 J	0.22 U	1.45	1.25	2.98 J	2.72 U	2.53	1.38 U	1.29	1.56
0119-97-0068	19-01268	0-0.25	3.66 U	13.93	3.37	1.53	12.87	4.83	0.6 U	2.41 U	1.43	0.94 U
0119-97-0069	19-01269	0-0.25	2.84 U	-1.79 U	1.39	1.07	3.04	4.1	2.9	2.79 U	1.33	0.97
0119-97-0071	19-01271	10-10.5	1.64 U	-4.21 U	1.32	0.31 U	2.62	1.6 U	0.58 J	0.79 U	1.37	1.17
0119-97-0072	19-01272	10-10.5	-0.71 U	2.22 U	1.28	0.96	2.49	1.36 U	0.29 U	4.81 U	1.3	[illegible].53
0119-97-0076	19-01272	10-10.5	2.34 U	0.06 U	2.59	1.05	10.68	2.22 U	1.66	0.7 U	1.14	0.83 J
19-003												
0119-97-0063	19-01263	3-3.3	1.73 U	-1.35 U	1.67	1.21	4.63	3.28	3.9	2.13 U	1.87	1.37
0119-97-0064	19-01264	3-3.3	0.69 U	0.08 U	2.71	0.86	11.62	2.77 J	1.71	2.38 J	1.54	0.07 U
0119-97-0065	19-01265	3-3.3	3.56 U	3.37	1.55	1.51	4.66	2.88 U	0.26 U	4.32	1.36	1.34
0119-97-0066	19-01266	0-0.25	-0.63 U	-0.55 U	1.66	1.53	3.24	1.04 U	3.84	2.44 U	1.87	0.27 J
0119-97-0067	19-01267	0-0.25	3.57 U	5.37 J	2.45	1.55	15.9	1.06 U	3.37	3.28 J	1.83	1.43
0119-97-0073	19-01273	4-4.3	1.69 U	-1.22 U	1.55	1.23	2.74	2.17 U	0.62 J	1.26 U	1.48	0.53 U
0119-97-0077	19-01263	3-3.3	2 U	0.37 U	1.63	1.15	3.52	2.16 U	2.45	2.24 J	1.48	1.45

Units are in pCi/g
NA = Not applicable

TABLE A-3

ANALYTICAL RESULTS FOR DETECTED INORGANICS AT PRSs C-19-001, 19-001(c), AND 19-003

PRS	SAMPLE NUMBER	LOCATION ID	DEPTH (ft)	Arsenic	Mercury	Selenium	Aluminum	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper
	ALL SOIL DATA UTL			7.82	0.1	1.7	38700	315	1.95	2.6	6120	19.3	19.2	15.5
	SAL			NA	23	380	77000	5300	NA	38	NA	210	4600	2800
19-003	0119-97-0066	19-01266	0-0.25	3.30	3.30	0.2 U	3920 J-	59.3	0.470	10.3	4890	5.50	2.60	128
19-003	0119-97-0067	19-01267	0-0.25	3.30	0.460	0.2 U	4370 J-	63.1	0.63	1.40	6980	5.80	1.70	20.5
19-001	0119-97-0068	19-01268	0-0.25	2.40	0.0 U	0.2 U	5770 J-	62.5	0.660	0.5 U	2760	4.50	2.00	17.8
19-001	0119-97-0069	19-01269	0-0.25	1.0	0.0 U	0.2 U	2100 J-	35.7	0.420	0.5 U	1510	2.00	1.40	4.72
C-19-001	0119-97-0051	19-01251	0-0.5	6.7 J-	0.1 U	0.3 UJ	8200	55.0	0.78	0.5 U	1800	6.3	3.2	4.9
C-19-001	0119-97-0052	19-01252	0-0.5	2.2 J-	0.1 U	0.3 UJ	6500	73.0	0.7	0.5 U	1900	5.0	3.1	5.1
C-19-001	0119-97-0053	19-01253	0-0.5	1.6 J-	0.1 U	0.3 UJ	3400	43.0	0.5 U	0.5 U	1800	3.3	1.6	2.8
C-19-001	0119-97-0054	19-01254	0-0.5	2.6 J-	0.1 U	0.3 UJ	7300	70.0	0.73	0.5 U	3200	5.3	2.9	5.5
C-19-001	0119-97-0055	19-01255	0-0.5	3.4 J-	0.1 U	0.3 UJ	8300	140	0.94	0.6 U	10000	6.1	3.4	8.6
C-19-001	0119-97-0056	19-01256	0-0.5	2.5 J-	0.1 U	0.3 UJ	6800	69.0	0.73	0.5 U	2400	4.6	2.5	4.9
	UNIT 3 UTL			5.0	NA	NA	3700.0	28.0	1.5	NA	1520.0	2.1	1.4	2.0
19-001	0119-97-0058	19-01258	5-5.3	0.670	0.0 U	0.2 U	1390 J-	27.0	0.4 U	0.5 U	4760	1.42	1.0 U	1.4
19-001	0119-97-0059	19-01259	5-5.3	1.20	0.0 U	0.2 U	793 J-	30.9	0.4 U	0.5 U	4610	1.70	1.0 U	2.90
19-001	0119-97-0060	19-01260	5-5.3	1.40	0.0 U	0.2 U	4990 J-	59.7	0.4 U	0.5 U	13200	2.50	1.00	2.70
19-001	0119-97-0061	19-01261	4.5-4.8	0.560	0.0 U	0.2 U	3450 J-	34.5	0.4 U	0.5 U	2040	2.0	0.9 U	1.40
19-001	0119-97-0062	19-01262	4.5-4.8	0.660	0.1 U	0.2 U	3780 J-	28.9	0.390	0.4 U	1820	1.70	0.8 U	1.2
19-001	0119-97-0071	19-01271	10-10.5	1.4	0.02 U	0.6 U	2360	31.1	0.45	0.1 U	5190	1.7	0.87	1.6
19-001	0119-97-0072	19-01272	10-10.5	1.7	0.02 U	0.6 U	3700	46.5	0.66	0.1 U	3520	2.2	1.4	2.0
19-001	0119-97-0076	19-01272	10-10.5	1.3	0.02 U	0.55 U	3030	40.5	0.56	0.1 U	2630	2.3	1.5	2.3
	UNIT 2 UTL			2.0	NA	NA	3700.0	28.0	1.5	NA	1520.0	1.6	1.3	2.0
19-003	0119-97-0063	19-01263	3-3.3	0.910	0.063	0.2 U	2560 J-	48.5	0.3 U	0.4 U	14300	1.50	0.8 U	1.40
19-003	0119-97-0064	19-01264	3-3.3	1.10	0.0 U	0.2 U	3750 J-	55.0	0.4 U	0.5 U	7560	2.00	1.0 U	2.20
19-003	0119-97-0065	19-01265	3-3.3	3.30	0.0 U	0.390	1960 J-	70.8	0.4 U	0.5 U	27400	1.0 U	1.0 U	1.40
19-003	0119-97-0073	19-01273	4-4.25	3.1	0.03	0.6 U	4400	82.0	0.9	0.1 U	11400	2.5	1.7	2.8
19-003	0119-97-0077	19-01263	3-3.3	1.1	0.0 U	0.2 U	1020 J-	32.2	0.4 U	0.4 U	10400	0.9 U	0.9 U	0.990

Units in mg/kg
NA = Not applicable

TABLE A-3

ANALYTICAL RESULTS FOR DETECTED INORGANICS AT PRSs C-19-001, 19-001(c), AND 19-003 (CONTINUED)

PRS	SAMPLE NUMBER	LOCATION ID	DEPTH (ft)	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Sodium	Vanadium	Zinc
	ALL SOIL DATA UTL			21300	23.3	4610	714	15.2	3410	915	41.9	50.8
			SAL	NA	400	NA	3200	1500	NA	NA	540	23000
19-003	0119-97-0066	19-01266	0-0.25	3970 J-	173.0 J+	1120	6210 J-	7.20	709	315	8.20	6380
19-003	0119-97-0067	19-01267	0-0.25	4070 J-	68.6 J+	1340	1790 J-	5.30	827	298	7.10	2540
19-001	0119-97-0068	19-01268	0-0.25	6250 J-	32.9 J+	1260	177 J-	3.9	992	308	9.90	46.3
19-001	0119-97-0069	19-01269	0-0.25	2340 J-	15.1 J+	536	102 J-	2.7	409	283	4.7	38.2
C-19-001	0119-97-0051	19-01251	0-0.5	8800	15.0	1200	210 J-	3.9	1100	88	13.0	34
C-19-001	0119-97-0052	19-01252	0-0.5	7200	15.0	1100	260 J-	4.7	1100	82	12.0	37
C-19-001	0119-97-0053	19-01253	0-0.5	3500	11.0	500	150 J-	2.1 U	650	73	5.4	30
C-19-001	0119-97-0054	19-01254	0-0.5	7000	16.0	1100	200 J-	4.9	1100	92	11.0	43
C-19-001	0119-97-0055	19-01255	0-0.5	8600	27.0	1900	320 J-	5.6	1600	110	13.0	51
C-19-001	0119-97-0056	19-01256	0-0.5	6400	15.0	1000	200 J-	3.5	1000	77	9.2	33
	UNIT 3 UTL			9040.0	16.2	628.0	426.0	2.6	735.0	1940.0	4.0	59.0
19-001	0119-97-0058	19-01258	5-5.3	1750 J-	7.40 J+	549	68.1 J-	2.00	262	473	3.20	13.5
19-001	0119-97-0059	19-01259	5-5.3	1770 J-	7.70 J+	746	101 J-	1.90	242	603	4.10	18.7
19-001	0119-97-0060	19-01260	5-5.3	3900 J-	11.0 J+	1690	109 J-	3.80	594	403	6.10	36.3
19-001	0119-97-0061	19-01261	4.5-4.8	3310 J-	4.50 J+	640	97.9 J-	2.40	421	319	5.30	15.5
19-001	0119-97-0062	19-01262	4.5-4.8	2610 J-	4.80 J+	1310	57.1 J-	2.7	547	332	3.70	12.6
19-001	0119-97-0071	19-01271	10-10.5	2740	7.0	659	75.1	2.0	518	136.0	3.8	102
19-001	0119-97-0072	19-01272	10-10.5	4230	6.4	872	103	2.7	556	89.5	6.3	18.6
19-001	0119-97-0076	19-01272	10-10.5	4320	10.7	664	113	2.5	485	84.5	6.3	20.6
	UNIT 2 UTL			9040.0	16.2	548.0	533.0	<2	2730.0	1940.0	4.0	59.0
19-003	0119-97-0063	19-01263	3-3.3	1800 J-	5.80 J+	1120	47.9 J-	3.2	299	297	3.70	8.20
19-003	0119-97-0064	19-01264	3-3.3	3740 J-	8.00 J+	1190	108 J-	3.20	542	459	6.00	40.9
19-003	0119-97-0065	19-01265	3-3.3	1030 J-	5.20 J+	4390	47.7 J-	3.40	905	760	5.60	5.70
19-003	0119-97-0073	19-01273	4-4.25	4400	8.6	1070	113	4.0	609	84.9	7.3	16.6
19-003	0119-97-0077	19-01263	3-3.3	850 J-	5.40 J+	504	38.8 J-	2.50	164	247	2.70	6.20

Units in mg/kg
NA = Not applicable

APPENDIX B DATA VALIDATION

TABLE B-1

SUMMARY TABLE OF QUALITY CONTROL RESULTS FOR TA-19

REQUEST NUMBER	SAMPLE ID	MATRIX	ANALYTE SUITE	QUALITY CONTROL (QC) COMMENTS
3253R	0119-97-0051	Soil	VOCs	Last internal standard was outside allowed limits. All analytes associated with the internal standard are qualified J or UJ. Acetone was found in the method blank. All acetone detected at less than 10 times the blank level are qualified U.
3253R	0119-97-0052	Soil	VOCs	There was a high surrogate recovery for bromofluorbenzene and the last internal standard was outside allowed limits. All detected values are qualified J+ and all analytes associated with the internal standard are qualified J or UJ. Acetone was found in the method blank. All acetone detected at less than 10 times the blank level are qualified U.
3253R	0119-97-0053	Soil	VOCs	There was a high surrogate recovery for bromofluorbenzene and the last internal standard was outside allowed limits. All detected values are qualified J+ and all analytes associated with the internal standard are qualified J or UJ. Acetone was found in the method blank. All acetone detected at less than 10 times the blank level are qualified U.
3253R	0119-97-0054	Soil	VOCs	There was a high surrogate recovery for bromofluorbenzene and the last internal standard was outside allowed limits. All detected values are qualified J+ and all analytes associated with the internal standard are qualified J or UJ. Acetone was found in the method blank. All acetone detected at less than 10 times the blank level are qualified U.
3253R	0119-97-0055	Soil	VOCs	There were high surrogate recoveries for bromofluorbenzene and dibromofluoromethane and a low surrogate recovery for toluene-d8. Also, all internal standards were outside allowed limits. All data were qualified J or UJ. Acetone was found in the method blank. All acetone detected at less than 10 times the blank level are qualified U.
3253R	0119-97-0056	Soil	VOCs	There was a high surrogate recovery for bromofluorbenzene and the last internal standard was outside allowed limits. All detected values are qualified J+ and all analytes associated with the internal standard are qualified J or UJ. Acetone was found in the method blank. All acetone detected at less than 10 times the blank level are qualified U.
3385R	0119-97-0058	Soil	VOCs	Acetone was found in the method blank. All acetone detected at less than 10 times the blank level are qualified U.
3385R	0119-97-0059	Soil	VOCs	Acetone was found in the method blank. All acetone detected at less than 10 times the blank level are qualified U.
3385R	0119-97-0060	Soil	VOCs	Acetone was found in the method blank. All acetone detected at less than 10 times the blank level are qualified U.
3385R	0119-97-0061	Soil	VOCs	Acetone was found in the method blank. All acetone detected at less than 10 times the blank level are qualified U.
3385R	0119-97-0062	Soil	VOCs	Acetone was found in the method blank. All acetone detected at less than 10 times the blank level are qualified U.
3385R	0119-97-0063	Soil	VOCs	Acetone was found in the method blank. All acetone detected at less than 10 times the blank level are qualified U.
3385R	0119-97-0064	Soil	VOCs	Acetone was found in the method blank. All acetone detected at less than 10 times the blank level are qualified U.
3385R	0119-97-0065	Soil	VOCs	There was a low surrogate recovery for bromofluorbenzene and all internal standards were outside allowed limits. All data were qualified J or UJ. Acetone was found in the method blank. All acetone detected at less than 10 times the blank level are qualified U.

TABLE B-1 (CONTINUED)

SUMMARY TABLE OF QUALITY CONTROL RESULTS FOR TA-19

REQUEST NUMBER	SAMPLE ID	MATRIX	ANALYTE SUITE	QUALITY CONTROL (QC) COMMENTS
3385R	0119-97-0066	Soil	VOCs	Acetone was found in the method blank. All acetone detected at less than 10 times the blank level are qualified U.
3385R	0119-97-0067	Soil	VOCs	There was a low surrogate recovery for bromofluorbenzene and all internal standards were outside allowed limits. All data were qualified J or UJ. Acetone was found in the method blank. All acetone detected at less than 10 times the blank level are qualified U.
3385R	0119-97-0068	Soil	VOCs	There was a low surrogate recovery for bromofluorbenzene and all internal standards were outside allowed limits. All data were qualified J or UJ. Acetone was found in the method blank. All acetone detected at less than 10 times the blank level are qualified U.
3385R	0119-97-0069	Soil	VOCs	Acetone was found in the method blank. All acetone detected at less than 10 times the blank level are qualified U.
3385R	0119-97-0077	Soil	VOCs	Acetone was found in the method blank. All acetone detected at less than 10 times the blank level are qualified U.
3385R	0119-97-0061	Soil	SVOCs	There was no surrogate recovery for 2,4,6-tribromophenol (0%). All analytes associated with the this surrogate are qualified R.
3385R	0119-97-0064	Soil	SVOCs	The fourth internal standard was outside allowed limits. All analytes associated with this internal standard are qualified J or UJ.
3385R	0119-97-0066	Soil	SVOCs	The fourth internal standard was outside allowed limits. All analytes associated with this internal standard are qualified J or UJ.
3385R	0119-97-0067	Soil	SVOCs	There was a high surrogate recovery for 2,4,6-tribromophenol. All detected data are qualified J+.
3385R	0119-97-0068	Soil	SVOCs	There was a high surrogate recovery for 2,4,6-tribromophenol and the last internal standard was outside allowed limits. All detected values are qualified J+ and all analytes associated with the internal standard are qualified J or UJ.
3254R	0119-97-0051	Soil	Metals	Antimony, arsenic, manganese, selenium, and thallium data are qualified J- or UJ for low recoveries in the matrix spike sample.
3254R	0119-97-0052	Soil	Metals	Antimony, arsenic, manganese, selenium, and thallium data are qualified J- or UJ for low recoveries in the matrix spike sample.
3254R	0119-97-0053	Soil	Metals	Antimony, arsenic, manganese, selenium, and thallium data are qualified J- or UJ for low recoveries in the matrix spike sample.
3254R	0119-97-0054	Soil	Metals	Antimony, arsenic, manganese, selenium, and thallium data are qualified J- or UJ for low recoveries in the matrix spike sample.
3254R	0119-97-0055	Soil	Metals	Antimony, arsenic, manganese, selenium, and thallium data are qualified J- or UJ for low recoveries in the matrix spike sample.
3254R	0119-97-0056	Soil	Metals	Antimony, arsenic, manganese, selenium, and thallium data are qualified J- or UJ for low recoveries in the matrix spike sample.
3386R	0119-97-0058	Soil	Metals	Aluminum and iron data are qualified J- for low recoveries in the laboratory control sample. Detected values of lead are qualified J+ and detected values of manganese are qualified J- for high and low recoveries in the matrix spike sample, respectively.
3386R	0119-97-0059	Soil	Metals	Aluminum and iron data are qualified J- for low recoveries in the laboratory control sample. Detected values of lead are qualified J+ and detected values of manganese are qualified J- for high and low recoveries in the matrix spike sample, respectively.

TABLE B-1 (CONTINUED)

SUMMARY TABLE OF QUALITY CONTROL RESULTS FOR TA-19

REQUEST NUMBER	SAMPLE ID	MATRIX	ANALYTE SUITE	QUALITY CONTROL (QC) COMMENTS
3386R	0119-97-0060	Soil	Metals	Aluminum and iron data are qualified J- for low recoveries in the laboratory control sample. Detected values of lead are qualified J+ and detected values of manganese are qualified J- for high and low recoveries in the matrix spike sample, respectively.
3386R	0119-97-0061	Soil	Metals	Aluminum and iron data are qualified J- for low recoveries in the laboratory control sample. Detected values of lead are qualified J+ and detected values of manganese are qualified J- for high and low recoveries in the matrix spike sample, respectively.
3386R	0119-97-0062	Soil	Metals	Aluminum and iron data are qualified J- for low recoveries in the laboratory control sample. Detected values of lead are qualified J+ and detected values of manganese are qualified J- for high and low recoveries in the matrix spike sample, respectively.
3386R	0119-97-0063	Soil	Metals	Aluminum and iron data are qualified J- for low recoveries in the laboratory control sample. Detected values of lead are qualified J+ and detected values of manganese are qualified J- for high and low recoveries in the matrix spike sample, respectively.
3386R	0119-97-0064	Soil	Metals	Aluminum and iron data are qualified J- for low recoveries in the laboratory control sample. Detected values of lead are qualified J+ and detected values of manganese are qualified J- for high and low recoveries in the matrix spike sample, respectively.
3386R	0119-97-0065	Soil	Metals	Aluminum and iron data are qualified J- for low recoveries in the laboratory control sample. Detected values of lead are qualified J+ and detected values of manganese are qualified J- for high and low recoveries in the matrix spike sample, respectively.
3386R	0119-97-0066	Soil	Metals	Aluminum and iron data are qualified J- for low recoveries in the laboratory control sample. Detected values of lead are qualified J+ and detected values of manganese are qualified J- for high and low recoveries in the matrix spike sample, respectively.
3386R	0119-97-0067	Soil	Metals	Aluminum and iron data are qualified J- for low recoveries in the laboratory control sample. Detected values of lead are qualified J+ and detected values of manganese are qualified J- for high and low recoveries in the matrix spike sample, respectively.
3386R	0119-97-0068	Soil	Metals	Aluminum and iron data are qualified J- for low recoveries in the laboratory control sample. Detected values of lead are qualified J+ and detected values of manganese are qualified J- for high and low recoveries in the matrix spike sample, respectively.
3386R	0119-97-0069	Soil	Metals	Aluminum and iron data are qualified J- for low recoveries in the laboratory control sample. Detected values of lead are qualified J+ and detected values of manganese are qualified J- for high and low recoveries in the matrix spike sample, respectively.
3386R	0119-97-0077	Soil	Metals	Aluminum and iron data are qualified J- for low recoveries in the laboratory control sample. Detected values of lead are qualified J+ and detected values of manganese are qualified J- for high and low recoveries in the matrix spike sample, respectively.

VOCs = Volatile organic compounds
SVOCs = Semivolatile organic compounds
Metals = Target analyte list metals

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APPENDIX C RISK ASSESSMENT CALCULATIONS

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Dose Conversion Factor (and Related) Parameter Summary
File: DOSFAC.BIN

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Cs-137+D	3.190E-05	3.190E-05	DCF2(1)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Cs-137+D	5.000E-05	5.000E-05	DCF3(1)
D-34	Food transfer factors:			
D-34	Cs-137+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(1,1)
D-34	Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.000E-02	3.000E-02	RTF(1,2)
D-34	Cs-137+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	8.000E-03	8.000E-03	RTF(1,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Cs-137+D , fish	2.000E+03	2.000E+03	BIOFAC(1,1)
D-5	Cs-137+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(1,2)

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	2.500E+04	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	3.000E-01	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	not used	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	3.000E+01	3.000E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Cs-137	5.850E+00	0.000E+00	---	S1(1)
R012	Concentration in groundwater (pCi/L): Cs-137	not used	0.000E+00	---	W1(1)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone effective porosity	2.000E-01	2.000E-01	---	EPCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	4.400E+02	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	4.050E+00	5.300E+00	---	BCZ
R013	Humidity in air (g/cm**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	9.990E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	4.800E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	0.000E+00	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	5.200E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	not used	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	not used	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	3.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	3.000E-01	2.000E-01	---	EPSZ
R014	Saturated zone hydraulic conductivity (m/yr)	1.000E+02	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	2.000E-02	2.000E-02	---	HGWT
R014	Saturated zone b parameter	4.050E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	3.000E-01	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	not used	1	---	NS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Unsat. zone 1, thickness (m)	not used	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	not used	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	not used	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	not used	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	not used	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	not used	1.000E+01	---	HCUZ(1)
R015	Unsat. zone 2, thickness (m)	not used	0.000E+00	---	H(2)
R015	Unsat. zone 2, soil density (g/cm**3)	not used	1.500E+00	---	DENSUZ(2)
R015	Unsat. zone 2, total porosity	not used	4.000E-01	---	TPUZ(2)
R015	Unsat. zone 2, effective porosity	not used	2.000E-01	---	EPUZ(2)
R015	Unsat. zone 2, soil-specific b parameter	not used	5.300E+00	---	BUZ(2)
R015	Unsat. zone 2, hydraulic conductivity (m/yr)	not used	1.000E+01	---	HCUZ(2)
R016	Distribution coefficients for Cs-137				
R016	Contaminated zone (cm**3/g)	1.390E+02	1.000E+03	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	not used	1.000E+03	---	DCNUCU(1,1)
R016	Unsaturated zone 2 (cm**3/g)	not used	1.000E+03	---	DCNUCU(1,2)
R016	Saturated zone (cm**3/g)	not used	1.000E+03	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.452E-06	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R017	Inhalation rate (m**3/yr)	2.000E+04	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	2.000E-03	2.000E-04	---	MLINH
R017	Dilution length for airborne dust, inhalation (m)	3.000E+00	3.000E+00	---	LM
R017	Exposure duration	2.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	7.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	0.000E+00	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	3.900E-02	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	1 shows circular AREA.	FS
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	not used	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	not used	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	3.650E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	not used	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	not used	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	not used	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	not used	-1	---	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	not used	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	not used	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	not used	1.000E+00	---	FGWIR
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	not used	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	not used	1.000E+00	---	STOR_T(2)
STOR	Milk	not used	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	not used	2.000E+01	---	STOR_T(4)
STOR	Fish	not used	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	not used	7.000E+00	---	STOR_T(6)
STOR	Well water	not used	1.000E+00	---	STOR_T(7)
STOR	Surface water	not used	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	not used	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average annual wind speed (m/sec)	not used	2.000E+00	---	WIND
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	suppressed
4 -- meat ingestion	suppressed
5 -- milk ingestion	suppressed
6 -- aquatic foods	suppressed
7 -- drinking water	suppressed
8 -- soil ingestion	active
9 -- radon	suppressed

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	25000.00 square meters	Cs-137	5.850E+00
Thickness:	0.30 meters		
Cover Depth:	0.00 meters		

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	7.452E-01	7.281E-01	6.951E-01	5.910E-01	3.715E-01	7.201E-02	0.000E+00	0.000E+00
M(t):	2.484E-02	2.427E-02	2.317E-02	1.970E-02	1.238E-02	2.400E-03	0.000E+00	0.000E+00

Maximum TDOSE(t): 7.452E-01 mrem/yr at t = 0.000E+00 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	7.445E-01	0.9991	2.857E-04	0.0004	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.164E-04	0.0006
Total	7.445E-01	0.9991	2.857E-04	0.0004	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.164E-04	0.0006

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.452E-01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.452E-01	1.0000

*Sum of all water independent and dependent pathways.