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Phase II and Voluntary Corrective Action Report for

Potential Release Sites
at TA-32

32-001, Former Incinerator
32-002(a,b), Former Septic Systems
32-003, Former Transformer
32-004, Former Radioactive Source Vault, Drain Line, and Outfall

Field Unit 1

Environmental
Restoration
Project

September 1996

A Department of Energy
Environmental Cleanup Program

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EXECUTIVE SUMMARY

This report addresses the Phase II Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) and voluntary corrective action (VCA) activities at potential release sites (PRSs) 32-001, 32-002(a, b), 32-003, and 32-004 at Los Alamos National Laboratory (LANL). Each of these PRSs is a solid waste management unit listed in the Hazardous and Solid Waste Amendments (HSWA) Module of LANL's Hazardous Waste Facility Permit. Radiological constituents, although not regulated by RCRA, were also addressed in this investigation.

Technical Area (TA) 32 is located south of Trinity Drive behind the present Los Alamos County Public Works Department Pavement Management Division building near the north edge of Los Alamos Canyon. It served as a medical research and training facility at Los Alamos Scientific Laboratory from 1944 until it was decommissioned in 1954. The Phase II and/or VCA activities conducted at each of the TA-32 PRSs are summarized individually below.

PRS 32-001. This PRS is the former location of an incinerator. A Phase II investigation was conducted at this site to determine the lateral and vertical extent of Aroclor 1260™, which was retained as a COPC in Phase I. Another objective was to further define the nature of contamination, if any, at the more precisely located incinerator footprint. Phase II analytical results for each of the Aroclors™ were all below the cleanup level of 1 mg/kg. Phase II samples collected at the incinerator footprint were submitted for a full suite of fixed laboratory analyses, and a screening assessment was conducted on the data. The results of the screening assessment indicate that no chemicals are present at the site at levels that pose an unacceptable risk to human health. Based on these results, PRS 32-001 is recommended for no further action (NFA) under the HSWA Module of LANL's Hazardous Waste Facility Permit.

PRSs 32-002(a,b). These PRSs are two septic systems. PRSs 32-002(a,b) are addressed as three main areas: the influent drain lines, the PRS 32-002(a) septic tank footprint, and the outfall area.

Drain Lines. At PRS 32-002(a), a Phase II investigation was conducted to determine how much of the influent drain lines remained, and to determine the nature and extent of any contamination. Phase II characterization located the influent drain line, and analytical results indicated the presence of elevated levels of hazardous and radiological constituents in the pipe contents (dry sludge) and, to a limited extent, on the pipe itself. A VCA was conducted to remove the drain line associated with PRS 32-002(a).

At PRS 32-002(b), a Phase II investigation was conducted to determine the nature and volume of waste associated with removal of the inflow lines and to determine whether any releases had

occurred in the soil surrounding the drain line. Phase II analytical results confirmed the presence of elevated levels of hazardous and radiological constituents in the contents of the drain line (dry sludge), as well as in the outfall area. A VCA was conducted to remove the drain line and soil associated with the former drain line location at PRS 32-002(b).

Confirmation samples were collected from both drain line areas and submitted for a full suite of fixed laboratory analyses. A screening assessment was conducted on the confirmation data to determine whether further remediation was necessary. The screening assessment concluded that the chemicals detected did not pose an unacceptable human health risk and were unlikely to result in adverse human health effects.

PRS 32-002(a) Septic Tank Footprint. A Phase II investigation was conducted for the PRS 32-002(a) septic tank footprint to determine the nature and extent of any contamination associated with possible releases from the former septic tank. Phase II samples were collected in the septic tank footprint, and analytical results from these samples indicated that gross alpha contamination and mercury were present. Additional samples were collected just outside the footprint of the septic tank to bound the extent of the contamination.

Because mercury was present at levels greater than SAL and the site offered easy access and unconsolidated material for excavation, a VCA was conducted to remove the contaminated material from the PRS 32-002(a) septic tank footprint area. Confirmation samples were collected, and the analytical results indicate that no elevated levels of mercury or radioactive contamination remain at the site.

Outfall Area. A Phase II investigation was conducted to further define the nature and extent of contamination in the outfall area. Phase II samples were collected and submitted for a full suite of fixed-laboratory analyses. A screening assessment and risk assessment were conducted on the Phase II data to determine whether remediation was necessary. Results of the risk assessment indicate that potential exposure to COPCs in soil in the outfall area at PRSs 32-002(a,b) would not result in adverse noncarcinogenic human health effects or an unacceptable cancer risk to recreational users.

To characterize the extent of PCB contamination, Phase II samples were collected and submitted for PCB analysis. PCBs were not detected in any of the Phase II samples. However, remedial activities were conducted as a best management practice to address the isolated area of PCB contamination identified during the Phase I investigation.

Recommendations for PRSs 32-002(a,b). Based on the results of Phase II and VCA activities at the influent drain lines, the PRS 32-002(a) septic tank footprint, and the outfall area at PRSs

32-002(a,b). PRSs 32-002(a,b) are recommended for NFA under the HSWA Module of LANL's Hazardous Waste Facility Permit.

PRS 32-003. This PRS is the former location of a transformer. A Phase II investigation was conducted at this site to determine the lateral and vertical extent of Aroclor 1260™ soil contamination. Phase II analytical results indicated that an area of PCB-contaminated soil approximately 38-ft long x 30-ft wide x 2- to 5-ft deep required excavation.

A VCA was conducted to remove this area of contaminated soil. The analytical results from confirmation samples indicate that the VCA was successful in removing all contamination greater than cleanup levels from the site. Based on these results, PRS 32-003 is recommended for NFA under the HSWA Module of LANL's Hazardous Waste Facility Permit.

PRS 32-004. PRS 32-004 consists of a radiation source vault, a drain line associated with the building containing the vault, and the associated outfall area. Each of these areas is addressed separately.

Radiation Source Vault. A Phase II investigation was conducted to define the location of the radiation source vault, and to determine the nature and extent of radiological contamination, if any. Samples collected from the corners of the former vault footprint were analyzed for gross alpha, beta, and gamma radioactivity. The results of these analyses did not indicate the presence of elevated radioactivity.

Drain Lines. A Phase II investigation was conducted at the PRS 32-004 drain line to determine whether any releases had occurred in the soil surrounding the pipe. The drain line was found to extend from the edge of the former building TA-32-3 location to the edge of Los Alamos Canyon. Phase II samples indicated that no radioactive contamination was present in the drain line, and the absence of sludge within the pipe suggested that no chemical contamination was present in the drain line. A VCA was conducted to remove the portion of the PRS 32-004 drain line on Los Alamos County property.

Confirmation samples were collected from beneath the drain line, and submitted for a full suite of fixed-laboratory analyses. The results indicate that no hazardous or radioactive chemicals remain at the site at levels that pose an unacceptable risk to human health.

Outfall. A Phase II investigation was conducted at the PRS 32-004 outfall area to determine the nature and extent of contamination, if any. A screening assessment was conducted on the Phase II data to determine whether remediation was necessary. The screening assessment

concluded that the chemicals present at the site did not pose an unacceptable risk and were unlikely to result in adverse human health effects.

Recommendations for PRS 32-004. Based on the results of Phase II and VCA activities at the radiation source vault, drain line, and outfall area, PRS 32-004 is recommended for NFA under the HSWA Module of LANL's Hazardous Waste Facility Permit.

TABLE ES-1

SUMMARY OF RECOMMENDATIONS

PRS	HSWA	PROPOSED ACTION		
		NFA CRITERIA	RATIONALE	SECTION NUMBER
32-001	X	4	Contaminants of concern are either not present or are present in concentrations that would pose an acceptable level of risk under projected future land use.	5.1
32-002(a)	X	4	Contaminants of concern are either not present or are present in concentrations that would pose an acceptable level of risk under projected future land use.	5.1
32-002(b)	X	4	Contaminants of concern are either not present or are present in concentrations that would pose an acceptable level of risk under projected future land use.	5.1
32-003	X	4	Contaminants of concern are either not present or are present in concentrations that would pose an acceptable level of risk under projected future land use.	5.1
32-004	X	4	Contaminants of concern are either not present or are present in concentrations that would pose an acceptable level of risk under projected future land use.	5.1

CONTENTS

1.0 INTRODUCTION 1

2.0 PRS 32-001 4

2.1 Phase II Site Characterization at PRS 32-001 4

2.1.1 Rationale For the Phase II Investigation at PRS 32-001 4

2.1.2 Phase II Field Investigation at PRS 32-001 4

2.1.3 Background Comparisons for Phase II Samples at PRS 32-001 7

2.1.4 Screening Assessment for Phase II Samples at PRS 32-001 8

2.1.5 Conclusions for the Phase II Investigation at PRS 32-001 10

2.2 Preliminary Ecological Assessment for PRS 32-001 10

2.3 Recommendations for PRS 32-001 10

3.0 PRSs 32-002(a,b) 11

3.1 Phase II and VCA Activities at the Drain Lines at PRSs 32-002(a,b) 11

3.1.1 Rationale for the Phase II Investigation of the Drain Lines at PRSs 32-002(a,b) 11

3.1.2 Phase II Field Investigation at the Drain Lines at PRSs 32-002(a,b) 11

3.1.3 Nature and Extent of Contamination at the Drain Lines at PRSs 32-002(a,b) 12

3.1.4 Remedial Activities at the Drain Lines at PRSs 32-002(a,b) 12

3.1.4.1 Rational for the VCA at the Drain Lines at PRSs 32-002(a,b) 12

3.1.4.2 Cleanup Level Derivation for the Drain Lines at PRSs 32-002(a,b) 12

3.1.4.3 Remedial Implementation at the Drain Lines at PRSs 32-002(a,b) 12

3.1.4.4 Confirmation Sampling at the Drain Lines at PRSs 32-002(a,b) 15

3.1.5 Conclusions for the Drain Lines at PRSs 32-002(a,b) 22

3.2 Phase II and VCA Activities at the PRS 32-002(a) Septic Tank Footprint 22

3.2.1 Rationale for the Phase II Investigation at the PRS 32-002(a) Septic Tank Footprint... 22

3.2.2 Phase II Field Investigation at the PRS 32-002(a) Septic Tank Footprint 23

3.2.3 Nature and Extent of Contamination at the PRS 32-002(a) Septic Tank Footprint 23

3.2.4 Remedial Activities at the PRS 32-002(a) Septic Tank Footprint 25

3.2.4.1 Rationale for the VCA at the PRS 32-002(a) Septic Tank Footprint 25

3.2.4.2 Cleanup Level Derivation for the PRS 32-002(a) Septic Tank Footprint 26

3.2.4.3 Remedial Implementation at the PRS 32-002(a) Septic Tank Footprint 26

3.2.4.4 Confirmation Sampling at the PRS 32-002(a) Septic Tank Footprint 26

3.2.5 Conclusions for the PRS 32-002(a) Septic Tank Footprint 26

3.3 Phase II and VCA Activities in the Outfall Area at PRSs 32-002(a,b) 28

3.3.1 Rationale for the Phase II Investigation in the Outfall Area at PRSs 32-002(a,b) 28

3.3.2 Phase II Field Investigation in the Outfall Area at PRSs 32-002(a,b) 28

3.3.3 Background Comparisons for Characterization Samples in the Outfall Area at PRSs 32-002(a,b) 30

3.3.4 Screening Assessment for Characterization Samples in the Outfall Area at PRSs 32-002(a,b) 34

3.3.5 Risk Calculations for the Outfall Area at PRSs 32-002(a,b) 36

3.3.5.1 Review of COPCs and Extent of Contamination for the Outfall Area at PRSs 32-002(a,b) 36

3.3.5.2 Exposure Assessment for the Outfall Area at PRSs 32-002(a,b) 37

3.3.5.3 Toxicity Assessment for the Outfall Area at PRSs 32-002(a,b) 41

3.3.5.4 Risk Characterization for the Outfall Area at PRSs 32-002(a,b) 41

3.3.5.5 Assessment of Uncertainty in the Risk Assessment for the Outfall Area at PRSs 32-002(a,b) 43

3.3.6 Conclusions for the Phase II Investigation in the Outfall Area at PRSs 32-002(a,b) 45

3.3.7 Remedial Activities in the Outfall Area at PRSs 32-002(a,b) 46

3.3.7.1 Rationale for the VCA in the Outfall Area at PRSs 32-002(a,b) 46

3.3.7.2 Cleanup Level Derivation for the Outfall Area at PRSs 32-002(a,b) 46

3.3.7.3 Remedial Implementation in the Outfall Area at PRSs 32-002(a,b) 46

3.3.7.4 Confirmation Sampling in the Outfall Area at PRSs 32-002(a,b) 46

3.3.8 Conclusions for the VCA in the Outfall Area at PRSs 32-002(a,b) 47

3.4 Preliminary Ecological Assessment 47

3.5 Recommendations for PRSs 32-002(a,b) 47

4.0 PRS 32-003 48

4.1 Phase II and VCA Activities at PRS 32-003 48

4.1.1 Rationale For the Phase II Investigation at PRS 32-003 48

4.1.2 Phase II Field Investigation at PRS 32-003 48

4.1.3 Nature and Extent of Contamination at PRS 32-003 48

4.1.4 Remedial Activities at PRS 32-003 48

4.1.4.1 Rationale For the VCA at PRS 32-003 48

4.1.4.2 Cleanup Level Derivation for PRS 32-003 50

4.1.4.3 Remedial Implementation at PRS 32-003 50

4.1.4.4 Confirmation Sampling at PRS 32-003 51

4.1.5 Conclusions for the VCA at PRS 32-003 51

4.2 Preliminary Ecological Assessment 53

4.3 Recommendations for PRS 32-003 53

5.0 PRS 32-004 54

5.1 Radiation Source Vault at PRS 32-004 54

5.1.1 Rationale For the Phase II Investigation at the Radiation Source Vault at PRS 32-004 54

5.1.2 Phase II Field Investigation at the Radiation Source Vault at PRS 32-004 54

5.1.3 Nature and Extent of Contamination at the Radiation Source Vault at PRS 32-004 56

5.1.4 Conclusions and Recommendations for the Radiation Source Vault at PRS 32-004 ... 56

5.2 PRS 32-004 Drain Line 56

5.2.1 Rationale for Phase II Investigation of the PRS 32-004 Drain Line 56

5.2.2 Phase II Field Investigation at the PRS 32-004 Drain Line 56

5.2.3 Nature and Extent of Contamination at the PRS 32-004 Drain Line 57

5.2.4 Remedial Activities at the PRS 32-004 Drain Line 57

5.2.4.1 Rationale For the VCA at the PRS 32-004 Drain Line 57

5.2.4.2 Cleanup Level Derivation at the PRS 32-004 Drain Line 57

5.2.4.3 Remedial Activities for the PRS 32-004 Drain Line 57

5.2.4.4 Confirmation Sampling for the PRS 32-004 Drain Line 58

5.2.5 Conclusions for the PRS 32-004 Drain Line 61

5.3 PRS 32-004 Outfall Area 61

5.3.1 Rationale for Phase II Investigation of the PRS 32-004 Outfall Area 61

5.3.2 Phase II Field Investigation at the PRS 32-004 Outfall Area 61

5.3.3 Background Comparisons for Phase II Samples in the PRS 32-004 Outfall Area 63

5.3.4 Screening Assessment for Phase II Samples in the PRS 32-004 Outfall Area 65

5.3.5 Evaluation of Samples Collected to Determine the Source of Contamination in the PRS 32-004 Outfall Area 68

5.3.6 Remedial Activities in the PRS 32-004 Outfall Area 69

5.3.7 Conclusions for the PRS 32-004 Outfall Area 69

5.4 Preliminary Ecological Assessment for PRS 32-004 69

5.5 Recommendations for PRS 32-004 69

6.0 WASTE MANAGEMENT 71

6.1 Deviations 71

6.2 Waste Characterization Data 71

7.0 REFERENCES 74

APPENDIX A RESULTS OF QUALITY ASSURANCE/QUALITY CONTROL ACTIVITIES A-1

APPENDIX B ANALYTICAL RESULTS B-1

APPENDIX C COST COMPARISON C-1

APPENDIX D RISK ASSESSMENT DATA AND EQUATIONS D-1

APPENDIX E CERTIFICATE OF COMPLETION E-1

LIST OF TABLES

Table 2.1.2-1 PCB Results For PRS 32-001 Phase II Characterization Samples 6

Table 2.1.3-1 Inorganics With Concentrations Above Background Screening Values in PRS 32-001 Phase II Characterization Samples 8

Table 2.1.3-2 Organic Compounds Detected in PRS 32-001 Phase II Characterization Samples ... 8

Table 2.1.4-1 Multiple Chemical Evaluation For PRS 32-001 Phase II Characterization Samples. 10

Table 3.1.4-1 Results of Confirmation Sampling at the PRS 32-002(a) Drain Line 16

Table 3.1.4-2 Estimates of Risk Associated with Elevated PAHs at the PRS 32-002(a) Drain Line 19

Table 3.1.4-3 Results Of Confirmation Sampling in the Excavation of the PRS 32-002(b) Drain Line 21

Table 3.2.3-1 Results For Characterization Samples at the PRS 32-002(a) Septic Tank Footprint 25

Table 3.2.4-1 Results Of Confirmation Sampling at the PRS 32-002(a) Septic Tank Footprint 27

Table 3.3.3-1 Statistical Tests For Background Comparison for Characterization Samplesfrom the Outfall Area At PRSs 32-002(a,b) 31

Table 3.3.3-2 Inorganics with Concentrations Above Background Screening Values in Characterization Samples From The Outfall Area at PRSs 32-002(a,b) 32

Table 3.3.3-3 Radionuclides with Concentrations Above Background Screening Values in CharacterizationSamples from the Outfall Area at PRSs 32-002(a,b) 33

Table 3.3.3-4 Organic Compounds Detected in Characterization Samples from the Outfall Area at PRSs 32-002(a,b) 34

Table 3.3.4-1 Multiple Chemical Evaluation for Phase II Characterization Samples in the Outfall Area at PRSs 32-002(a,b) 35

Table 3.3.5-1 Cancer Risk for the Recreational Scenario in the Outfall Area at PRSs 32-002(a,b) 42

Table 3.3.5-2 Noncarcinogenic Hazard Index Summary for the Recreational Scenario in the Outfall Area at PRSs 32-002(a,b) 44

Table 3.3.7-1 Results of Confirmation Sampling in the Outfall Area at PRSs 32-002(a,b) 47

Table 4.1.4-1 Results of Confirmation Sampling at PRS 32-003 52

Table 5.1.2-1 Results from Phase II Characterization Samples at the Radiation Source Vault at PRS 32-004 56

Table 5.2.4-1 Results of Confirmation Sampling at the PRS 32-004 Drain Line 59

Table 5.3.3-1 Statistical Tests for Background Comparison in Characterization Samples from the PRS 32-004 Outfall Area 64

Table 5.3.3-2 Inorganics with Concentrations Above Background Screening Values in Characterization Samples from the PRS 32-004 Outfall Area 64

Table 5.3.3-3 Organic Compounds Detected in Characterization Samples from the PRS 32-004 Outfall Area 66

Table 5.3.4-1 Multiple Chemical Evaluation Characterization Samples from the PRS 32-004 Outfall Area 67

Table 5.3.5-1 Comparison of Results for Samples Collected Upgradient, at, and Downgradient from the Mouth of the PRS 32-004 Outfall Pipe 70

Table 6.2-1 Waste Management Summary 73

LIST OF FIGURES

Fig. 1.1-1. Locations of potential release sites at TA-32. 2

Fig. 2.1.2-1. Locations of samples collected at PRS 32-001. 5

Fig. 3.1.4-1. Locations of samples collected at the influent drain lines at PRSs 32-002(a,b). 14

Fig. 3.2.2-1. Locations of samples collected at the PRS 32-002(a) septic tank footprint. 24

Fig. 3.3.2-1. Locations of samples collected in the outfall area at PRSs 32-002(a,b). 29

Fig. 3.3.5-1. Analytical results for lead and mercury in the outfall area at PRSs 32-002(a,b). 38

Fig. 4.1.3-1. Locations of samples collected at PRS 32-003. 49

Fig. 5.1.2-1. Locations of samples collected at the PRS 32-004 radiation source vault. 55

1.0 INTRODUCTION

This report addresses the Phase II Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) and voluntary corrective action (VCA) activities at potential release sites (PRSs) 32-001, 32-002(a,b), 32-003, and 32-004 at Los Alamos National Laboratory (LANL). Each of these PRSs is a solid waste management unit listed in the Hazardous and Solid Waste Amendments (HSWA) Module of LANL's Hazardous Waste Facility Permit (EPA 1990, 0306). Radiological constituents, although not regulated by RCRA, were also addressed in this investigation.

Technical Area (TA) 32 is located south of Trinity Drive behind the present Los Alamos County Public Works Department Pavement Management Division building near the north edge of Los Alamos Canyon (Figure 1.1-1). It served as a medical research and training facility at Los Alamos Scientific Laboratory from 1944 until it was decommissioned in 1954. Research activities at the site involved radioisotopes, including plutonium-238, plutonium-239, americium-241, carbon-14, and tritium. Volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and target analyte list (TAL) metals may also have been used at the facility (LANL 1992, 0783). TA-32 comprises the PRSs described below. The Phase II and/or VCA activities conducted at each of these PRSs are discussed individually in Sections 2.0 through 5.0 of this report.

PRS 32-001. This PRS is the former location of an incinerator that adjoined the northeast corner of the medical research and training facility's main building (TA-32-1). The incinerator was constructed of brick and was 2.5-ft wide x 2.5-ft long x 10-ft high. The incinerator received combustible wastes from the medical research facility, and the ash was disposed of off-site as described in the Response to the Notice of Deficiency (NOD) for TA-32 (LANL 1996, 06-0148). PRS 32-001 is currently located beneath asphalt in the current working area of the Los Alamos County Public Works Department Pavement Management Division (LANL 1992, 0783).

PRS 32-002(a). This PRS is the location of a former wood-frame septic tank (structure TA-32-7), measuring 4-ft wide x 8-ft long x 4-ft deep, as well as the associated drain line and outfall. The former septic tank received waste from building TA-32-1 via a 6-in. diameter influent septic line constructed of cast iron, vitrified clay pipe (VCP), and a material known as "orangeburg" (a material similar to tar paper). The septic tank was thought to have been left at the site after decommissioning in 1954, but was apparently removed sometime afterward.

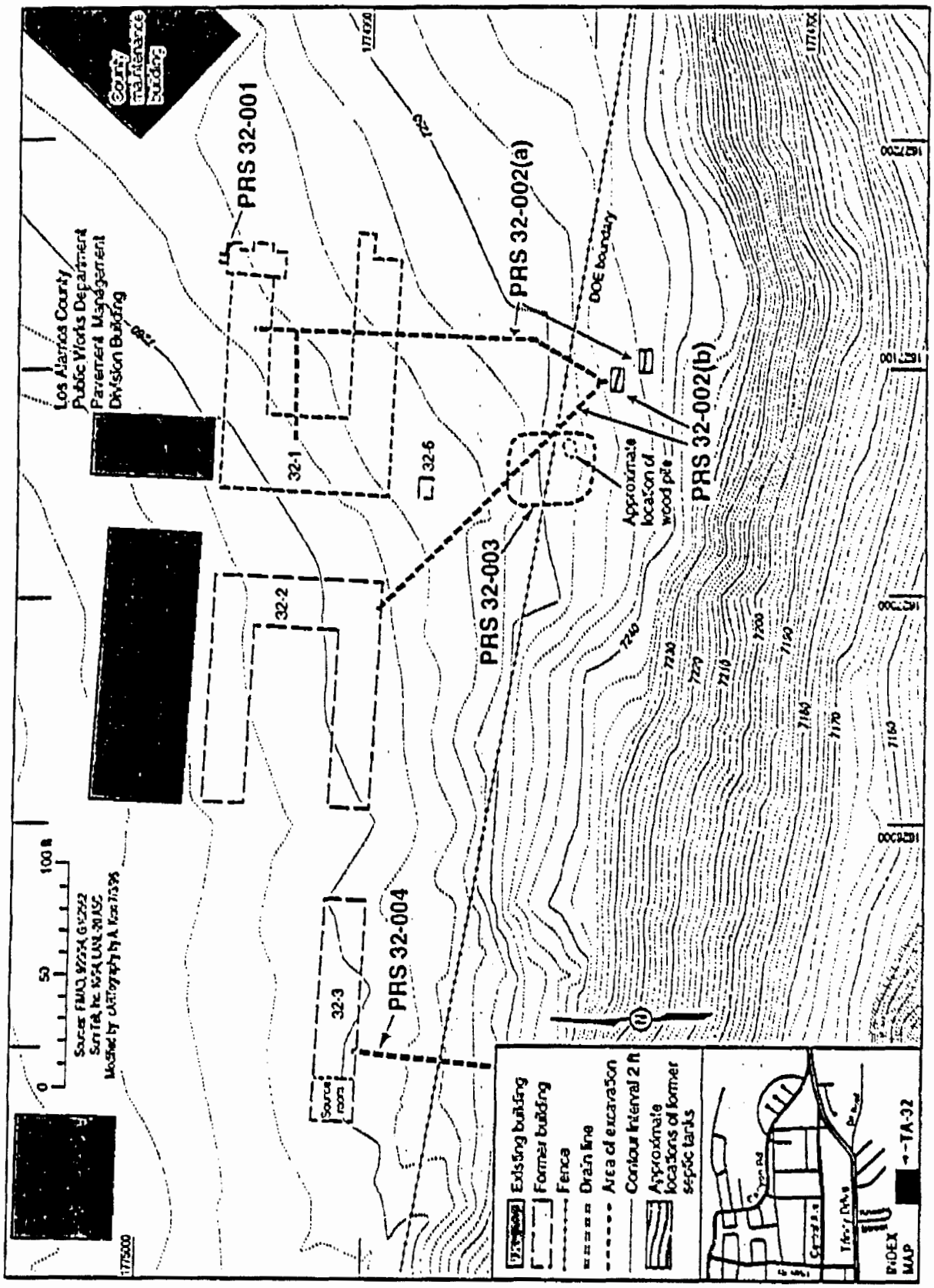

Fig. 1.1-1 Locations of potential release sites at TA-32.

There are no archival records indicating the fate of this tank. The outfall pipe, constructed of 4-in. VCP, was abandoned in place. It is located at the edge of Los Alamos Canyon and discharged directly onto the hillside (LANL 1992, 0783). Phase I sampling results support the likelihood that radionuclides, VOCs, SVOCs, metals, and other waste from laboratory sinks and drains were discharged through this septic tank and its associated piping and drain lines (LANL 1995, 06-0128).

PRS 32-002(b). This PRS is the location of a former reinforced concrete septic tank (structure TA-32-8) measuring 9-ft wide x 5-ft long x 6-ft deep, as well as the associated drain line and outfall. This former septic tank and the influent drain line from building TA-32-2 were installed when the PRS 32-002(a) septic system could no longer meet the usage requirements of laboratory building TA-32-1. The influent septic line for septic tank TA-32-7 was then diverted to septic tank TA-32-8, and the remainder of the TA-32-7 effluent line is believed to have been abandoned in place. Septic tank TA-32-8, was removed in 1988 (LANL 1992, 0783). The outfall pipe for PRS 32-002(b) consisted of a 6-in. diameter VCP that discharged directly onto the hillside in Los Alamos Canyon. Phase I sampling results support the likelihood that radionuclides, VOCs, SVOCs, metals, and other waste from laboratory sinks and drains were discharged through this septic tank and its associated piping and drain lines (LANL 1995, 06-0128).

PRS 32-003. This PRS was a transformer station consisting of three transformers on a wooden platform elevated 19.5 ft above the ground on poles. A wood debris pile and several sawed-off poles were found at the site and are believed to be the remains of the transformer platform (LANL 1995, 06-0128).

PRS 32-004. This PRS consists of a 6-in. VCP drain line and outfall that served former building TA-32-3. The line was connected to a sink adjacent to a room where a radiation source was maintained. This radiation source vault is also included in PRS 32-004. The drain line ran from TA-32-3 directly to the edge of the mesa and discharged onto the hillside of Los Alamos Canyon (LANL 1995, 06-0128).

2.0 PRS 32-001

2.1 Phase II Site Characterization at PRS 32-001

2.1.1 Rationale For the Phase II Investigation at PRS 32-001

In the Phase I investigation of PRS 32-001, the polychlorinated biphenyl (PCB) Aroclor 1260™ was the only chemical retained as a chemical of potential concern (COPC) (LANL 1995, 06-0128). A Phase II investigation was recommended for this site because the lateral and vertical extent of Aroclor 1260™ was not determined during the Phase I investigation. The Phase II sampling and analysis plan was included in the RFI Report for TA-32 (LANL 1995, 06-0128).

In addition, new archival information was identified during the development of the Phase II sampling plan allowing for a more accurate determination of the former incinerator location. Before the Phase II investigation, the incinerator location was surveyed to within a 10-ft radius. As discussed in the Response to the NOD for TA-32, the survey results indicated that one of the two Phase I samples was collected from within the radius and the other was collected just outside the radius (LANL 1996, 06-0148). As proposed in the NOD response, further sampling was conducted during the Phase II investigation at the correct location of the former incinerator (LANL 1996, 06-0148). Phase II RFI samples were submitted for a full suite of fixed-laboratory analyses to ensure that the site had been adequately characterized.

2.1.2 Phase II Field Investigation at PRS 32-001

The Phase II investigation at PRS 32-001 had two objectives. The first objective was to determine the lateral and vertical extent of PCB contamination at the site of the former incinerator pad. To define the extent, samples were collected in accordance with the Environmental Protection Agency (EPA) guidance document "Verification of PCB Spill Cleanup by Sampling and Analysis" (EPA 1985, 1242). Eighteen samples were collected from nine locations at depths of 0–10 in. and 10–15 in. using a hand auger (Fig. 2.1.2-1). These samples were submitted to the Mobile Chemistry Analytical Laboratory (MCAL) for analysis of PCBs using an EPA SW846-equivalent method. As shown in Table 2.1.2-1, all results for each of the Aroclors™ were below the cleanup level of 1 mg/kg.

Although PCBs were detected at elevated levels in one Phase I sample, no PCBs were detected at greater than 1 mg/kg in any of the 18 samples collected during the Phase II investigation. The Phase I sample containing PCBs (AAA4690) was collected at a depth of 11 in. below

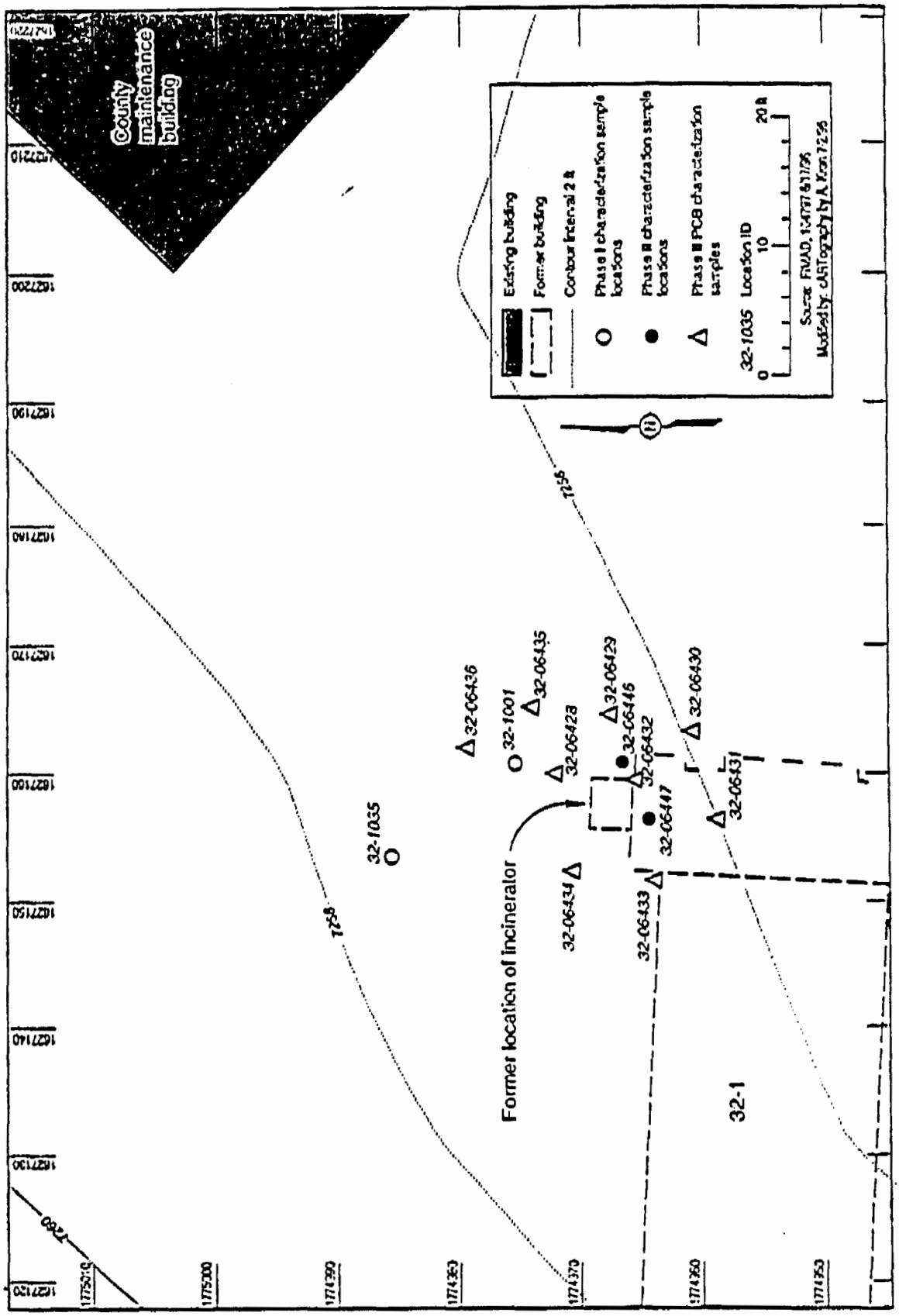

Fig. 2.1.2-1. Locations of samples collected at PRS 32-001.

TABLE 2.1.2-1

PCB RESULTS FOR PRS 32-001 PHASE II CHARACTERIZATION SAMPLES

LOCATION ID	SAMPLE ID	DEPTH (in.)	AROCLOR 1242™ (mg/kg)	AROCLOR 1254™ (mg/kg)	AROCLOR 1260™ (mg/kg)
32-06428	0132-96-0151	0–10	<0.1	<0.1	0.976
32-06429	0132-96-0152	10–15	<0.1	<0.1	<0.1
32-06429	0132-96-0153	0–10	<0.1	<0.1	0.194
32-06430	0132-96-0154	0–10	<0.1	<0.1	<0.1
32-06430	0132-96-0155	10–15	<0.1	<0.1	<0.1
32-06431	0132-96-0156	0–10	<0.1	<0.1	0.513
32-06431	0132-96-0157	10–15	<0.1	<0.1	0.354
32-06432	0132-96-0158	0–10	<0.1	<0.1	0.278
32-06433	0132-96-0159	0–10	<0.1	<0.1	0.980
32-06433	0132-96-0160	10–15	<0.1	<0.1	0.155
32-06434	0132-96-0161	0–10	<0.1	<0.1	0.099
32-06434	0132-96-0162	10–15	<0.1	<0.1	<0.1
32-06435	0132-96-0163	0–10	<0.1	<0.1	0.279
32-06435	0132-96-0164	10–15	<0.1	<0.1	0.579
32-06436	0132-96-0165	0–10	<0.1	<0.1	0.447
32-06436	0132-96-0166	10–15	<0.1	<0.1	<0.1
32-06428	0132-96-0167	10–15	<0.1	<0.1	<0.1
32-06432	0132-96-0168	10–15	<0.1	<0.1	<0.1

ground surface (bgs). This sample contained Aroclor 1260™ at a concentration of 2.0 mg/kg. The Toxic Substances Control Act (TSCA) cleanup level for PCBs in soil on property where access is unrestricted (such as TA-32) is 10 mg/kg, provided that the soil is excavated to a minimum depth of 10 in. and replaced with clean soil (EPA 1995, 1329). The only sample with a detected value of PCBs contained less than the cleanup level of 10 mg/kg and was collected at 11 in. bgs. Soil above that depth was found to contain less than 1 mg/kg of PCBs. Therefore, no cleanup activities were required at this site.

The second objective of the Phase II investigation at PRS 32-001 was to confirm that the former incinerator location had been adequately characterized. This objective was set forth in the Response to the NOD for TA-32 (LANL 1996, 06-0148). To meet this objective, two additional samples were collected south of the former incinerator location. These two samples were located within the 10-ft x 10-ft area identified as the former incinerator location in the NOD response (Fig. 2.1.2-1) (LANL 1996, 06-0148). The samples were collected at depths of 2–10 in. and 2–11 in. (no samples were collected at the 0–2 in. depth interval because there was a 2-in. cover of asphalt at the site). Both samples were submitted for fixed-laboratory analysis for VOCs, SVOCs, and TAL metals. The samples were also submitted for Mobile Radiological Analytical Laboratory (MRAL) analysis for gross alpha, beta, and gamma radiation and tritium. The following sections discuss the background comparison and screening assessment for these two characterization samples.

2.1.3 Background Comparisons for Phase II Samples at PRS 32-001

Inorganics. Two soil samples collected during the Phase II RFI at PRS 32-001 were analyzed for TAL metals. Some analyses included one or more laboratory duplicates. In this screening assessment, the highest detected value was used for samples where a laboratory duplicate was analyzed. Five inorganics were detected above their background screening values in at least one sample: copper, manganese, mercury, sodium, and zinc. These chemicals are therefore carried forward to the screening assessment. The data for these chemicals are presented in Table 2.1.3-1.

Evaluation of Organics. One organic compound, trichloroethene, was detected. Trichloroethene is carried forward to the screening assessment. The data for this chemical are presented in Table 2.1.3-2.

TABLE 2.1.3-1

INORGANICS WITH CONCENTRATIONS ABOVE BACKGROUND SCREENING VALUES IN PRS 32-001 PHASE II CHARACTERIZATION SAMPLES

LOCATION ID	SAMPLE ID	DEPTH (in.)	COPPER (mg/kg)	MANGANESE (mg/kg)	MERCURY (mg/kg)	SODIUM (mg/kg)	ZINC (mg/kg)
UTL	N/A[a]	N/A	15.5	714	0.1	915	50.8
SAL[b]	N/A	N/A	2 800	n/a[c]	23	n/a	23 000
32-06446	0132-96-0209	2–10	**16.5**[d]	298	0.41	1 130	79.3
32-06447	0132-96-0210	2–11	**7.3**[e]	**780**[e]	0.24	**1 150**[e]	**36**[e]

[a] N/A = Not applicable.
[b] SAL = Screening action level.
[c] n/a = Not available.
[d] Values in bold exceed the background screening value.
[e] Value is the maximum of a sample and its laboratory duplicate.

TABLE 2.1.3-2

ORGANIC COMPOUNDS DETECTED IN PRS 32-001 PHASE II CHARACTERIZATION SAMPLES

LOCATION ID	SAMPLE ID	DEPTH (in.)	TRICHLOROETHENE (mg/kg)
SAL	N/A[a]	N/A	7.1
32-06446	0132-96-0209	2–10	0.009
32-06447	0132-96-0210	2–11	0.006

[a] N/A = Not applicable.

2.1.4 Screening Assessment for Phase II Samples at PRS 32-001

This subsection discusses the comparison with screening action levels (SALs) for COPCs detected at levels greater than background screening levels in the Phase II investigation at PRS 32-001. Five inorganics (copper, manganese, mercury, sodium, and zinc) and one organic (trichloroethene) were detected at levels above background screening values.

Greater than or equal to SAL. No chemicals were detected at concentrations greater than or equal to their SALs.

No SAL. Two chemicals, manganese and sodium, have no SALs. To evaluate their potential for toxicity, manganese and sodium were compared to the recommended daily allowances

(RDAs) for infants and adults. Assuming the highest concentration of manganese detected at PRS 32-001 (780 mg/kg), an infant ingesting soil at a rate of 200 mg per day would ingest 0.156 mg of manganese per day. This is well below the RDA of 0.6 to 1 mg/day for infants. An adult ingesting soil at a rate of 100 mg per day would ingest 0.078 mg of manganese per day. This is well below the RDA of 2–5 mg/day for adults. Because ingestion of the highest concentration of manganese at the site would represent an ingestion of less than the RDA for both infants and adults, manganese is eliminated as a COPC.

Assuming the highest concentration of sodium detected at PRS 32-001 (1 150 mg/kg), an infant ingesting soil at a rate of 200 mg per day would ingest 0.23 mg of sodium each day. This is well below the RDA of 46 mg/day for infants. An adult ingesting soil at a rate of 100 mg per day would ingest 0.115 mg of sodium per day. This is well below the RDA of 500 mg/day for adults. Therefore, sodium is eliminated as a COPC. Because ingestion of the highest concentration of sodium at the site would represent an ingestion of less than the RDA for both infants and adults, sodium is eliminated as a COPC.

Less than SAL. Four chemicals (copper, mercury, trichloroethene, and zinc) were detected at concentrations less than their 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). Because there is only one carcinogen (tricholorethene), a multiple chemical evaluation is not conducted for this category. SALs for all chemicals were normalized and summed as described in Section 3.0 of the RFI Report (LANL 1995, 06-0128). The results of the analysis are shown in Table 2.1.4-1.

The results of the multiple chemical evaluation based on noncarcinogenic effects are less than one, indicating that adverse human health effects are unlikely. In addition, if the results of the Phase I multiple constituent evaluation (0.2) are added to the results of the Phase II multiple chemical evaluation (0.03), the total normalized sum would be 0.23. Therefore, all of the chemicals detected at concentrations less than their SALs in both the Phase I and Phase II investigations are eliminated as COPCs.

At the conclusion of this screening assessment, no chemicals remain as COPCs.

TABLE 2.1.4-1

MULTIPLE CHEMICAL EVALUATION FOR PRS 32-001 PHASE II CHARACTERIZATION SAMPLES

CHEMICAL	SAMPLE VALUE (mg/kg)	SAL (mg/kg)	NORMALIZED VALUE
SAL BASED ON NONCARCINOGENIC EFFECTS			
Copper	16.5	2 800	0.006
Mercury	0.41	23	0.02
Zinc	79.3	23 000	0.003
NORMALIZED SUM			0.03

2.1.5 Conclusions for the Phase II Investigation at PRS 32-001

Based on the data collected during the Phase II investigation of PRS 32-001, no COPCs are retained for this site.

2.2 Preliminary Ecological Assessment for PRS 32-001

In cooperation with the New Mexico Environment Department and EPA Region 6, the Laboratory Environmental Restoration (ER) Project is developing an approach for ecological risk assessment. Further ecological risk assessment at PRS 32-001 will be deferred until this site can be assessed as part of the ecological exposure unit methodology currently being developed.

2.3 Recommendations for PRS 32-001

Based on the results of both the Phase I and Phase II investigations, PRS 32-001 is recommended for no further action (NFA) under the HSWA Module of LANL's Hazardous Waste Facility Permit. NFA is recommended based on LANL's NFA Criteria Policy, criterion 4, which states that the PRS has been characterized or remediated in accordance with current applicable state or federal regulations, and available data indicate that contaminants of concern are either not present or are present in concentrations that pose an acceptable level of risk. A Class III permit modification will be requested to remove PRS 32-001 from the HSWA Module of LANL's Hazardous Waste Facility Permit (Environmental Restoration Project 1995, 1173).

3.0 PRSs 32-002(a,b)

PRSs 32-002(a,b) were addressed as three main areas: the influent drain lines, the PRS 32-002(a) septic tank footprint, and the outfall area. The Phase II investigation and VCA activities at the outfall area and influent drain lines are discussed together because these PRSs share a common outfall area, and the activities at their drain lines were conducted together. The activities at each of the three areas are discussed in detail in Sections 3.1, 3.2, and 3.3, respectively. VCAs were conducted to remove the influent drain lines, soil at the former septic tank location, and a small amount of PCB-contaminated soil in the outfall area.

3.1 Phase II and VCA Activities at the Drain Lines at PRSs 32-002(a,b)

3.1.1 Rationale for the Phase II Investigation of the Drain Lines at PRSs 32-002(a,b)

PRS 32-002(a). Phase I samples were collected on the hillside below PRS 32-002(a), and results from the samples indicate that chemicals may have passed through the septic system. A Phase II investigation was therefore recommended for the PRS 32-002(a) influent drain line area to determine how much of the influent drain line remained, and to determine whether any releases had occurred in the soil surrounding the drain line.

PRS 32-002(b). Phase I samples were collected in the drain line area at PRS 32-002(b) from two trenches excavated across the former influent drain line (LANL 1995, 06-0128). Analytical results indicated that lead, mercury, and polycyclic aromatic hydrocarbons (PAHs) were present at concentrations greater than SALs at the influent drain line location. A Phase II investigation was therefore recommended for PRS 32-002(b) to determine the nature and volume of waste associated with removal of the inflow lines and to determine whether any releases had occurred in the soil surrounding the drain line.

3.1.2 Phase II Field Investigation at the Drain Lines at PRSs 32-002(a,b)

The objective of the Phase II investigation of the influent drain lines at PRSs 32-002(a,b) was to locate the influent drain lines and characterize their contents. Exploratory trenches were excavated to locate the drain lines, and samples of sludge from within the pipe were analyzed for waste characterization purposes and to determine health and safety requirements for the VCA. The drain line immediately north of the PRS 32-002(a) septic tank footprint was never located during trenching, confirming that the portion of the drain line immediately north of the PRS 32-002(a) septic tank had been previously removed.

3.1.3 Nature and Extent of Contamination at the Drain Lines at PRSs 32-002(a,b)

The Phase II investigation of the interior of the influent drain lines at PRSs 32-002(a,b) indicated that most of the pipe was free of sludge and residual radioactive contamination. However, one location in the drain line contained sludge that had elevated levels of lead (30 500 mg/kg), mercury (44 200 mg/kg), plutonium-238 (0.21 pCi/g), plutonium-239 (60.1 pCi/g), cesium (5.97 pCi/g), americium (2.79 pCi/g), uranium-238 (16.9 pCi/g), uranium-235 (0.87 pCi/g), and uranium-234 (19.6 pCi/g). Based on visual inspection and field screening results, there is no evidence that releases have occurred from the drain line. This was verified using confirmation sampling. The drain line and its contents were removed during the VCA.

3.1.4 Remedial Activities at the Drain Lines at PRSs 32-002(a,b)

3.1.4.1 Rational for the VCA at the Drain Lines at PRSs 32-002(a,b)

PRS 32-002(a). Phase II investigation at the PRS 32-002(a) drain line identified the influent drain line and indicated the presence of elevated levels of hazardous and radiological constituents in the pipe contents (dry sludge). In addition, residual radioactivity was present to a limited extent on the interior surface of the pipe. Because hazardous and radiological chemicals were present in the pipe, a VCA was conducted to remove the drain line associated with PRS 32-002(a).

PRS 32-002(b). Phase II characterization at the PRS 32-002(b) drain line confirmed the presence of elevated levels of hazardous and radiological constituents in the contents of the drain line (dry sludge), as well as in the outfall area. Because hazardous and radiological constituents were present, a VCA was conducted to remove the drain line and soil associated with the former septic tank location at PRS 32-002(b).

3.1.4.2 Cleanup Level Derivation for the Drain Lines at PRSs 32-002(a,b)

If evidence of a release had been discovered during the Phase II investigation or the VCA, SALs would have been used as cleanup levels for soil remaining in the trench.

3.1.4.3 Remedial Implementation at the Drain Lines at PRSs 32-002(a,b)

PRS 32-002(a). The PRS 32-002(a) drain line was exposed using a backhoe and visually inspected for breaks and cracks. All portions of the drain line were excavated to depths of approximately 3.5–4.5 ft. The width of the excavation was approximately 4 ft. The pipe was exposed in 25-ft increments to ensure effective implementation of the activities outlined in the

VCA plan, which included visual inspection, field screening, pipe removal, confirmation sampling, and removal of any contaminated soil (LANL 1995, 06-0128).

The lower 30 ft of pipe were composed of VCP, the upper 65 ft were composed of cast iron, and the middle 60 ft were composed of orangeburg, a tar-paper-like material. A total of 155 ft of the north-south trending portion of the drain line was removed (Fig. 3.1.4-1). During excavation of the north end of the PRS 32-002(a) drain line, a separate east-west trending line was located intersecting the main north-south trending line from the west. The intersection was approximately 15 ft from the north end of the main north-south trending line (Figure 3.1.4-1). The east-west trending line was composed of cast iron and was approximately 40 ft long. This portion of drain line was also removed.

Restoration activities included backfilling the drain line trenches with the material removed during excavation. The fill material was placed into the trench and compacted in 8-in. layers using a ground compactor. Asphalt was placed over the trench only in areas that were covered with asphalt before excavation. Native grass seed and mulch were distributed over areas not previously covered by asphalt.

PRS 32-002(b). The PRS 32-002(b) drain line was exposed using a backhoe and visually inspected for breaks and cracks. All portions of the drain line were excavated to depths of approximately 3.5–4.5 ft. The width of the excavation was approximately 4 ft. The pipe was exposed in 25-ft increments to ensure effective implementation of the activities outlined in the VCA plan, which included visual inspection, field screening, pipe removal, confirmation sampling, and removal of any contaminated soil (LANL 1995, 06-0128).

The majority of the PRS 32-002(b) drain line was composed of VCP, and the northern-most 12 ft of pipe, which was originally the connection to building TA-32-2, was composed of cast iron (Fig. 3.1.4-1). The VCP portion of the line was composed of 2.5-ft sections, and the cast iron portion was composed of 5-ft sections. Following the excavation of each 25-ft segment, the pipe and surrounding soil were screened for VOCs using a photoionization detector (PID), and for gross alpha, gross beta, and gamma radioactivity using an Eberline ESP-1™ with a Geiger-Mueller™ pancake probe. Each section of the drain line was then carefully removed from the trench so that no material from inside the pipe spilled into the trench. The contents of each pipe were placed into a drum liner and managed in a 55-gallon drum. Each pipe section was then thoroughly cleaned, both inside and outside, using a small amount of Fantastik™ spray cleaner and cloth towels. The byproducts of the cleaning operation were also collected in a drum liner and managed in a 55-gallon drum. A total of 116 ft of drain line were removed.

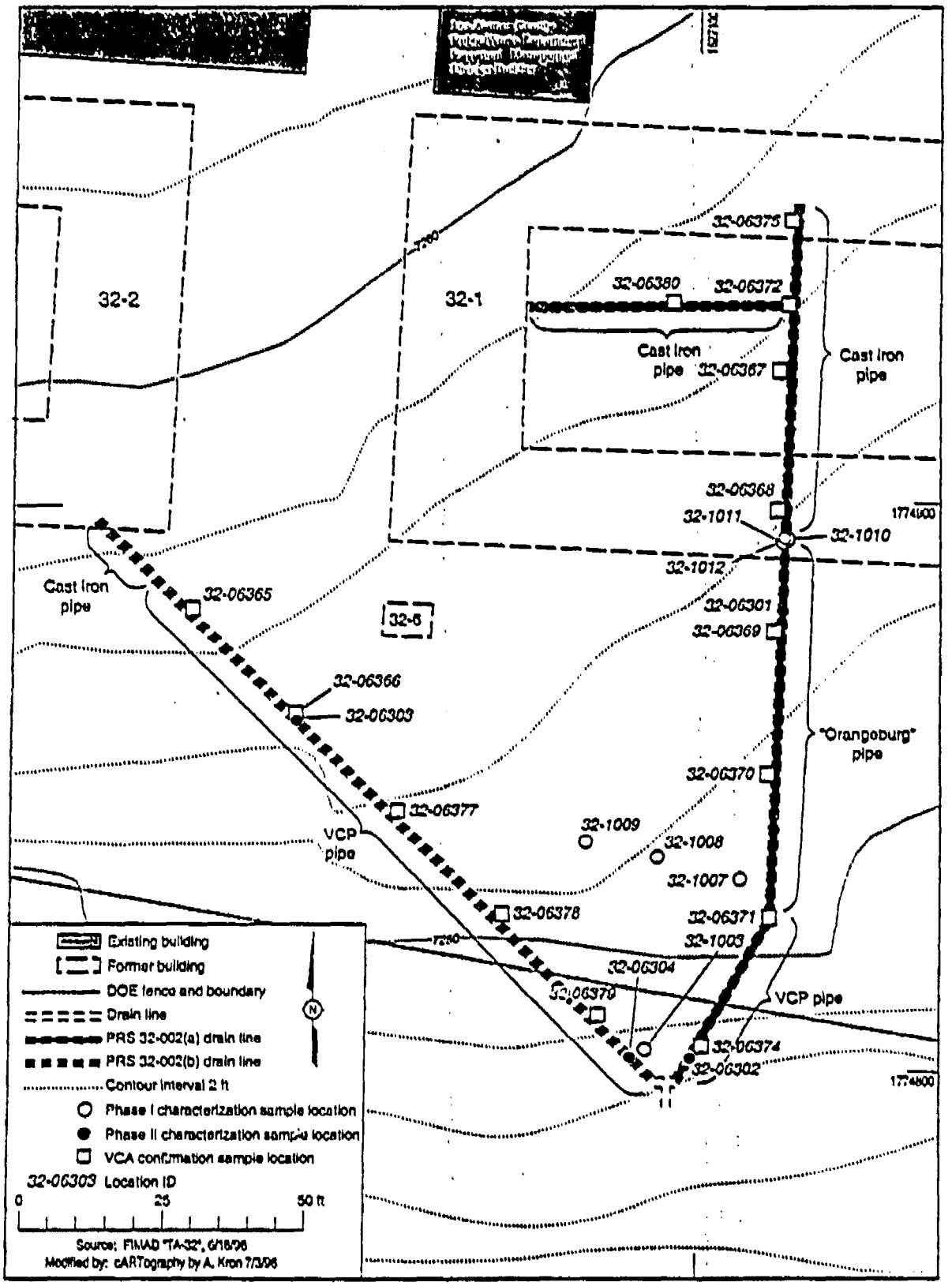

Fig. 3.1.4-1. Locations of samples collected at the influent drain lines at PRSs 32-002(a,b).

Restoration activities included backfilling the drain line trenches with the material removed during excavation. The fill material was placed into the trench and compacted in 8-in. layers using a ground compactor. Asphalt was placed over the trench only in areas that were covered with asphalt before excavation. Native grass seed and mulch were distributed over areas not previously covered by asphalt.

3.1.4.4 Confirmation Sampling at the Drain Lines at PRSs 32-002(a,b)

PRS 32-002(a) Drain Line. A total of nine confirmation soil samples were collected at 25-ft intervals in the base of the trench beneath the PRS 32-002(a) drain line. These samples were submitted for fixed-laboratory analysis for TAL metals, SVOCs, VOCs, isotopic plutonium, isotopic uranium, tritium, and gamma spectrometry. One of the nine verification samples was collected within the excavation of the east-west trending portion of the line. The remaining eight verification samples were collected within the excavation of the north-south trending portion as follows: four were collected beneath the cast iron segment, three were collected beneath the orangeburg segment, and one was collected beneath the VCP segment of the drain line (Fig. 3.1.4-1).

The results of the confirmation samples were below SALs for all analytes except several PAHs. These results are summarized in Table 3.1.4-1.

The orangeburg pipe present at this site, which is associated with former operations at PRS 32-002(a), could potentially be a source of elevated levels of PAHs. In order to determine if additional clean up was required, the average concentrations of PAHs that exceed SALs at these four locations were used to estimate lifetime excess cancer risk by ratio to SAL (Table 3.1.4-2). The ratio of the average site concentrations to the SAL represents the risk associated with the reasonable maximum exposure assuming residential land use. This scenario is reasonable at the PRS 32-002(a) drain lines because the area is located on a mesa top that could potentially be developed for residential use. In these ratios, nondetected values were replaced by one-half the reported detection limit, and multiple values for a specific location were averaged before combining them with other sample locations. The SAL represents an excess cancer risk of one in a million (1×10^{-6}).

TABLE 3.1.4-1

RESULTS OF CONFIRMATION SAMPLING AT THE PRS 32-002(a) DRAIN LINE

		LOCATION ID	32-06368	32-06369	32-06370	32-06370	32-06371	32-06372	32-06374	32-06375	32-06367	32-06373
		SAMPLE ID	6132-96-0601	6132-96-0602	6132-96-0604	6132-96-0605	6132-96-0606	6132-96-0607	6132-96-0608	6132-96-0609	6132-96-0610	6132-96-0616
		DEPTH (ft)	0–2	0–2	0–3	0–3	0–3	0–3	0–3	0–6	0–2	0–6
ANALYTE	UTL	SAL										
ORGANICS (mg/kg)												
Acenaphthene	n/a[a]	360	0.37(U)[b]	0.38(U)	0.33(U)	0.33(U)	0.3(J)[c]	0.19(U)	0.19(U)	0.18(U)	0.35(U)	0.41(U)
Acetone	n/a	2 000	0.02(U)	0.02(U)	0.02(U)	0.02(U)	NA[d]	0.02	0.033(U)	0.022	0.02(U)	NA
Anthracene	n/a	19	0.37(U)	0.11(J)	0.33(U)	0.33(U)	1.5	0.19(U)	0.19(U)	0.18(U)	0.064(J)	0.081(J)
Benzoic acid	n/a	100 000	3.7(U)	3.8(U)	3.3(U)	3.3(U)	6.6(U)	0.96(U)	0.99(U)	0.91(U)	3.5(U)	2(U)
Benzo[a]anthracene	n/a	0.61	0.17(J)	0.34(J)	0.053(J)	0.051(J)	4.2	0.25	0.19(U)	0.18(U)	0.68	0.73
Benzo[a]pyrene	n/a	0.061	0.14(J)	0.27(J)	0.33(U)	0.048(J)	3.5	0.2	0.35	0.18(U)	0.52	0.58
Benzo[b]fluoranthene	n/a	0.61	0.2(J)	0.4	0.07(J)	0.068(J)	5.5	0.2	0.33	0.18(U)	0.81	0.59
Benzo[g,h,i]perylene	n/a	n/a	0.074(J)	0.079(J)	0.33(U)	0.33(U)	0.83	0.19(U)	1.2	0.18(U)	0.2(J)	0.33(J)
Benzo[k]fluoranthene	n/a	6.1	0.075(J)	0.17(J)	0.33(U)	0.33(U)	3 200	0.19(U)	0.28	0.18(U)	0.31(J)	0.58
Bis(2-ethylhexyl)phthalate	n/a	32	0.37	0.36	0.33(U)	0.33(U)	0.66(U)	0.19(U)	0.19(U)	0.18(U)	0.35	0.41(U)
Carbazole	n/a	22	0.06(J)	0.065(J)	0.33(U)	0.33(U)	0.53	NA	NA	NA	0.043(J)	NA
Chrysene	n/a	24	0.19(J)	0.36(J)	0.065(J)	0.067(J)	3.8	0.23	0.36	0.18(U)	0.77	0.81
Di-n-butyl phthalate	n/a	6 500	0.37(U)	0.38(U)	0.33(U)	0.33(U)	0.66(U)	0.19(U)	0.19(U)	0.18(U)	0.35(U)	0.41(U)
Dibenzofuran	n/a	260	0.37(U)	0.38(U)	0.33(U)	0.33(U)	0.17(J)	0.19(U)	0.19(U)	0.18(U)	0.35(U)	0.41(U)
Dibenzo[a,h]anthracene	n/a	0.061	0.37(U)	0.33(U)	0.33(U)	0.33(U)	0.33(J)	0.19(U)	0.19(U)	0.18(U)	0.073(J)	0.41(U)
Dichlorodifluoromethane	n/a	110	0.005(U)	0.01(U)	0.01(U)	0.01(U)	0.01(U)	NA	0.012(U)	0.011(U)	0.01(U)	NA
Fluoranthene	n/a	2 600	0.35(J)	0.61	0.097(J)	0.09(J)	6.1	0.45	0.2	0.4	1.1	1.3
Indeno[1,2,3-cd]pyrene	n/a	0.61	0.076(J)	0.091(J)	0.33(U)	0.33(U)	1	0.19(U)	0.64	0.18(U)	0.23(J)	0.29(J)
Methylene chloride	n/a	11	0.005(U)	0.003(J)	0.005	0.005	0.005	0.006(U)	0.006(U)	0.0056(U)	0.006(U)	NA
Naphthalene	n/a	800	0.37(U)	0.38(U)	0.33(U)	0.33(U)	0.062(J)	0.19(U)	0.19(U)	0.18(U)	0.35(U)	0.41(U)
Phenanthrene	n/a	n/a	0.11(J)	0.31(J)	0.047(J)	0.038(J)	3.7	0.19(U)	0.19(U)	0.18(U)	0.17(J)	0.28(J)
Pyrene	n/a	2 000	0.26(J)	0.47	0.071(J)	0.064(J)	6.6	0.3	0.19(U)	0.22	0.79	1
Toluene	n/a	1 900	0.005(U)	0.005(U)	0.005(U)	0.005(U)	0.005(U)	0.006(U)	0.006(U)	0.0056(U)	0.005(U)	NA
Trichlorofluoromethane	n/a	710	0.005(U)	0.006	0.005(U)	0.005(U)	0.005(U)	0.006(U)	0.006(U)	0.0056(U)	0.005(U)	NA

TABLE 3.1.4-1 (CONTINUED)

RESULTS OF CONFIRMATION SAMPLING AT THE PRS 32-002(a) DRAIN LINE

		LOCATION ID	32-06368	32-06369	32-06370	32-06370	32-06371	32-06372	32-06374	32-06375	32-06367	32-06369
		SAMPLE ID	0132-95-0601	0132-95-0602	0132-95-0604	0132-95-0605	0132-95-0606	0132-95-0607	0132-95-0608	0132-95-0609	0132-95-0610	0132-95-0616
		DEPTH (ft)	0–2	0–2	0–3	0–3	0–3	0–3	0–3	0–6	0–2	0–6
ANALYTE	UTL	SAL										
RADIONUCLIDES (pCi/g)												
Americium-241	0.335[e]	22	0.1(U)[f]	0.026(U)	0.035(U)	−0.063(U)	0.037(U)	0.036(U)[f]	0.007(U)	0.21(U)	0.082(U)	0.75(U)
Cesium-137	1.7[e]	5.1	0.025(U)[f]	0.022(U)	−0.023(U)	0.013(U)	0.03(U)	0.018(U)[f]	0.109(U)	0.03(U)	−0.014(U)	0.16(U)
Plutonium-233	0.104[e]	27	0.033[f]	0.007	0.032	0.077	0.037	NA	0.073	0.006(U)[f]	0.065	0.022(U)[f]
Plutonium-233	0.032[e]	24	0.021[f]	0.681	0.027	0.055	2.7	0.013	0.109(J)	0.02(U)[f]	0.026(UJ)[g]	0.02(U)[f]
Tritium	1.44[h]	260	0.123(U)	0.108(U)	0.054(U)	0.077(U)[f]	0.007(U)	0.145(U)	0.063(U)	0.91[U]	0.132(U)	0.27(U)[f]
Uranium-234	1.94	13	0.751[f]	0.707	0.691	0.7	0.45	0.531	0.835	1.7[f]	0.834	NA
Uranium-235	0.034	10	0.023[f]	0.034	0.025	0.023	0.009(U)	0.126	0.031	0.1116(U)[f]	0.032	0.83(U)
Uranium-238	1.82	67	0.495[f]	0.52	0.587	0.506	0.309	0.458	0.556	1.6[f]	0.616	NA
INORGANICS (mg/kg)												
Aluminum	38 700	77 000	4 400	4 400	3 050	3 820	1 300	8 100	4 300	9 200	3 900	11 700
Antimony	1	31	11(U)	11(U)	5.43(U)	5.43(U)	5.12(U)	12(U)	12(U)	11(U)	11(U)	6.6(U)
Arsenic	7.82	n/a	1.4	1.3	1.45	1.58	1.03	2.4	2.5	0.0551	1.9	1.4
Barium	315	5 300	53	71	65.8	62.6	16.8	140	47	150	61	162
Beryllium	1.95	n/a	0.57(U)	0.56(U)	0.435(U)	0.433(U)	0.41(U)	0.95	0.6(U)	0.82	0.56(U)	1(J)
Cadmium	2.7[i]	38	0.57(U)	0.56(U)	0.543(U)	0.543(U)	0.512(U)	0.6(U)	0.6(U)	0.56(U)	0.56(U)	0.9(U)
Calcium	6 120	n/a	930	1 600	791	1 010	454	2 400	1 300	2 100	1 100	1 690
Chromium	19.3	211	3.4	3.3	3.24	3.8	1.53	6	4.8	7.1	3.3	6.8
Cobalt	19.2	4 600	1.1	3.3	2.57(J)	2.58(J)	1.02(U)	4.8	2.4	4.8	2.2	6.7(J)
Copper	15.5	2 800	3.4	3.3	3.48	3.65	1.53(J)	7.1	6	6.2	3.3	7.8
Iron	21 300	n/a	8 400	8 700	6 950	7 930	4 210	10 000	6 100	15 000	8 700	12 400
Lead	23.3	400	26	110	19	18.2	7.48	25	24	65(J)[j]	17	1.8
Magnesium	4 610	n/a	570	690	635	754	376	1 500	640	1 500	480	1 590
Manganese	714	n/a	200	300	275	275	177	300	190	450	230	512

TABLE 3.1.4-1 (CONTINUED)

RESULTS OF CONFIRMATION SAMPLING AT THE PRS 32-002(a) DRAIN LINE

		LOCATION ID	32-06368	32-06369	32-06370	32-06370	32-06371	32-06372	32-06374	32-06375	32-06367	32-06369
		SAMPLE ID	6132-96-0601	6132-96-0602	6132-96-0604	6132-96-0605	6132-96-0606	6132-96-0607	6132-96-0608	6132-96-0609	6132-96-0610	6132-96-0610
		DEPTH (ft.)	0–2	0–2	0–3	0–3	0–3	0–3	0–3	0–6	0–2	0–6
ANALYTE	UTL	SAL	INORGANICS (mg/kg)									
Mercury	0.1[j]	23	4.1[g]	0.11(UJ)	0.048(U)	0.075(J)	0.07	0.12(UJ)	1.2	0.11(UJ)	0.22(UJ)	0.06(U)
Nickel	15.2	1 500	3.4	4.4	4.27(J)	4.78	2.03(J)	6	3.6	6.9	4.4	3.3(J)
Potassium	3 410	n/a	740	760	731	781	329	1 700	650	1 700	760	1 730
Selenium	1.7	380	0.23(U)	0.22(U)	0.271(U)	0.277(U)	0.255(U)	0.24(U)	0.24(U)	0.35	0.22(U)	0.17(U)
Silver	n/a	380	2.3(U)	2.2(U)	0.543(U)	0.549	0.512(U)	2.4(U)	2.4(U)	2.2(U)	2.2(U)	1.7(U)
Sodium	915	n/a	1 500	2 200	1 700	1 870	331(J)	4 900	1 400	3 500	2 200	3 210
Thallium	1[j]	5.4	0.35	0.28(U)	0.217(U)	0.221(U)	0.204(U)	0.3(U)	0.3(U)	1.4(U)	0.28(U)	0.22(U)
Vanadium	41.9	540	9.4	9.1	9.45	10.1	4.81(J)	17	7.7	16	8.8	13.8
Zinc	50.8	23 000	39	44	36	41.5	28.9	27	69	49	37	47.5

[a] n/a = Not available.
[b] U = Undetected quantity (see Appendix A).
[c] J = Estimated quantity (see Appendix A).
[d] NA = Not analyzed.
[e] Maximum reported value in the Environmental Surveillance reports.
[f] Value is the maximum of a sample and its laboratory duplicate.
[g] UJ = Estimated undetected quantity (see Appendix A).
[h] Calculated based on a background screening value of 13 pCi/mL and 10% moisture.
[i] Units are pCi/mL.
[j] Maximum reported background concentration in soil.
[k] J- = Estimated quantity, biased low (see Appendix A).
[l] For silver, the detection limit is used as a background screening value.

TABLE 3.1.4-2

ESTIMATES OF RISK ASSOCIATED WITH ELEVATED PAHs AT THE PRSs 32-002(a) DRAIN LINE

CHEMICAL	SAL[a] (mg/kg)	AVERAGE CONCENTRATION[b] (mg/kg)	LIFETIME EXCESS CANCER RISK
Benzo(a)anthracene	0.61	1.17	2×10^{-6}
Benzo(a)pyrene	0.061	1.06	2×10^{-5}
Benzo(b)fluoranthene	0.61	1.57	3×10^{-6}
Benzo(k)fluoranthene	6.1	0.76	1×10^{-7}
Dibenzo(a,h)anthracene	0.061	0.21	3×10^{-6}
Indeno(1,2,3-cd)pyrene	0.61	0.48	8×10^{-7}
		TOTAL	3×10^{-5}

[a] SAL concentration is equivalent to 1×10^{-6} lifetime excess cancer risk for each COPC assuming residential land use.
[b] The average concentration represents the arithmetic average of concentrations at sample locations 32-06369, 32-06370, 32-06371, and 32-06374.

The total risk associated with elevated PAHs at PRS 32-002(a) is 3×10^{-5} (Table 3.1.4-2). However, because the drain line represents a narrow source of contamination, it would be reasonable to assume that the area of elevated PAHs would only be present over a small portion of the 500 m² residential exposure unit. As shown in Figure 3.1.4-1, these four sample locations could define a residential exposure unit approximately 90-ft long and, therefore, 50-ft wide. If the contaminants are conservatively assumed to travel laterally from the pipe 5 ft in each direction, the affected area would be one-fifth of the residential exposure unit. Using this assumption, the area-weighted risk associated with residual PAHs in this area is 6×10^{-6} for the reasonable maximum exposure. This risk level is within the acceptable risk range of 1×10^{-4} to 1×10^{-6} specified by the National Contingency Plan (NCP) and proposed in RCRA Subpart S (EPA 1990, 0559; EPA 1990, 1358).

PRS 32-002(b) Drain Line. A total of five confirmation soil samples were collected at 25-ft intervals in the base of the trench beneath the PRS 32-002(b) drain line. These samples were submitted for fixed-laboratory analysis for TAL metals, SVOCs, VOCs, isotopic plutonium, isotopic uranium, tritium, and gamma spectrometry.

The results from the confirmation samples were below SALs for all analytes except the PAHs benzo(a)pyrene and benzo(b)fluoranthene (Table 3.1.4-3). There is no archival evidence to indicate that PAHs were used or generated at the medical research laboratories that PRS 32-002(b) served. Therefore, it is highly unlikely that PAHs are attributable to releases from PRS 32-002(b). The mesa top where the PRS 32-002(b) drain line was located is covered by an asphalt parking lot associated with the current Los Alamos County Public Works Department Pavement Management Division. This parking lot covers the mesa top from the Public Works Department buildings to the edge of Los Alamos Canyon. Therefore, the PAHs detected at the site are likely a result of runoff and subsequent infiltration from this parking lot.

While PAHs at the site are not likely attributable to Laboratory activities, risk estimates were calculated based on the average benzo(a)pyrene and benzo(b)fluoranthene concentrations as a ratio to SAL. The results indicate that site levels of benzo(a)pyrene would be associated with a 3×10^{-6} lifetime cancer risk. Benzo(b)fluoranthene, which was detected at concentrations equal to SAL, would be associated with 1×10^{-6} lifetime cancer risk. Therefore, the overall lifetime cancer risk due to the presence of these PAHs at the site would be 4×10^{-6}. This risk level is within the acceptable risk range of 1×10^{-4} to 1×10^{-6} specified by NCP and proposed in RCRA Subpart S (EPA 1990, 0559; EPA 1990, 1358). Therefore, PAHs are eliminated as COPCs.

TABLE 3.1.4-3

RESULTS OF CONFIRMATION SAMPLING IN THE EXCAVATION OF THE PRS 32-002(b) DRAIN LINE

		LOCATION ID	32-06365	32-06366	32-06378	32-06377	32-06379
		SAMPLE ID	0132-96-0611	0132-96-0612	0132-96-0613	0132-96-0614	0132-96-0615
		DEPTH (in.)	0–3	0–3	0–6	0–6	0–3
ANALYTE	UTL	SAL					
ORGANICS (mg/kg)							
Acenaphthene	N/A[a]	360	0.38(U)[b]	0.69(U)	0.38(U)	0.35(U)	0.36(U)
Acetone	N/A	2 000	0.02(U)	0.02(U)	0.006(J)[c]	0.006(J)	0.003
Anthracene	N/A	19	0.38(U)	0.085(J)	0.38(U)	0.35(U)	0.36(U)
Benzoic acid	N/A	100 000	3.8(U)	6.9(U)	1.9(U)	0.076(J)	1.8(U)
Benzo[a]anthracene	N/A	0.61	0.38(U)	0.27(J)	0.38(U)	0.023(J)	0.36(U)
Benzo[a]pyrene	N/A	0.061	0.38(U)	0.3(J)	0.38(U)	0.03(J)	0.36(U)
Benzo[b]fluoranthene	N/A	0.61	0.38(U)	0.61(J)	0.38(U)	0.048(J)	0.36(U)
Benzo[g,h,i]perylene	N/A	n/a[d]	0.38(U)	0.13(J)	0.38(U)	0.045(J)	0.36(U)
Benzo[k]fluoranthene	N/A	6.1	0.38(U)	0.24(J)	0.38(U)	0.036(J)	0.36(U)
Bis(2-ethylhexyl)phthalate	N/A	32	0.38(U)	0.69	0.38(U)	0.059(J)	0.36(U)
Carbazole	N/A	22	0.38(U)	0.11	NA[e]	NA	NA
Chrysene	N/A	24	0.38(U)	0.48(J)	0.38(U)	0.075(J)	0.36(U)
Di-n-butyl phthalate	N/A	6 500	0.054(J)	0.77	0.38(U)	0.35(U)	0.36(U)
Dibenzofuran	N/A	260	0.38(U)	0.69(U)	0.38(U)	0.35(U)	0.36(U)
Dibenzo[a,h]anthracene	N/A	0.061	0.38(U)	0.69(U)	0.38(U)	0.35(U)	0.36(U)
Dichlorodifluoromethane	N/A	110	0.01(U)	0.01(U)	0.012(U)	0.002(J)	0.01(U)
Fluoranthene	N/A	2 600	0.38(U)	0.09	0.38(U)	0.09(J)	0.36(U)
Indeno[1,2,3-cd]pyrene	N/A	0.61	0.38(U)	0.14(J)	0.38(U)	0.026(J)	0.36(U)
Methylene chloride	N/A	11	0.003(J)	0.005(U)	0.012	0.014	0.008
Naphthalene	N/A	800	0.38(U)	0.69(U)	0.38(U)	0.35(U)	0.36(U)
Phenanthrene	N/A	n/a	0.38(U)	0.45(J)	0.38(U)	0.35(U)	0.36(U)
Pyrene	N/A	2 000	0.041(J)	1	0.38(U)	0.074(J)	0.36(U)
Toluene	N/A	1 000	0.005(U)	0.005(U)	0.006(U)	0.002(J)	0.005(U)
Trichlorofluoromethane	N/A	710	0.006	0.003(J)	0.006(U)	0.006(U)	0.005(U)
RADIONUCLIDES (pCi/g)							
Plutonium-239	0.092	24	0.039(J)[f]	0.011(U)	0.018[f]	0.016	0.003(U)[f]
Uranium-235	0.084	10	0.024[f]	0.026	0.022[f]	0.02	1.17(U)[f]
INORGANICS (mg/kg)							
Beryllium	1.05	n/a	0.74[f]	0.53	0.85(J)[f]	0.52(J)	0.19(J)[f]
Cadmium	2.7	38	0.6[f]	0.53	0.83(U)[f]	0.85(U)	0.8(U)[f]
Cobalt	19.2	4 600	4.4[f]	2.1	11(J)	3.6	2.4(U)[f]

TABLE 3.1.4-3 (CONTINUED)

RESULTS OF CONFIRMATION SAMPLING IN THE EXCAVATION OF THE PRS 32-002(b) DRAIN LINE

		LOCATION ID	32-06365	32-06366	32-06378	32-06377	32-06379
		SAMPLE ID	0132-96-0611	0132-96-0612	0132-96-0613	0132-96-0614	0132-96-0615
		DEPTH (in.)	0–3	0–3	0–6	0–6	0–3
ANALYTE	UTL	SAL					
INORGANICS (mg/kg)							
Copper	15.5	2 600	5.4[f]	5.3	6.5[f]	5.8	1.4(J)[f]
Lead	23.3	400	35.1[f]	7.8	20.1(J+)[f,g]	23.6(J+)	1.9
Mercury	0.1	23	5	0.11[f]	0.06(UJ)[h]	0.06(UJ)	0.05
Nickel	15.2	1 500	4.8[f]	3.2	5.6(J)[f]	3.3(J)	0(U)
Silver	NA	380	2.4[f]	2.1(U)	1.5(U)[f]	1.6(U)	1.5(U)[f]
Sodium	915	n/a	3 270[d]	1 000	1 770[d]	1 120(J)	405(J)
Thallium	1	5.4	1.5[f]	1.3	0.29(UJ)[f]	0.3(UJ)	0.22(U)
Vanadium	41.9	540	15.6[f]	9.5	9.3(J)[f]	11.1(J)	1.5(U)[f]
Zinc	50.8	23 000	76.7(J)[f]	54(J)	63.9[f]	49.1	45.2[f]

[a] N/A = Not applicable.
[b] U = Undetected quantity (see Appendix A).
[c] J = Estimated quantity (see Appendix A).
[d] n/a = Not available.
[e] NA = Not analyzed.
[f] Value represents the maximum of a sample concentration and its laboratory duplicate.
[g] J+ = Estimated quantity, biased high (see Appendix A).
[h] UJ = Estimated undetected quantity (see Appendix A).

3.1.5 Conclusions for the Drain Lines at PRSs 32-002(a,b)

The results of VCA confirmation sampling at the influent drain lines at PRSs 32-002(a,b) indicate that contaminants are not present at levels greater than cleanup levels or at levels that would pose an unacceptable human health risk in soils surrounding the drain lines.

3.2 Phase II and VCA Activities at the PRS 32-002(a) Septic Tank Footprint

3.2.1 Rationale for the Phase II Investigation at the PRS 32-002(a) Septic Tank Footprint

Phase I samples were collected on the hillside below PRS 32-002(a). Results from these samples indicate that chemicals may have passed through the septic system. Therefore, a Phase II investigation was recommended for the PRS 32-002(a) septic tank footprint to determine the nature and extent of any contamination associated with possible releases from

the former septic tank. The Phase II sampling and analysis plan was included in the RFI Report for TA-32, and it was updated in the Response to the NOD for TA-32 (LANL 1995, 06-0128; LANL 1996, 06-0148).

3.2.2 Phase II Field Investigation at the PRS 32-002(a) Septic Tank Footprint

Phase II field activities at the PRS 32-002(a) septic tank footprint began by establishing the location of the former septic tank based on archival engineering drawings and the location of the outfal pipe. Sampling was conducted in the septic tank footprint. A total of ten samples were collected from eight locations (Fig. 3.2.2-1). Four initial samples were collected at the corners of the septic tank footprint as specified in the Phase II sampling and analysis plan included in the RFI Report for TA-32 (LANL 1995, 06-0128). These samples were collected at depths of 0–12 in. and 0–18 in. using augers and disposable scoops. These samples were analyzed at an analytical laboratory for TAL metals and SVOCs, at the MCAL for PCBs, and at the MRAL for gross alpha, beta, and gamma radioactivity. Results indicated that gross alpha contamination and mercury were present in these samples. Therefore, four additional samples were collected just outside the septic tank footprint to bound the extent of the contamination. These samples were analyzed at the MCAL by x-ray fluorescence (XRF) for metals, and at the MRAL for gross alpha, beta, and gamma radioactivity.

3.2.3 Nature and Extent of Contamination at the PRS 32-002(a) Septic Tank Footprint

The Phase II investigation at the PRS 32-002(a) septic tank footprint indicated that mercury and gross alpha activity (likely associated with plutonium and uranium) were present at a depth of 18 in. bgs within a 12-ft x 8-ft area. Screening results from the MRAL indicate that alpha radioactivity was present at levels ranging from 7.24–48.6 pCi/g, relative to a minimum detectable activity of 13.60 pCi/g. XRF results indicate that mercury was present at levels ranging from undetectable to approximately 37.2 mg/kg, relative to a SAL of 23 mg/kg. The extent of contamination is bounded by sample locations 32-06341, 32-1002, 32-1036, 32-06343, and 32-06362 (Table 3.2.3-1).

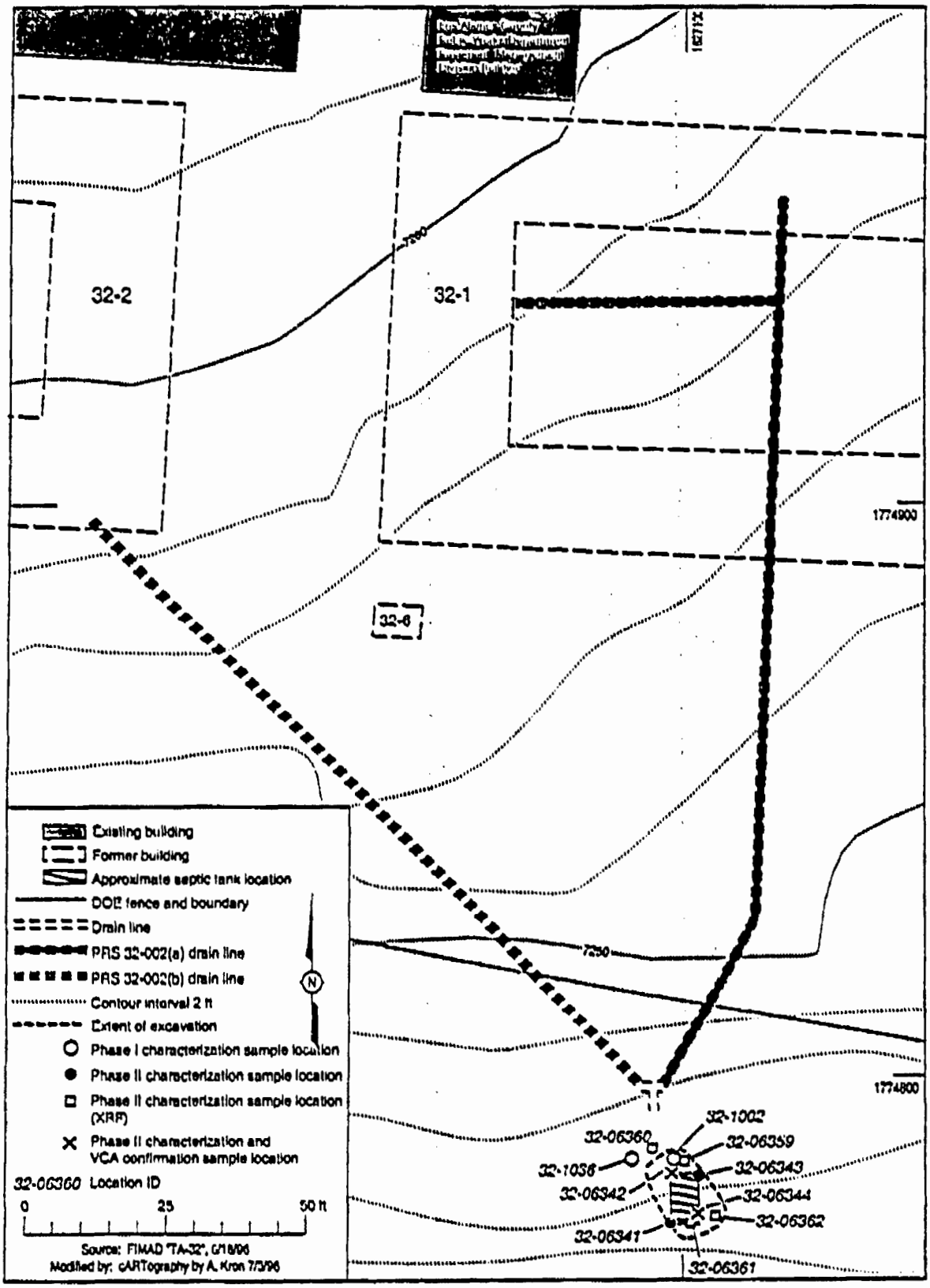

Fig. 3.2.2-1. Locations of samples collected at the PRS 32-002(a) septic tank footprint.

TABLE 3.2.3-1

RESULTS FOR CHARACTERIZATION SAMPLES AT THE PRS 32-002(a) SEPTIC TANK FOOTPRINT

LOCATION ID	SAMPLE ID	DEPTH (in.)	FIXED LABORATORY MERCURY RESULTS (mg/kg)	MCAL MERCURY RESULTS[a] (mg/kg)	MRAL GROSS ALPHA RADIOACTIVITY RESULTS[b] (pCi/g)
		SAL	23	N/A[c]	N/A
		UTL	0.1	N/A	N/A
32-06341	0132-96-0138	0-18	11.6	NA[d]	12.41
32-06342	0132-96-0139	0-18	25.3	NA	11.38
32-06343	0132-96-0140	0-13	3.7	NA	7.24
32-06344	0132-96-0141	0-12	37.2	NA	24.82
32-06359	0132-96-0551	2-8	NA	<5	7.24
32-06360	0132-96-0552	2-8	NA	10.7	13.44
32-06361	0132-96-0553	2-8	NA	24.3	48.6
32-06362	0132-96-0554	2-8	NA	<5	10.34
32-1036	AAA1285	0-4	6.5[e]	NA	NA
32-1002	AAA4691	4-6	14[e]	NA	NA

[a] Results for mercury from the mobile chemistry analytical laboratory using x-ray fluorescence for metals.
[b] Results for gross alpha activity from the mobile radiological analytical laboratory.
[c] N/A = Not applicable.
[d] NA = Not analyzed.
[e] Result is the maximum of triplicate analyses.

3.2.4 Remedial Activities at the PRS 32-002(a) Septic Tank Footprint

3.2.4.1 Rationale for the VCA at the PRS 32-002(a) Septic Tank Footprint

The Phase II investigation at the PRS 32-002(a) septic tank footprint indicated the presence of elevated levels of mercury and gross alpha radioactivity. MRAL results indicated that alpha radioactivity was present at levels ranging from 7.24–24.82 pCi/g, relative to a minimum detectable activity of 13.60 pCi/g. XRF and fixed-laboratory results indicated that mercury was present at levels ranging from undetectable to approximately 37.2 mg/kg, relative to a SAL of 23 mg/kg. Because mercury was present at levels greater than SAL and the site offered easy access and unconsolidated material for excavation, the contaminated material was removed from the PRS 32-002(a) septic tank footprint area.

3.2.4.2 Cleanup Level Derivation for the PRS 32-002(a) Septic Tank Footprint

SALs were used as cleanup levels for the COPCs identified at the site because the nature of the site and the cleanup methodology made these reasonably achievable goals. The SAL of 23 mg/kg was selected as a cleanup level for mercury. The SALs for plutonium-239 (24 pCi/g), uranium-234 (13 pCi/g), uranium-235 (10 pCi/g), and uranium-238 (67 pCi/g) were selected as cleanup levels to address the gross alpha radioactivity detected at the site.

3.2.4.3 Remedial Implementation at the PRS 32-002(a) Septic Tank Footprint

Remedial activities conducted at the PRS 32-002(a) septic tank footprint included excavation and removal of contaminated soil. The results from Phase II characterization samples indicated that contamination was present at depths less than 18 in. bgs. Therefore, the footprint area was excavated to a depth of approximately 18 in. bgs. The lateral boundary of the excavation measured 12 ft x 8 ft and encompassed the Phase II sampling locations (Fig. 3.2.2-1). Approximately 4 yd^3 of soil were removed from the footprint area. The excavated material was placed in a B-25 box for disposal.

Restoration activities included backfilling the excavation with clean fill material obtained from the Los Alamos County landfill stockpile. The fill was compacted using the backhoe bucket, and native grass seed and mulch were distributed over the area.

3.2.4.4 Confirmation Sampling at the PRS 32-002(a) Septic Tank Footprint

Two confirmation samples and one duplicate sample were collected from the base of the excavation (Fig. 3.2.2-1). These samples were sent to an analytical laboratory to confirm that the cleanup goals of the VCA were achieved. The samples were analyzed for TAL metals, isotopic plutonium, isotopic uranium, and gamma spectrometry. The results from the confirmation samples show that no elevated levels of mercury or radioactive contamination remain at the site (Table 3.2.4-1).

3.2.5 Conclusions for the PRS 32-002(a) Septic Tank Footprint

The results of VCA confirmation sampling at the PRS 32-002(a) footprint indicate that no elevated levels of COPCs remain at the site. Therefore, the VCA was successful in removing all contamination greater than cleanup levels from the site.

TABLE 3.2.4-1

RESULTS OF CONFIRMATION SAMPLING AT THE PRS 32-002(a) SEPTIC TANK FOOTPRINT

		LOCATION ID	32-06344	32-06342	32-06342
		SAMPLE ID	0132-96-0801	0132-96-0802	0132-96-0807
		DEPTH (in.)	0–6	0–6	0–6
ANALYTE	UTL	SAL			
INORGANICS (mg/kg)					
Aluminum	38 700	77 000	24 00	3 200	3 900
Arsenic	7.82	n/a[a]	1.4	2.2	1.8
Barium	315	5 300	42	42	40
Cadmium	2.7	38	2.1	0.54 (U)[b]	0.53
Calcium	6 120	n/a	890	1 300	980
Chromium	19.3	211	16	9.8	9.1
Cobalt	19.2	4 600	1.4	1.8	1.8
Copper	15.5	2 800	12	6	5.1
Iron	21 300	n/a	4 200	4 500	5 200
Lead	23.3	400	61	32	31
Magnesium	4 610	n/a	270	480	520
Manganese	714	n/a	180	120	140
Mercury	0.1	23	9.4	5.9	8.3
Nickel	15.2	1 500	4	2.8	2.9
Potassium	3410	n/a	410	430	490
Sodium	915	n/a	290	230	220
Vanadium	41.9	540	7.9	7.7	7.9
Zinc	50.8	23 000	67	39	32
RADIONUCLIDES (pCi/g)					
Plutonium-238	0.014	27	–0.002	0.002	0.002
Plutonium-239/240	0.052	24	0.495	0.134	0.159
Uranium-234	1.94	13	1.4	1.3	1.3
Uranium-235	0.084	10	0.07	0.06	0.06
Uranium-238	1.82	67	1.5	1.5	1.5

[a] n/a = Not available.
[b] U = Undetected.

3.3 Phase II and VCA Activities in the Outfall Area at PRSs 32-002(a,b)

3.3.1 Rationale for the Phase II Investigation in the Outfall Area at PRSs 32-002(a,b)

Phase I samples were collected in the outfall area at PRSs 32-002(a,b). Analytical results from these samples indicated that mercury, manganese, lead, chromium, and Aroclor 1260™ were present at concentrations greater than SALs. A Phase II investigation was therefore recommended to further define the nature and extent of contamination in the outfall area. To determine whether remediation of the outfall area would be required, a full screening assessment and human health risk assessment were conducted.

3.3.2 Phase II Field Investigation in the Outfall Area at PRSs 32-002(a,b)

The Phase II sampling and analysis plan was included in the RFI Report for TA-32 (LANL 1995, 06-0128). The objective of the Phase II investigation in the outfall area at PRSs 32-002(a,b) was to characterize the presence of radionuclides and determine the lateral and vertical extent of inorganics and PCB contamination. To characterize the nature and extent of radiological and inorganics contamination, 29 samples were collected from 29 locations at depths of 0–10 in. Each sample was screened by XRF for metals and analyzed for tritium and gross alpha, beta, and gamma radiation at the MRAL. Data from these samples were then used to select sampling locations for fixed-laboratory analyses. Samples for fixed-laboratory analyses were selected from areas with elevated concentrations of metals and gross beta radioactivity. To bound the extent of contamination, samples for fixed-laboratory analyses were also selected from areas with no elevated concentrations of metals and radioactivity.

Twelve samples were collected from nine of the initial 29 locations for fixed-laboratory analysis for TAL metals, SVOCs, isotopic plutonium, isotopic uranium, americium-241, and tritium (Fig. 3.3.2-1). Ten of these samples were collected from a depth of 6–12 in., and two were collected from a depth of 15–22 in.

To characterize the extent of PCB contamination, 5 samples were collected from 5 locations at depths up to 8 in. bgs (Fig. 3.3.2-1). These samples were analyzed for PCBs in the MCAL. PCBs were not detected in any of the five samples.

The following sections discuss the background comparison and screening assessment for the Phase I and Phase II characterization data. Because PCBs were not detected in any sample, PCBs are not included in the screening assessment.

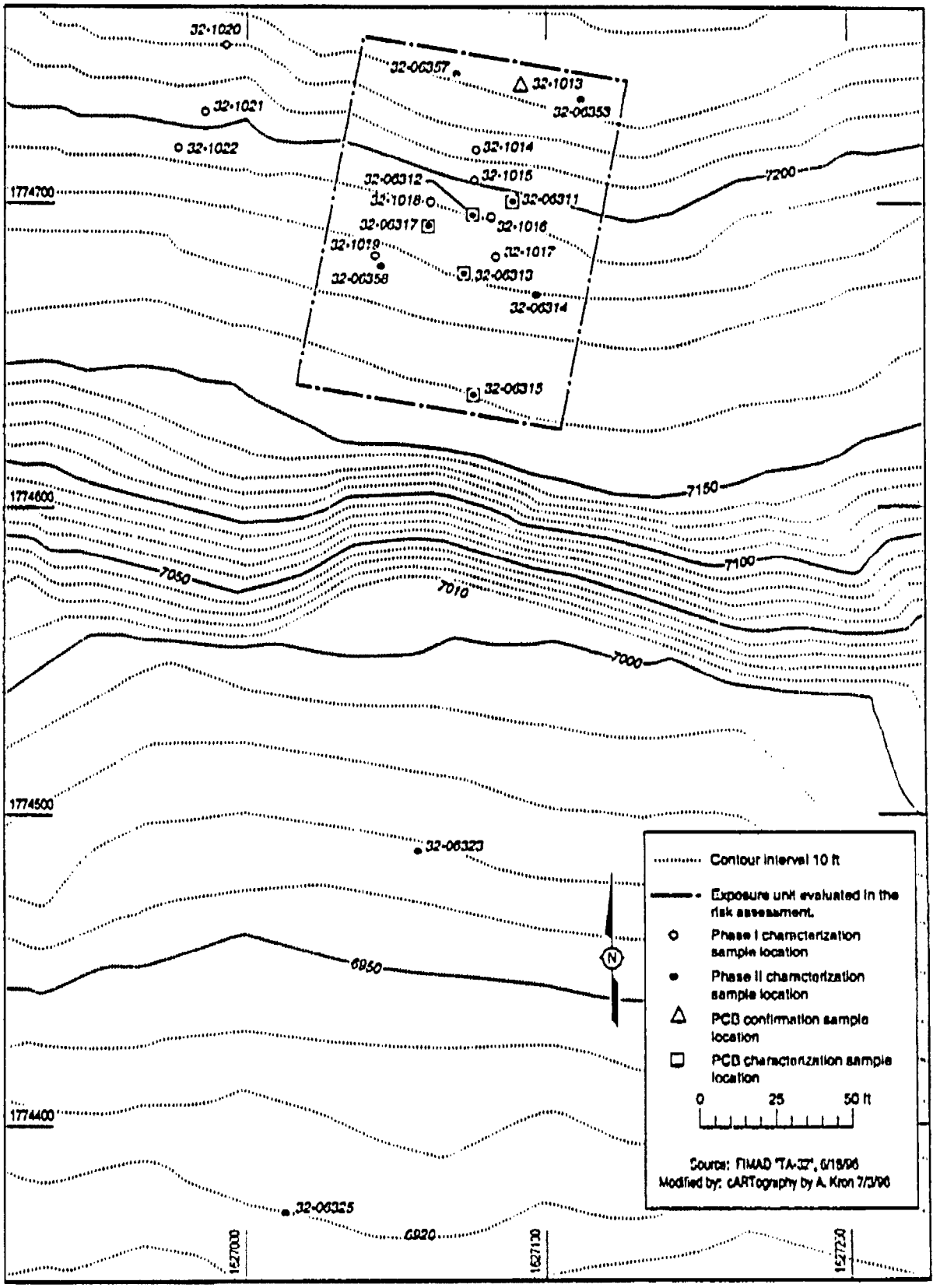

Fig. 3.3.2-1. Locations of samples collected in the outfall area at PRSs 32-002(a,b).

3.3.3 Background Comparisons for Characterization Samples in the Outfall Area at PRSs 32-002(a,b)

Inorganics. Twelve soil samples collected during the Phase II investigation of the outfall area at PRSs 32-002(a,b) were analyzed for TAL metals. Some of these analyses included one or more laboratory duplicates. For the purposes of this screening assessment, the highest detected value was used for samples where a laboratory duplicate was analyzed. In addition, six soil samples collected during the Phase I investigation of the outfall area and analyzed for TAL metals were included in the background comparison.

Twelve inorganics were detected above their background screening values in at least one sample: arsenic, barium, cadmium, chromium, cobalt, copper, lead, mercury, silver, thallium, vanadium, and zinc. No further background comparisons are performed for cadmium, mercury, silver, and thallium because the background data for these metals are inadequate to support other statistical tests. Therefore, these four metals are carried forward to the screening assessment.

Further background comparisons were performed for arsenic, barium, chromium, cobalt, copper, lead, vanadium, and zinc. These comparisons were conducted according to "Application of LANL Background Data to ER Project Decision-Making" (Ryti et al. 1996, 1298). The data for these metals do not appear to satisfy normality assumptions; therefore, nonparametric tests were used for further background comparisons. The Gehan modification to the Wilcoxon Rank Sum test and the Quantile test were used for these evaluations. The Gehan test is best suited for assessing complete shifts in distribution, whereas the Quantile test is better suited for assessing partial shifts. These two tests can detect most types of differences between distributions. Observed significance levels (P-values) for these tests are presented in Table 3.3.3-1. If a P-value is less than some small probability, typically 0.05, 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 for arsenic, barium, cobalt, and vanadium are indicative of site concentrations that are not statistically elevated above background. However, the results for chromium, copper, lead, and zinc are indicative of site concentrations that are greater than background.

Based on the background comparisons and further statistical tests performed to compare site and background data, cadmium, chromium, copper, lead, mercury, silver, thallium, and zinc are carried forward to the screening assessment. The concentrations for each sample that has at least one value above background screening values for these analytes are presented in Table 3.3.3-2.

TABLE 3.3.3-1

STATISTICAL TESTS FOR BACKGROUND COMPARISON FOR CHARACTERIZATION SAMPLES FROM THE OUTFALL AREA AT PRSs 32-002(a,b)

ANALYTE	GEHAN TEST P-VALUE	QUANTILE TEST P-VALUE
Arsenic	0.99	0.49
Barium	1	0.99
Chromium	0.31	0.012
Cobalt	1	1
Copper	0.20	0.041
Lead	<0.0005	<0.0005
Vanadium	1	0.98
Zinc	<0.0005	<0.0005

Radionuclides. Twelve soil samples collected during the Phase II RFI of the outfall area at PRSs 32-002(a,b) were analyzed for americium-241, isotopic plutonium, isotopic uranium, and tritium. Some analyses included one or more laboratory duplicates. The highest detected value for these samples and duplicates was used in this screening assessment.

Six radionuclides were detected above their background screening values: americium-241, cesium-137, plutonium-239, uranium-234, uranium-235, and uranium-238. These radionuclides are carried forward to the screening assessment. The data for these six radionuclides are presented in Table 3.3.3-3.

Evaluation Of Organics. Twelve soil samples collected during the Phase II investigation of the outfall area at PRSs 32-002(a,b) were analyzed for organics. In addition, six soil samples collected during the Phase I investigation and analyzed for organics are included in this evaluation. Two organics, bis(2-ethylhexyl)phthalate and di-n-butyl phthalate, were detected in one or more of these samples. These two chemicals are carried forward to the screening assessment. The data for these chemicals are presented in Table 3.3.3-4.

TABLE 3.3.3-2

INORGANICS WITH CONCENTRATIONS ABOVE BACKGROUND SCREENING VALUES IN CHARACTERIZATION SAMPLES FROM THE OUTFALL AREA AT PRSs 32-002(a,b)

LOCATION ID	SAMPLE ID	DEPTH (ft)	CADMIUM (mg/kg)	CHROMIUM (mg/kg)	COPPER (mg/kg)	LEAD (mg/kg)	MERCURY (mg/kg)	SILVER (mg/kg)	THALLIUM (mg/kg)	ZINC (mg/kg)
UTL	N/A[a]	N/A	2.6[b]	19.3	15.5	23.3	0.1[b]	n/a[c]	1[b]	50.8
SAL	N/A	N/A	38	210	2 800	400	23	380	5.4	23 000
32-06325	0132-96-0321	0–6	0.536[d]	24.0[d]	9.2(J+)[d,e]	84.0[d]	12	6.14[d]	2.1(U)[d,f]	52.9[d]
32-06323	0132-96-0322	0–6	0.59(U)	2.4	4.7(J+)	18	0.12(U)	2.4(U)	2.4(U)	44
32-06313	0132-96-0323	0–6	1	84	31(J+)	200	42	19	2.1(U)	190
32-06313	0132-96-0324	15–22	0.51(U)	9.1	3(J+)	11	NA[g]	4	2(U)	29
32-06312	0132-96-0325	0–6	1.9	77	27(J+)	220	48[h]	21	2.1(U)	110
32-06312	0132-96-0326	6–12	0.52(U)	7.2	6.2(J+)	37	6.4	3.1	2.1(U)	37
32-06315	0132-96-0327	0–6	0.53(U)	16	5.3(J+)	58	4.3	2.1	2.1(U)	45
32-06353	0132-96-0751	0–6	0.51(U)	3	7.1	43(J-)	0.2[d]	2(U)	1.3(U)	57(J-)
32-06357	0132-96-0752	0–6	0.303[d]	6.30[d]	6.79[d]	40.6(J-)[d]	1.4	2(U)[d]	1.3(U)[d]	43.1(J-)[d]
32-06358	0132-96-0754	0–6	0.5(U)	1.8	3.1	15(J-)	0.49	2(U)	1.3(U)	38(J-)
32-06314	0132-96-0755	0–6	0.5(U)	1.5	2.6	9.3(J-)	0.2	2(U)	1.3(U)	21(J-)
32-1014	AAA4703	0–4	1.5	37	16	150	17(J)[d]	7	0.3	73
32-1015	AAA4704	0–4	3	100	38	450	51(J)[d]	28	0.6	170
32-1016	AAA4705	0–5	5.6	440	170	1 600	303(J)[d]	150	2.4	320
32-1017	AAA4706	0–6	0.6	58	17	200	17[d]	12	<0.1	140
32-1018	AAA4707	0–15	0.4	8.6	4.3	46	<0.1[d]	2.6	<0.1	50

[a] N/A = Not applicable.
[b] The maximum value in the background range was used as a background screening value.
[c] n/a = No background value is available. The detection limit was used as a background screening value.
[d] Value represents the maximum of a sample concentration and its laboratory duplicate.
[e] J+ = Estimated quantity, biased high (see Appendix A).
[f] U = Undetected quantity (see Appendix A).
[g] NA = Not analyzed.
[h] Values in bold exceed the SAL.
[i] J- = Estimated quantity, biased low (see Appendix A).

TABLE 3.3.3-3

RADIONUCLIDES WITH CONCENTRATIONS ABOVE BACKGROUND SCREENING VALUES IN CHARACTERIZATION SAMPLES FROM THE OUTFALL AREA AT PRSs 32-002(a,b)

LOCATION ID	SAMPLE ID	DEPTH (in.)	AMERICIUM-241 (pCi/g)	CESIUM-137 (pCi/g)	PLUTONIUM-239 (pCi/g)	URANIUM-234 (pCi/g)	URANIUM-235 (pCi/g)	URANIUM-238 (pCi/g)
UTL	N/A[a]	N/A	0.336[b]	1.7[b]	0.092[b]	1.94	0.084	1.82
SAL	N/A	N/A	22	5.1	24	13	10	67
32-06325	0132-96-0321	0–6	0.228(J)[c,d]	NA[e]	1.7(U)[c,f]	1.66[c]	0.073(U)[c]	1.73[c]
32-06323	0132-96-0322	0–6	0.04(UJ)[g]	NA	0.389(U)	1.35	0.065(U)	1.47
32-06313	0132-96-0323	0–6	1.07(J)	NA	3.76(U)	3.55	0.126(U)	3.04
32-06312	0132-96-0325	0–6	0.929(J)	NA	5(U)	1.96	0.075(U)	1.68
32-06312	0132-96-0326	6–12	0(UJ)	NA	0.356(U)	0.81	0.027(U)	0.592
32-06315	0132-96-0327	0–6	0.077(UJ)	NA	0.613(U)	0.937	0.034(U)	0.816
32-06353	0132-96-0751	0–6	0.31(U)[c]	1.7[c]	0.091[c]	1.8[c]	0.086(J)[c]	2.04[c]
32-06357	0132-96-0752	0–6	0.34(U)	2.56	0.916	3.2	0.16(J)	3.8
32-06358	0132-96-0754	0–6	0.28(U)	0.61	0.108	1.5	0.06(J)	1.4
32-06314	0132-96-0755	0–6	0.29(U)	0.58	0.099	1.4	0.07(J)	1.8

[a] N/A = Not applicable.
[b] Value represents the maximum reported background concentration in soil from LANL *Environmental Surveillance Reports* (Purtymun et al. 1997, 0211; ESG 1988, 0408; ESG 1989, 0308; Environmental Protection Group 1990, 0497; Environmental Protection Group 1992, 0740).
[c] Value represents the maximum of a sample concentration and its laboratory duplicate.
[d] J = Estimated quantity (see Appendix A).
[e] NA = Not analyzed.
[f] U = Undetected quantity (see Appendix A).
[g] UJ = Estimated undetected quantity (see Appendix A).

TABLE 3.3.3-4

ORGANIC COMPOUNDS DETECTED IN CHARACTERIZATION SAMPLES FROM THE OUTFALL AREA AT PRSs 32-002(a,b)

LOCATION ID	SAMPLE ID	DEPTH (in.)	BIS(2-ETHYLHEXYL) PHTHALATE (mg/kg)	DI-N-BUTYL PHTHALATE (mg/kg)
SAL	N/A[a]	N/A	32	6 500
32-1015	AAA4704	0–4	5.5	<0.33
32-1016	AAA4705	0–5	<0.33	0.92
32-1017	AAA4706	0–6	<0.33	1.7
32-1018	AAA4707	0–15	<0.33	2.2
32-1019	AAA4708	0–15	<0.33	2.9

[a] N/A = Not applicable.

3.3.4 Screening Assessment for Characterization Samples in the Outfall Area at PRSs 32-002(a,b)

This section discusses the comparison with SALs for COPCs detected at levels greater than background screening levels in the Phase II investigation of the outfall area at PRSs 32-002(a,b). Eight inorganics (cadmium, chromium, copper, lead, mercury, silver, thallium, and zinc), six radionuclides (americium-241, cesium-137, plutonium-239, uranium-234, uranium-235, and uranium-238), and two organic compounds [bis(2-ethylhexyl)phthalate and di-n-butyl phthalate] were detected at levels above background screening values.

Greater than or equal to SAL. Three chemicals, total chromium, lead, and mercury, were detected at concentrations greater than their SALs.

No SAL. All chemicals carried forward to the screening assessment have SALs.

Less than SAL. Thirteen chemicals were detected at concentrations less than their SALs: cadmium, copper, silver, thallium, zinc, bis(2-ethylhexyl) phthalate, di-n-butyl phthalate, americium-214, cesium-137, plutonium-239, uranium-234, uranium-235, and uranium-238.

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, radiological, or noncarcinogenic). Because there is only one carcinogen, bis(2-ethylhexyl)phthalate, a multiple chemical evaluation is not conducted for this category. SALs for all chemicals were normalized and summed as described in Section 3.0 of the RFI Report (LANL 1995, 06-0128). The results of the analysis are shown in Table 3.3.4-1.

TABLE 3.3.4-1

MULTIPLE CHEMICAL EVALUATION FOR PHASE II CHARACTERIZATION SAMPLES IN THE OUTFALL AREA AT PRSs 32-002(a,b)

CHEMICAL	SAMPLE VALUE (mg/kg)	SAL (mg/kg)	NORMALIZED VALUE
SAL BASED ON RADIOLOGICAL EFFECTS			
Americium-241	1.07	22	0.05
Cesium-137	2.56	5.1	0.5
Plutonium-239	0.92	24	0.04
Uranium-234	3.55	13	0.27
Uranium-235	0.16	10	0.02
Uranium-238	3.8	67	0.06
NORMALIZED SUM			0.94
SAL BASED ON NONCARCINOGENIC EFFECTS			
Cadmium	5.6	38	0.15
Copper	170	2 800	0.06
Di-n-butyl phthalate	2.9	6 500	0.004
Silver	150	380	0.39
Thallium	2.4	5.4	0.44
Zinc	320	23 000	0.01
NORMALIZED SUM			1.1

The results of the radiological multiple chemical evaluation are less than one, indicating that adverse human health effects are unlikely. Therefore, these radionuclides are eliminated as COPCs. The results of the multiple chemical evaluation based on noncarcinogenic effects are slightly greater than one, indicating that adverse human health effects may be possible. Those chemicals contributing more than 0.1 to the normalized sum (cadmium, silver, and thallium) are carried forward to the risk assessment. All other chemicals with concentrations below their SALs are eliminated as COPCs.

At the conclusion of this screening assessment, three chemicals with concentrations greater than SALs (total chromium, lead, and mercury) and three chemicals with concentrations less than SALs (cadmium, silver, and thallium) are carried forward to the risk assessment.

3.3.5 Risk Calculations for the Outfall Area at PRSs 32-002(a,b)

A human health risk assessment was conducted on the characterization data from the outfall area at PRSs 32-002(a,b) to determine whether adverse human health effects were likely for recreational users of the outfall area. Because the outfall area is a steep cliff (38°–74°), it is highly unlikely to be developed for residential use (see Section 3.3.5.2.1). Therefore, residential use of the outfall area was not considered. The risk was calculated for the most likely exposure (MLE) and the reasonable maximum exposure (RME) in the recreational scenario. The exposure concentrations for the MLE used the average of the sample values; the exposure concentrations for the RME used the 95% upper confidence limit (UCL) of the mean of the sample values. The results indicate that potential exposure to COPCs in the soil in the outfall area at PRSs 32-002(a,b) should not result in unacceptable carcinogenic risk or adverse noncarcinogenic health effects at the MLE or RME.

The human health risk assessment presented here follows the process outlined in the policy document "Risk-Based Corrective Action Process" (Dorries 1996, 1297). The human health risk assessment process consists of four steps: review of COPCs, exposure assessment, toxicity assessment, and risk characterization.

3.3.5.1 Review of COPCs and Extent of Contamination for the Outfall Area at PRSs 32-002(a,b)

The screening assessment for PRS 32-002(a,b) identified six COPCs, three detected at levels greater than SALs (total chromium, lead, and mercury), and three detected at levels less than SALs (cadmium, silver, and thallium).

The risk assessment addressing the elevated inorganics is based on laboratory analytical data from an exposure unit located above the main topographic break in the hill slope (Fig. 3.3.5-1). This area was selected to assess exposure for two reasons.

First, the XRF screening data and laboratory analytical data both indicate that COPC concentrations are higher in the area above the topographic break. For example, screening results using XRF for metals indicated that mercury was present in the upper portion of the outfall area at concentrations ranging from approximately 6.12–49 mg/kg. XRF measurements in the lower portion of the outfall area were much lower, ranging from approximately 5.55– 7.05 mg/kg. Laboratory analytical data confirm that mercury is present at levels greater than the SAL (23 mg/kg) only in the upper portion of the outfall area. Additionally, laboratory analytical data indicate that the highest lead concentrations were detected in the upper portion of the outfall area. The highest detected lead concentration, 1 600 mg/kg, was used to evaluate the human health risk associated with the presence of lead in the outfall area.

Second, the area above the topographic break is proximal to the mesa top, and is expected to have the greatest likelihood for recreational use. Therefore, the risk assessment conducted using data from the area above the main topographic break represents a worst-case risk calculation for recreational use of the entire outfall area.

3.3.5.2 Exposure Assessment for the Outfall Area at PRSs 32-002(a,b)

Exposure assessment is the process of quantifying the exposure to a chemical by measuring or estimating the intensity, frequency, and duration of exposure. The principal elements of exposure assessment include:

- characterization of physical setting,
- identification of potentially exposed populations and exposure scenarios,
- identification of potential exposure pathways,
- calculation or measurement of exposure point concentrations, and
- estimation of potential chemical intake.

Each of these steps is described in the following sections.

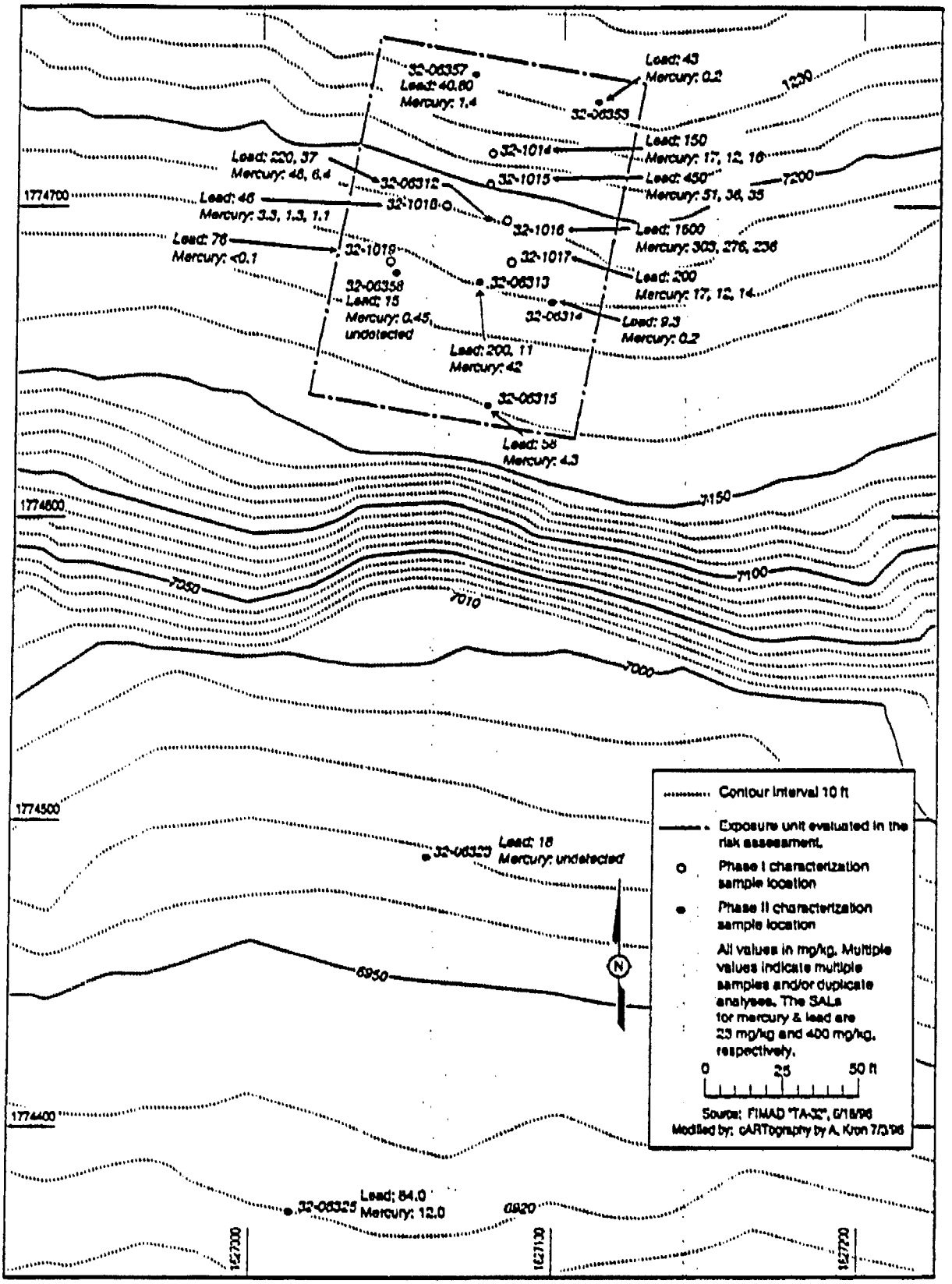

Fig. 3.3.5-1. Analytical results for lead and mercury in the outfall area at PRSs 32-002(a,b).

3.3.5.2.1 Characterization of Physical Setting for the Outfall Area at PRSs 32-002(a,b)

The outfall area for PRSs 32-002(a,b) is situated on a steep canyon slope behind the Los Alamos County Public Works Department Pavement Management Division. The entire outfall area is located on Department of Energy (DOE) property. The upper portion of the outfall area is a steep slope (38°), and the middle portion is a steep cliff (74°) that forms a topographic break on the hillside. The lower portion fans out to a gentle slope (24°). Because of the steepness of the terrain, the outfall area might be used for hiking or climbing, but it is highly unlikely to be developed for residential use.

3.3.5.2.2 Identification of Potentially Exposed Populations and Exposure Scenarios for the Outfall Area at PRSs 32-002(a,b)

Identification of potentially exposed populations requires investigation of the circumstances under which individuals may come into contact with COPCs at the site. Because of the site topography, the potentially exposed population would likely be hikers and rock climbers. Therefore, the recreational scenario will be used to evaluate the actual exposure case. The exposure parameters of the recreational scenario are listed in Appendix D and explained in detail in the guidance document "Risk-Based Corrective Action Process" (Dorries, 1996, 1297).

3.3.5.2.3 Identification of Potential Exposure Pathways for the Outfall Area at PRSs 32-002(a,b)

Exposure pathways are the mechanisms through which an individual may come into contact with a chemical in the environment. Exposure pathways are influenced by environmental conditions, the potential for the chemical to move from one medium (e.g., soil, water, or air) to another, and the general lifestyles and/or work activities of the potentially exposed population (e.g., hiking, gardening). Although many potential pathways are possible, only a few may be complete. For a pathway to be complete, each of the following elements must exist:

- a source and mechanism for chemical release into the environment (e.g., air, water, or soil),
- a point of contact with the environment,
- an exposure route at the contact point (e.g., inhalation, ingestion, or dermal contact), and
- a receptor.

COPCs at PRSs 32-002(a,b) are in the surface to near-surface soil or sediments, and complete pathways are possible.

A conceptual exposure model is presented in the RFI Work Plan for TA-32 (LANL 1992, 0783). The following potential human exposure pathways are identified:

- incidental ingestion of soil,
- dermal contact with soil, and
- inhalation of fugitive dust.

These exposure pathways were evaluated for the recreational exposure scenario in this risk assessment.

3.3.5.2.4 Calculation or Measurement of Exposure Point Concentrations for the Outfall Area at PRSs 32-002(a,b)

The outfall area for PRSs 32-002(a,b) is a steep slope that descends to a cliff and then fans out to a gentle slope near the canyon bottom. The cliff section forms a topographic break such that the outfall area can be considered as upper and lower portions. Analytical data for the outfall area indicate that COPC concentrations are higher in the portion above the topographic break than below the break. Therefore, the results of the risk assessment on the data for the upper portion of the outfall area will represent a worst case for recreational use of the entire outfall area at PRSs 32-002(a,b). Statistics and concentrations used in the risk assessment are presented for each COPC in Appendix D.

3.3.5.2.5 Estimation of Potential Chemical Intake for the Outfall Area at PRSs 32-002(a,b)

The health hazards associated with exposure to a COPC are proportional to the amount of the COPC taken up by the body (i.e., the dose). Intake of COPCs is calculated for each of the potentially complete pathways included in the recreational scenarios in a deterministic manner as described in "Risk Assessment Guidance for Superfund, Part A" (EPA 1989, 0305).

Because the toxicity endpoints for lead are specific to children, lead was evaluated using the Integrated Exposure Uptake Biokinetic (IEUBK) Model. The IEUBK Model estimates lead uptake and resultant blood lead concentrations in children (EPA 1994, 1178). To determine if lead soil concentrations in the outfall area posed undue risk to children potentially using the site for recreational activities, lead uptake from soil ingestion due to recreational activities at the site was added to modeled lead uptake for a resident child. The model default values for food ingestion, water ingestion, and air concentration were used because no representative site-specific data were available.

Specific exposure parameters relating to the recreational scenario are shown in Appendix D. The MLE scenario assumes that a person would be hiking outdoors at the site for 2 hours per day for 10 days per year for nine years. The RME scenario assumes that a person would be hiking outdoors at the site for 2 hrs per day for 170 days per year for 30 years. The scenario used in the IEUBK model assumes a child would be outside at the site for 2 hrs per day for 170 days per year for 7 years.

3.3.5.3 Toxicity Assessment for the Outfall Area at PRSs 32-002(a,b)

The purpose of the toxicity assessment is to present information regarding the potential for COPCs to cause adverse health effects in exposed individuals. An additional purpose is to provide an estimate of the relationship between the extent of exposure to a chemical and the increased likelihood and/or severity of adverse health effects. The EPA has derived reference doses to define a level of exposure that would not be associated with adverse effects throughout a lifetime. This information is presented in detail in the toxicity profiles for each of the COPCs included in Appendix D.

Six COPCs were retained at this site: cadmium, total chromium, lead, mercury, silver, and thallium. Cadmium is classified as a probable human carcinogen. Chromium is classified as a known human carcinogen in the form of chromium VI, but as a noncarcinogen in the form of chromium III. Appendix D presents the apportioning of total chromium as 1 part chromium VI and 6 parts chromium III. The remaining COPCs (lead, mercury, silver, and thallium) are classified as noncarcinogens. Therefore, cadmium and total chromium are evaluated for potential carcinogenic risk as well as potential noncarcinogenic adverse health effects, and the remaining COPCs are evaluated for their potential noncarcinogenic adverse health effects.

3.3.5.4 Risk Characterization for the Outfall Area at PRSs 32-002(a,b)

Risk characterization is the final step in the risk assessment process. Toxicity and exposure assessments are summarized and integrated into quantitative and qualitative expressions of risk. To characterize potential carcinogenic effects, probabilities that an individual will develop cancer over a lifetime of exposure are estimated from projected intakes and chemical-specific dose-response information. To characterize potential noncarcinogenic effects, comparisons are made between projected intakes of COPCs and toxicity values including reference doses. Major assumptions, scientific judgments, and estimates of the uncertainties embodied in the assessment are also presented.

3.3.5.4.1 Characterization of Carcinogenic Risk for the Outfall Area at PRSs 32-002(a,b)

Carcinogenic risks are estimated as the incremental probability of an individual developing cancer as the result of exposure to a carcinogen. Cadmium and chromium VI are the only chemicals evaluated in this risk assessment for carcinogenicity. Both cadmium and chromium VI are carcinogenic only via the inhalation pathway. Therefore, the cancer risk via the inhalation exposure pathway is the estimate of the total excess cancer risk for the exposed individual. Cancer risk for the MLE and RME in the recreational scenario is summarized in Table 3.3.5-1. The risk estimates range from a high of 1×10^{-6} (1 in one million) under the RME to a low of 4×10^{-9} (4 in one billion) under the MLE. This risk level is within the acceptable risk range of one in ten thousand to one in one million specified by the NCP and proposed in RCRA subpart S (EPA 1990, 0559; EPA 1990, 1358). These results indicate that cadmium and chromium VI concentrations in the soil should not pose an unacceptable cancer risk to current and future recreational users.

3.3.5.4.2 Characterization of Noncarcinogenic Effects for the Outfall Area at PRSs 32-002(a,b)

Human health risks associated with soil ingestion, dust inhalation, and dermal contact with soil were calculated for cadmium, total chromium, lead, mercury, silver, and thallium. A hazard quotient of one is used to evaluate potential noncarcinogenic health risk from exposure. At this

TABLE 3.3.5-1

CANCER RISK FOR THE RECREATIONAL SCENARIO IN THE OUTFALL AREA AT PRSs 32-002(a,b)

	INHALATION OF FUGITIVE DUST	PERCENT CONTRIBUTION
MOST LIKELY EXPOSURE (MLE)		
Cadmium	8.2×10^{-11}	2
Chromium VI	4.3×10^{-9}	98
Scenario total	4×10^{-9}	–
REASONABLE MAXIMUM EXPOSURE (RME)		
Cadmium	6.3×10^{-8}	4
Chromium VI	1.4×10^{-6}	96
Scenario total	1×10^{-6}	–

value, COPC intake is equal to the reference dose, which is the dose that is believed to be below the threshold for adverse effects. In Table 3.3.5-2, hazard quotients for the COPCs are presented by pathway for the MLE and RME in the recreational scenario. The calculated hazard quotients are below one, and exposures are therefore not expected to result in adverse effects. Because all of the COPCs are metals, it is possible that additive exposure could result in toxicity. However, when hazard quotients for these COPCs are summed, the resultant hazard index is still less than one, indicating adverse effects are unlikely to occur. Therefore, exposure to inorganics at this site is not likely to result in adverse noncarcinogenic health effects under the exposure assumptions for the recreational scenario.

3.3.5.4.3 Lead Assessment for the Outfall Area at PRSs 32-002(a,b)

The IEUBK model estimates the body's lead uptake and the subsequent lead blood level. The lead intake from recreational exposure (12 µg/day) was added to lead intake from residential sources to estimate total lead intake by a Los Alamos resident child who also participates in recreational activities at the site. From the total lead intake, the IEUBK model was used to estimate lead uptake by the body and blood level concentrations. The model was then used to calculate the probability of exceeding a blood lead concentration of 10 µg/dL. The model results in a 2% probability of exceeding the 10 µg/dL cutoff point, which is well below the recommended 5% probability of exceeding the cutoff point. This result, which used the site maximum soil concentration of 1 600 mg/kg lead, indicates that the presence of lead at this site does not pose an unacceptable risk to human health.

3.3.5.5 Assessment of Uncertainty in the Risk Assessment for the Outfall Area at PRSs 32-002(a,b)

Uncertainty is inherent in many aspects of the risk assessment process and generally arises from the inability to fully characterize site conditions, the toxicology of the COPCs, and the degree to which an individual will be exposed to those chemicals. Various assumptions are then made based on information presented in the scientific literature or on professional judgment. While some assumptions have significant scientific basis, others have less scientific basis. The assumptions that introduce the greatest amount of uncertainty and their effect on the carcinogenic dose and noncarcinogenic risk estimates are discussed below. This discussion is qualitative in nature because the uncertainties associated with risk assessment results are often difficult to quantify.

TABLE 3.3.5-2

NONCARCINOGENIC HAZARD INDEX SUMMARY FOR THE RECREATIONAL SCENARIO IN THE OUTFALL AREA AT PRSs 32-002(a,b)

	INHALATION OF FUGITIVE DUST	INGESTION OF SOIL	DERMAL CONTACT WITH SOIL	TOTAL	PERCENT CONTRIBUTION
MOST LIKELY EXPOSURE (MLE)					
Cadmium	1.8×10^{-6}	1.1×10^{-5}	3.6×10^{-7}	1.3×10^{-5}	0.6
Chromium	N/A[a]	6.3×10^{-7}	1×10^{-7}	7.3×10^{-7}	0.03
Chromium VI	N/A	1.8×10^{-5}	2.9×10^{-6}	2.1×10^{-5}	0.9
Mercury	5.8×10^{-5}	1.8×10^{-3}	2.8×10^{-4}	2.1×10^{-3}	92
Silver	N/A	2.8×10^{-5}	4.4×10^{-6}	3.2×10^{-5}	1.4
Thallium	N/A	1.0×10^{-4}	1.6×10^{-5}	1.2×10^{-4}	5
Total by pathway	6×10^{-5}	1.90×10^{-3}	3.1×10^{-4}	–	–
% Contribution by pathway	3	84	13	–	–
Scenario total (hazard index)	–	–	–	2.3×10^{-3}	–
REASONABLE MAXIMUM EXPOSURE (RME)					
Cadmium	4.3×10^{-4}	9.7×10^{-4}	4.1×10^{-4}	1.8×10^{-3}	0.6
Chromium	N/A	2.2×10^{-5}	4.7×10^{-6}	7×10^{-5}	0.02
Chromium VI	N/A	6.4×10^{-4}	1.4×10^{-3}	2×10^{-3}	0.7
Mercury	7.1×10^{-3}	0.08	0.17	0.26	92
Silver	N/A	9.2×10^{-4}	1.9×10^{-3}	2.9×10^{-3}	1
Thallium	N/A	5.2×10^{-3}	0.01	0.02	5.8
Total by pathway	7.5×10^{-3}	0.09	0.19	–	–
% Contribution by pathway	3	31	66	–	–
Scenario total (hazard index)	–	–	–	0.3	–

[a] N/A = Not applicable. No inhalation reference dose is available.

3.3.5.5.1 Site Conditions

Steep hill slopes such as the outfall at TA-32 are inherently complex in that sediment and associated contaminants are distributed in discrete catchment areas. These catchments may not be contiguous with each other. Therefore, samples were collected in a biased manner in catchment areas along and adjacent to drainage pathways to increase the probability of detecting any elevated levels of chemicals. This biased sampling approach may lead to an over estimation of contamination present within an exposure unit. This in turn may lead to an overestimation of human health risk.

3.3.5.5.2 Toxicology of the Chemicals of Potential Concern

Uncertainty is inherent in the toxicity values for each COPC. The toxicity profiles included in Appendix D discuss the scientific studies upon which the toxicity values are based. Uncertainty factors applied to the study results account for the quality of available data and differences between study animals and human populations, and are designed to provide a health protective bias. The uncertainty factors used to derive reference doses for COPCs at PRSs 32-002(a,b) range from 3 for silver to 100 for chromium. The health protective bias embedded in the reference dose and cancer slope factor are more likely to overestimate rather than underestimate noncarcinogenic health effects and cancer risk.

3.3.5.5.3 Exposure Characteristics

Uncertainties are also inherent in the exposure characteristics for individual COPCs and individual exposures. These range from uncertainty in the chemical data, to uncertainty in the intake parameters. The data have been previously evaluated as described in Appendix A. However, it is very unlikely that a hiker will choose to spend 2 hours per day in the area of elevated levels of COPCs at PRSs 32-002(a,b) on a repetitive basis. The cancer risk and potential for noncarcinogenic adverse health effects is therefore likely to be overestimated.

3.3.6 Conclusions for the Phase II Investigation in the Outfall Area at PRSs 32-002(a,b)

The results of the human health risk assessment indicate that potential exposure to COPCs in soil in the outfall area at PRSs 32-002(a,b) would not result in adverse noncarcinogenic health effects or an unacceptable cancer risk to recreational users. In addition, the results for lead indicate that it does not pose an unacceptable level of risk at this site.

3.3.7 Remedial Activities in the Outfall Area at PRSs 32-002(a,b)

3.3.7.1 Rationale for the VCA in the Outfall Area at PRSs 32-002(a,b)

Results from the risk assessment conducted on the data from the Phase II investigation indicated that no remediation was warranted based on human health concerns in the outfall area at PRSs 32-002(a,b). However, the PCB Aroclor 1260™ was detected during the Phase I investigation at 17 mg/kg at location 32-1013, near the mouth of the outfall pipe. Because this area of PCB contamination was very small (1 ft^3) and was easily accessible, remedial activities were conducted as a best management practice to address this small area of PCB contamination.

3.3.7.2 Cleanup Level Derivation for the Outfall Area at PRSs 32-002(a,b)

The TSCA cleanup level for PCBs in soil was selected as a cleanup level for PCBs in the outfall area at PRSs 32-002(a,b). The TSCA cleanup level on property where access is unrestricted is 10 mg/kg, provided that the soil is excavated to a minimum depth of 10 in. and replaced with clean soil (EPA 1995, 1329). Therefore, the cleanup level of 10 mg/kg was selected for samples collected at greater than or equal to 10 in. bgs, and a cleanup level of 1 mg/kg was selected for samples collected at less than 10 in. bgs.

3.3.7.3 Remedial Implementation in the Outfall Area at PRSs 32-002(a,b)

Remedial activities in this area consisted of removing approximately 1 ft^3 of soil near the mouth of the outfall pipe at location 32-1013. Remedial activities also included grouting the mouth of the outfall pipe as a best management practice.

3.3.7.4 Confirmation Sampling in the Outfall Area at PRSs 32-002(a,b)

Confirmation sampling in the outfall area focused on the elevated Aroclor 1260™ identified during the Phase I investigation at location 32-1013 (Fig. 3.3.2-1). Approximately 1 ft^3 of soil was first removed from the area of sample location 32-1013. Then, two samples were collected at depths of 0–10 in. and 10–12 in. from the base of the small excavation. These samples were analyzed for PCBs at the MCAL. Results of the confirmation sampling were compared to the cleanup level of 1 mg/kg for PCBs in surface soils. No values were greater than the cleanup level (Table 3.3.7-1).

3.3.8 Conclusions for the VCA in the Outfall Area at PRSs 32-002(a,b)

The results of VCA confirmation sampling in the outfall area at PRSs 32-002(a,b) indicate that no PCBs remain in the surface soils at the site at levels greater than 1 mg/kg. Therefore, the VCA was successful in removing all PCB contamination greater than cleanup levels from the site.

TABLE 3.3.7-1

RESULTS OF CONFIRMATION SAMPLING IN THE OUTFALL AREA AT PRSs 32-002(a,b)

LOCATION ID	SAMPLE ID	DEPTH (in.)	AROCLOR 1242™ (mg/kg)	AROCLOR 1254™ (mg/kg)	AROCLOR 1260™ (mg/kg)
32-01013	0132-96-0317	0–10	<1	<1	<1
32-01013	0132-96-0318	10–12	<1	<1	<1

3.4 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 PRSs 32-002(a,b) will be deferred until these sites can be assessed as part of the ecological exposure unit methodology currently being developed.

3.5 Recommendations for PRSs 32-002(a,b)

Based on the results of Phase II and VCA activities in the outfall area and influent drain lines at PRSs 32-002(a,b) and the septic tank footprint at PRS 32-002(a), PRSs 32-002(a,b) are recommended for NFA. This recommendation is based on LANL's No Further Action Criteria Policy, criterion 4, which states that the PRS has been characterized or remediated in accordance with current applicable state or federal regulations, and available data indicate that chemicals of concern are either not present or are present in concentrations that pose an acceptable level of risk. A Class III permit modification will be requested to remove these PRSs from the HSWA Module of the LANL's Hazardous Waste Facility Permit (Environmental Restoration Project 1995, 1173).

4.0 PRS 32-003

4.1 Phase II and VCA Activities at PRS 32-003

4.1.1 Rationale For the Phase II Investigation at PRS 32-003

As discussed in the RFI report for TA-32, analytical results from the Phase I investigation at the former transformer location, PRS 32-003, indicated that the PCB Aroclor 1260™ was the only chemical retained as a COPC (LANL 1995, 06-0128). A Phase II investigation was conducted for this site to determine the lateral and vertical extent of Aroclor 1260™ (LANL 1995, 06-0128).

4.1.2 Phase II Field Investigation at PRS 32-003

The objective of the Phase II investigation at PRS 32-003 was to determine the lateral and vertical extent of PCB contamination. After removal of the wood debris pile thought to be the remnants of the former transformer platform, soil samples were collected from seven locations at depths from 0–5 in. to define the extent of contamination. These samples were collected in accordance with the EPA guidance document "Verification of PCB Spill Cleanup by Sampling and Analysis" (EPA 1985, 1242). These samples were sent to the MCAL for analysis of PCBs. Results from these samples indicated the presence of PCB contamination in the soil. Based on these results, the Phase II investigation extended outward from the wood pile area in a radial pattern to bound the extent of PCB contamination in the soil.

4.1.3 Nature and Extent of Contamination at PRS 32-003

The Phase II investigation at PRS 32-003 indicated that PCBs were present in the soil at localized levels up to 4 700 mg/kg. Analytical results indicated that an area approximately 38 ft-long x 30-ft wide x 2 to 5-ft deep required excavation. The extent of the excavation is shown on Fig. 4.1.3-1.

4.1.4 Remedial Activities at PRS 32-003

4.1.4.1 Rationale For the VCA at PRS 32-003

Results of the Phase II investigation indicated that PCBs were present at the site at levels greater than the cleanup level of 1 mg/kg in the upper 10 in. of soil and 10 mg/kg at depths greater than 10 in. Therefore, a VCA was conducted to remove the PCB contaminated soil associated with PRS 32-003.

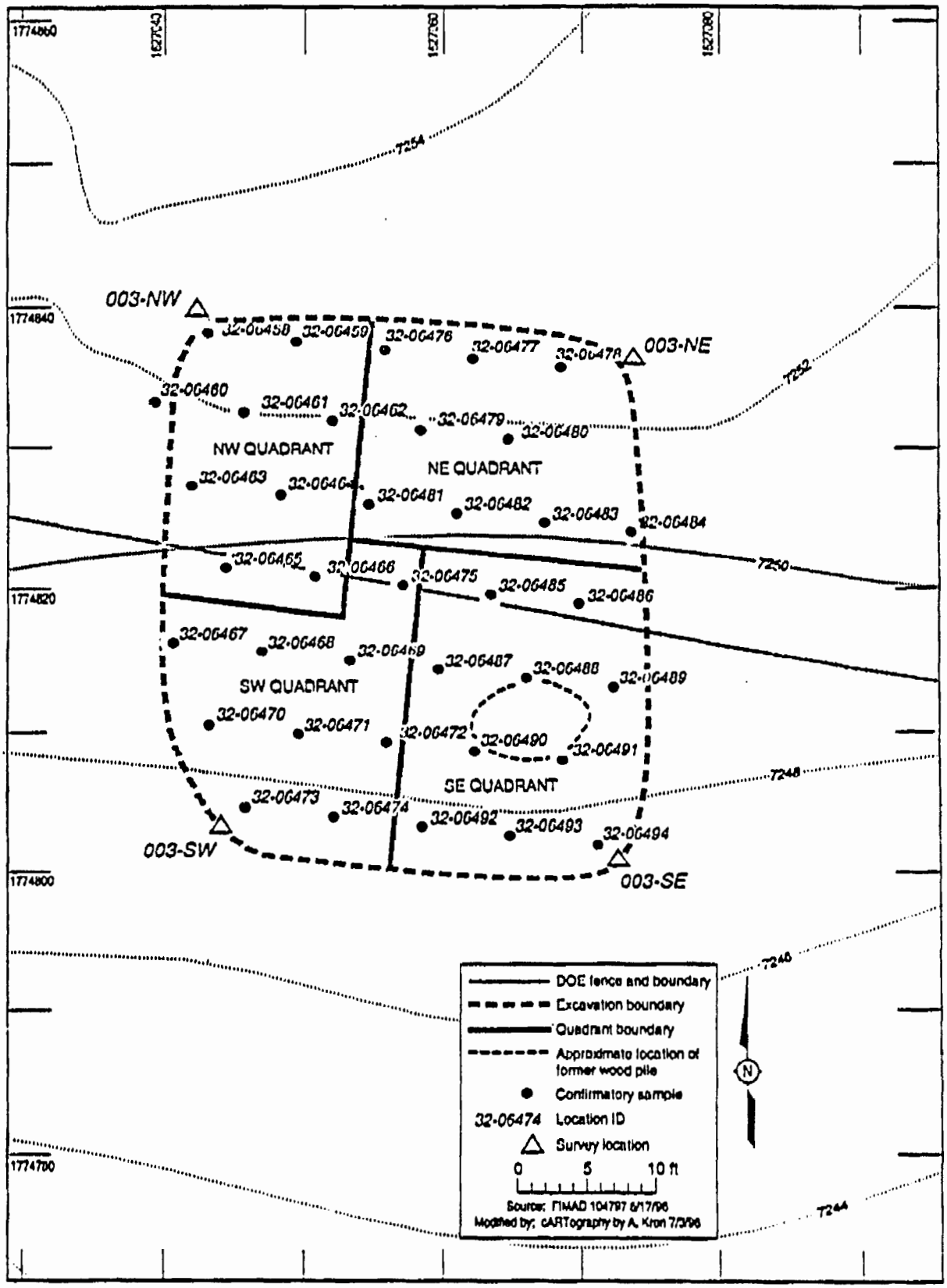

Fig. 4.1.3-1. Locations of samples collected at PRS 32-003.

4.1.4.2 Cleanup Level Derivation for PRS 32-003

The TSCA cleanup level for PCBs in soil was selected as a cleanup level for PCBs at PRS 32-003. The TSCA cleanup level on property where access is unrestricted (such as TA-32) is 10 mg/kg, provided that the soil is excavated to a minimum depth of 10 in. and replaced with clean soil (EPA 1995, 1329). Therefore, the cleanup level of 10 mg/kg was selected for samples collected at greater than or equal to 10 in. bgs, and a cleanup level of 1 mg/kg was selected for samples collected at less than 10 in. bgs.

4.1.4.3 Remedial Implementation at PRS 32-003

Remedial activities conducted at PRS 32-003 began with the removal and disposal of the wood debris pile. The entire pile of debris was removed, broken into smaller pieces, and placed in a drum for final disposal as PCB debris. Once the wood debris was removed, a 38 ft x 30 ft area was excavated (Fig. 4.1.3-1). The depth of this excavation varied across the area depending on the topography before the excavation and variations in the depth of contamination identified during the Phase II investigation.

The contaminated soil was removed from the excavation area in a series of lifts. A total of four lifts of PCB-contaminated soil were excavated using both a trackhoe and a backhoe. Samples were collected from each lift and submitted for PCB analysis at the MCAL. Results from these samples were used to determine whether the required cleanup level of 10 mg/kg for total PCBs was achieved. Excavation ceased in areas where results indicated that the PCB concentration was below 10 mg/kg. The total depth of the entire 38 ft x 30 ft excavation ranged from approximately 2–5 ft (the northern half was deeper than the southern half due to the topography before the excavation and the presence of contaminants at lower depths). A small amount of soil was also removed down to approximately 10 in. bgs from a narrow zone along the west, north, and east sides of the main excavation. Five roll-off bins (20-yd^3 capacity each) and two B-25 boxes (4-yd^3 capacity each) were used to remove approximately 100 yd^3 of contaminated soil from the site for disposal.

Restoration activities involved backfilling the excavation with clean fill material obtained from the Los Alamos County landfill stockpile. The fill was roll compacted, and native grass seed and mulch were distributed over the area.

4.1.4.4 Confirmation Sampling at PRS 32-003

Confirmation samples were collected in a hexagonal, equidistant grid pattern as proposed in the EPA guidance document, "Verification of PCB Spill Cleanup by Sampling and Analysis" (EPA 1985, 1242). The areal extent of contamination was found to be approximately 1 140 ft^2. The guidance therefore required that 37 discrete locations, spaced equidistant, be sampled in order to meet the verification requirements (Fig. 4.1.3-1). The guidance also states that samples from these 37 discrete locations may be composited in up to four quadrants for confirmation analysis.

The 38 ft x 30 ft area included in the VCA was divided into four quadrants, with 10 sampling locations contained within the southeast quadrant, and 9 sampling locations contained within each of the northeast, northwest, and southwest quadrants (Fig 4.1.3-1). According to "Verification of PCB Spill Cleanup by Sampling and Analysis," the performance required for each sample analysis is 80% accuracy and 30% relative standard deviation (EPA 1985, 1242). Assuming a 0.5% false positive rate for analytical errors, the maximum allowable PCB concentration in any one composite confirmation sample is 14.2 mg/kg. To calculate the concentration below which the composite sample result is considered clean, 14.2 mg/kg is divided by the number of samples in the composite. This calculation yields a value of 1.42 mg/kg for this site. Therefore, if the result of the composite sample is less than 1.42 mg/kg, then all discrete samples are considered clean. However, if the result for a composite sample is between 1.42 mg/kg and 14.2 mg/kg, then all discrete samples must be analyzed to confirm that the cleanup level of 10 mg/kg has been achieved (EPA 1985, 1242).

The results for the composite samples ranged from 0.49 to 2.9 mg/kg. Therefore, all discrete samples that composed the composite samples were analyzed. The results of the discrete samples that composed the composite samples were all less than 10 mg/kg, confirming that the cleanup goal was met. The data for each of the 37 discrete samples as well as the composite samples are provided in Table 4.1.4-1.

4.1.5 Conclusions for the VCA at PRS 32-003

The results of VCA confirmation sampling at PRS 32-003 indicate that the VCA was successful in removing all PCB contamination greater than cleanup levels from the site.

TABLE 4.1.4-1

RESULTS OF CONFIRMATION SAMPLING AT PRS 32-003

LOCATION ID	SAMPLE ID	DEPTH[a] (ft bgs)	MATRIX	PCB CONCENTRATION (mg/kg)
NE Quadrant Composite	0132-96-0410	4.5 - 5	Soil	2.8
NW Quadrant Composite	0132-96-0409	4 - 4.5	Soil	2.9
SE Quadrant Composite	0132-96-0411	2.5 - 3	Soil	0.71
SW Quadrant Composite	0132-96-0412	2.5 - 3	Soil	0.49
32-06458	0132-96-0715	1.5–2.0	Soil	4.83
32-06459	0132-96-0252	2.5 - 3	Soil	<0.1
32-06460	0132-96-0256	0.8–1.1	Soil	0.54
32-06461	0132-96-0705	2.5 - 3	Soil	3.58
32-06462	0132-96-0706	4 - 4.5	Soil	<0.1
32-06463	0132-96-0709	4 - 4.5	Soil	0.1
32-06464	0132-96-0710	4 - 4.5	Soil	0.46
32-06465	0132-96-0716	4 - 4.5	Soil	0.55
32-06466	0132-96-0717	4 - 4.5	Soil	3.53
32-06467	0132-96-0721	0.8–1.1	Soil	1.89
32-06468	0132-96-0722	2.5 - 3	Soil	0.16
32-06469	0132-96-0723	2.5 - 3	Soil	3.27
32-06470	0132-96-0727	2.5 - 3	Soil	0.13
32-06471	0132-96-0728	2.5 - 3	Soil	0.26
32-06472	0132-96-0729	2.5 - 3	Soil	0.37
32-06473	0132-96-0732	2.5 - 3	Soil	0.63
32-06474	0132-96-0733	2.5 - 3	Soil	1.45
32-06475	0132-96-0718	4.5 - 5	Soil	0.83
32-06476	0132-96-0253	4.5 - 5	Soil	0.63
32-06477	0132-96-0254	4.5 - 5	Soil	2.16
32-06478	0132-96-0255	4.5 - 5	Soil	1.28
32-06479	0132-96-0707	4.5 - 5	Soil	<0.1
32-06480	0132-96-0708	4.5 - 5	Soil	0.1
32-06481	0132-96-0711	4.5 - 5	Soil	<0.1

TABLE 4.1.4-1 (CONTINUED)

RESULTS OF CONFIRMATION SAMPLING AT PRS 32-003

LOCATION ID	SAMPLE ID	DEPTH[a] (ft bgs)	MATRIX	CONCENTRATION (mg/kg)
32-06482	0132-96-0712	4.5 - 5	Soil	<0.1
32-06483	0132-96-0713	4.5 - 5	Soil	<0.1
32-06484	0132-96-0714	1.3-1.8	Soil	3.12
32-06485	0132-96-0719	4.5 - 5	Soil	3.57
32-06486	0132-96-0720	4.5 - 5	Soil	4.51
32-06487	0132-96-0724	2.5 - 3	Soil	1.44
32-06488	0132-96-0725	2.5 - 3	Soil	1.62
32-06489	0132-96-0726	2.5 - 3	Soil	0.92
32-06490	0132-96-0730	2.5 - 3	Soil	<0.1
32-06491	0132-96-0731	2.5 - 3	Soil	<0.1
32-06492	0132-96-0734	2.5 - 3	Soil	0.18
32-06493	0132-96-0735	2.5 - 3	Soil	0.68
32-06494	0132-96-0736	2.5 - 3	Soil	3.03

[a] Depths are approximate.

4.2 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 32-003 will be deferred until this site can be assessed as part of the ecological exposure unit methodology currently being developed.

4.3 Recommendations for PRS 32-003

PRS 32-003 is recommended for NFA based on LANL's No Further Action Criteria Policy, criterion 4, which states that the PRS has been characterized or remediated in accordance with current applicable state or federal regulations, and available data indicate that chemicals of concern are either not present or are present in concentrations that pose an acceptable level of risk. A Class III permit modification will be requested to remove this site from the HSWA Module of LANL's Hazardous Waste Facility Permit (Environmental Restoration Project 1995, 1173).

5.0 PRS 32-004

The Phase II investigation at PRS 32-004 was divided over three main areas: the former radiation source vault location, the drain line location, and the outfall area. Detailed discussion of the field activities at each of these areas is included in Sections 5.1, 5.2, and 5.3, respectively. A VCA was conducted at PRS 32-004 to remove the drain lines.

5.1 Radiation Source Vault at PRS 32-004

5.1.1 Rationale For the Phase II Investigation at the Radiation Source Vault at PRS 32-004

PRS 32-004 was identified after the Phase I investigation. It included a vault room where a radioactive source was stored. Therefore, a Phase II investigation was recommended, which included the radiation source vault area. The objective of the investigation was to define the location of the radiation source vault, and to determine the nature and extent of radiological contamination, if any.

5.1.2 Phase II Field Investigation at the Radiation Source Vault at PRS 32-004

The former location of the radiation source room vault was determined using engineering drawings and historical survey points. The surface of the area was then screened for alpha, beta, and gamma radioactivity using an Eberline ESP-1™ with a Geiger-Mouller™ pancake probe. Four samples were collected from the corners of the former vault footprint at a depth of 0–12 in. below the asphalt (Fig. 5.1.2-1). These samples were sent to the MRAL for analysis for gross alpha, beta, and gamma radioactivity. The results of these analyses did not indicate the presence of elevated radioactivity. The results of the Phase II analyses are presented in Table 5.1.2-1.

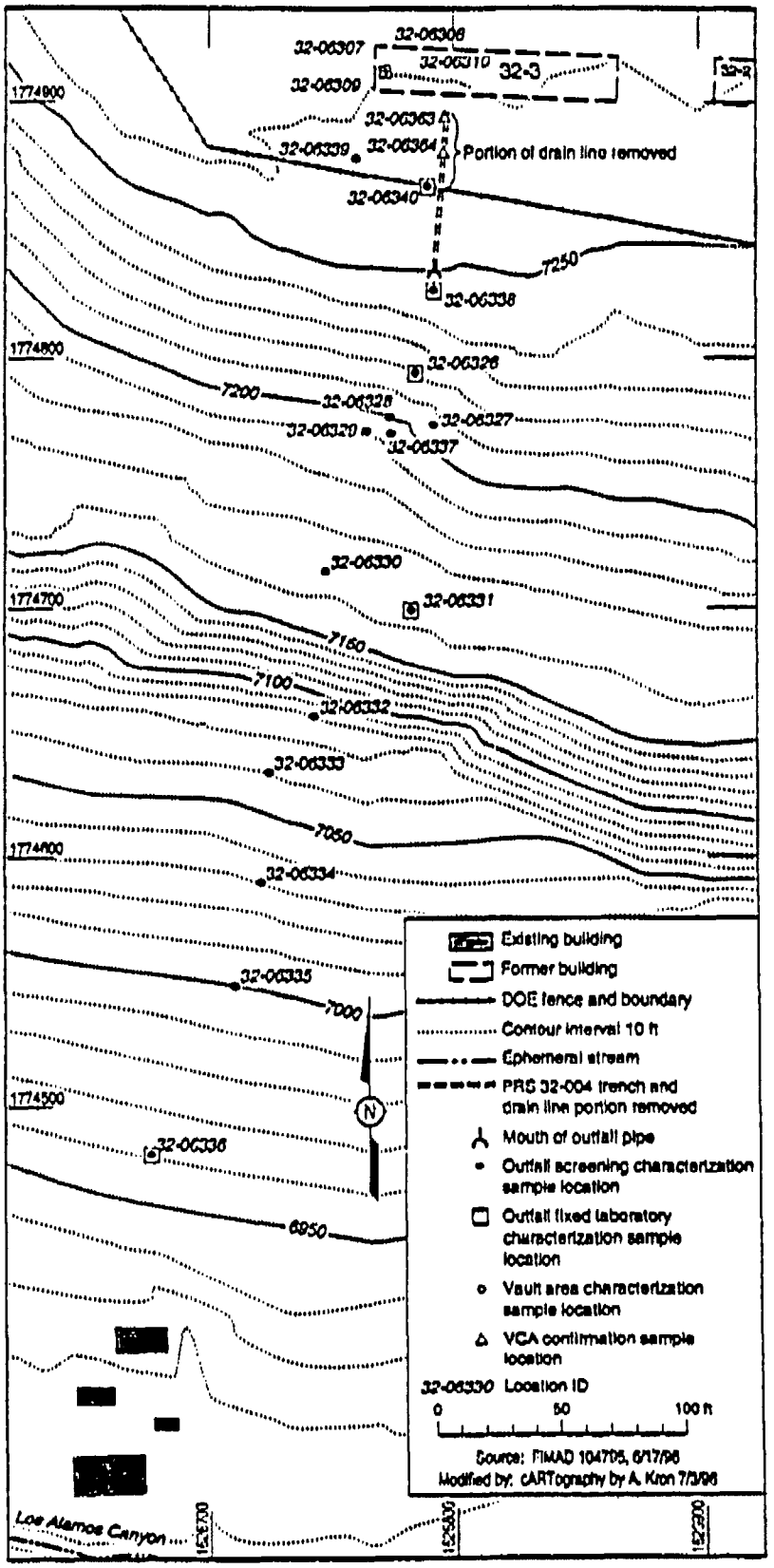

Fig. 5.1.2-1. Locations of samples collected at the PRS 32-004 radiation source vault.

TABLE 5.1.2-1

RESULTS FROM PHASE II CHARACTERIZATION SAMPLES AT THE RADIATION SOURCE VAULT AT PRS 32-004

LOCATION ID	SAMPLE ID	DEPTH (in.)	GROSS ALPHA (pCi/g)	GROSS BETA (pCi/g)	GROSS GAMMA (pCi/g)
MINIMUM DETECTABLE ACTIVITY			98.79	35.03	3.17
32-06307	0132-96-0301	0–12	6.83	2.69	5.65
32-06309	0132-96-0302	0–8	12.7	13.2	6.28
32-06308	0132-96-0303	0–12	15.6	10.2	5.34
32-06310	0132-96-0304	0–8	10.7	12.5	9.65

5.1.3 Nature and Extent of Contamination at the Radiation Source Vault at PRS 32-004

The results of the Phase II investigation did not indicate the presence of any radioactive contamination.

5.1.4 Conclusions and Recommendations for the Radiation Source Vault at PRS 32-004

The results of the Phase II investigation at the PRS 32-004 radiation source vault indicated that no radioactive contamination is present at the site.

5.2 PRS 32-004 Drain Line

5.2.1 Rationale for Phase II Investigation of the PRS 32-004 Drain Line

A Phase II investigation was recommended for the PRS 32-004 drain line to determine whether the drain line had been previously removed, and whether any releases had occurred in the soil surrounding the pipe.

5.2.2 Phase II Field Investigation at the PRS 32-004 Drain Line

The Phase II investigation in the PRS 32-004 drain line area had two objectives. The first objective was to determine the presence of the drain line. The second objective was to determine if any releases had occurred. Exploratory trenches were excavated to locate the drain line, which was found to extend from the edge of former building TA-32-3 to the edge of Los Alamos Canyon (Fig. 5.1.2-1). Field screening was conducted during excavation as the line was exposed. The field screening instruments included a PID to monitor for VOCs, a Jerome™

monitor to monitor mercury vapor, and hand-held radiation instruments to measure alpha, beta, and gamma radioactivity.

The interior of the pipe was exposed and sampled for waste characterization purposes and to determine health and safety requirements during the VCA. The interior of the drain line was accessed near the footprint of building TA-32-3 and at the mouth of the outfall pipe. No sludge was found within the pipe, so swipe samples were collected and analyzed for radioactivity.

5.2.3 Nature and Extent of Contamination at the PRS 32-004 Drain Line

The results of the Phase II investigation of the interior of the pipe indicated that the pipe was free of sludge and residual radioactive contamination. Visual inspection, field screening results, and fixed-laboratory analytical results indicated that no releases had occurred from the drain line.

5.2.4 Remedial Activities at the PRS 32-004 Drain Line

5.2.4.1 Rationale For the VCA at the PRS 32-004 Drain Line

The Phase II investigation at the PRS 32-004 drain line area confirmed the presence of the drain line. Phase II characterization of the contents of the drain line revealed no evidence of radiological or hazardous contamination. However, archival evidence suggests that radiological and hazardous constituents may have been associated with former Laboratory activities at this PRS, and past releases from the drain line were possible but not confirmed. In addition, the drain line for PRS 32-004 was located on Los Alamos County property, which might be developed for future residential use. Therefore, a VCA was conducted to remove the drain line and confirm that no releases had occurred from the pipe.

5.2.4.2 Cleanup Level Derivation at the PRS 32-004 Drain Line

If evidence of a release had been discovered, SALs would have been used as cleanup levels for soil remaining in the trench.

5.2.4.3 Remedial Activities for the PRS 32-004 Drain Line

Remedial activities at the PRS 32-004 drain line consisted of excavating and removing the drain line. A backhoe was used to expose the drain line for visual inspection for breaks and cracks. The vertical depth of the excavation ranged from approximately 2.5 ft to 3 ft bgs. The width of the excavation was approximately 4 ft.

A total of 37.5 ft of VCP and a single 5-ft section of cast iron pipe were removed during the VCA (Fig. 5.1.2-1). The VCP portion was composed of 2.5-ft sections. Following the exposure of each 25-ft segment, the pipe and surrounding soil were screened for VOCs using a PID, and for alpha, gross beta, and gamma radioactivity using an Eberline ESP-1™ with a Geiger-Mueller™ pancake probe. Each section of pipe was carefully removed from the trench so that any material potentially inside the pipe would not spill into the trench; however, no material was present inside the pipe. Each pipe section was thoroughly cleaned, both inside and outside, using a small amount of Fantastik™ spray cleaner to ensure that any residual radioactive contamination was removed. The residue from the cleaning operation was collected in a drum liner and managed in a 55-gallon drum as low-level radioactive waste. The drain line trench was backfilled with material derived from the trench, and the area was repaved.

No evidence of contamination was found inside or outside the 42.5 ft of drain line removed from the Los Alamos County property. Approximately 50 ft of drain line remain at the site on DOE property in a relatively undisturbed area. Because no contamination was found within the drain line that was removed, the portion of the drain line on DOE property was left in place. Each end of the remaining line was grouted as a best management practice.

Restoration activities involved backfilling the drain line trench with the material that was removed during excavation. The fill material was placed into the trench and compacted in 8-in. layers using a ground compactor. An asphalt patch was then placed over the trench.

5.2.4.4 Confirmation Sampling for the PRS 32-004 Drain Line

Two soil confirmation samples were collected from beneath the pipe at a 25-ft interval (Fig. 5.1.2-1). These samples were submitted for fixed-laboratory analysis for TAL metals, SVOCs, VOCs, isotopic plutonium, isotopic uranium, and tritium. The results of the confirmation samples were below SALs for all analytes except the PAH benzo(a)pyrene (Table 5.2.4-1). In addition, benzo(g,h,i,)perylene and phenanthrene have no SALs for comparison.

There is no archival evidence to indicate that PAHs were used or generated at the medical research laboratory that PRS 32-004 served. Therefore, it is highly unlikely that PAHs are attributable to releases from PRS 32-004. The mesa top where the PRS 32-004 drain line was located is covered by an asphalt parking lot associated with the current Los Alamos County Public Works Department Pavement Management Division. This parking lot covers the mesa top from the Public Works Department buildings to the edge of Los Alamos Canyon. Therefore, the PAHs detected at the site are likely associated with the presence of asphalt in the parking lot.

TABLE 5.2.4-1

RESULTS OF CONFIRMATION SAMPLING AT THE PRS 32-004 DRAIN LINE

		LOCATION ID	32-06363	32-06364
		SAMPLE ID	0132-96-0621	0132-96-0622
		DEPTH (in.)	0–6	0–6
ANALYTE	UTL	SAL		
INORGANICS (mg/kg)				
Aluminum	38 700	77 000	6 300[a]	7 030
Antimony	1	31	5.78(U)[a,b]	5.81(U)
Arsenic	7.82	n/a[c]	1.43[a]	1.43
Barium	315	5 300	91.6[a]	66.2
Beryllium	1.95	n/a	0.921[a]	1.13
Cadmium	2.7	38	0.578(U)[a]	0.581(U)
Calcium	6 120	n/a	1 950[a]	1 860
Chromium	19.3	211	5.74[a]	6.17
Cobalt	19.2	4 600	2.45(U)[a]	2.87(U)
Copper	15.5	2 800	5.84[a]	7.76
Iron	21 300	n/a	12 100[a]	11 400
Lead	23.3	400	19.1[a]	17.5
Magnesium	4 610	n/a	1 220[a]	1 210
Manganese	714	n/a	311[a]	204
Mercury	0.1	23	0.446[a]	0.55
Nickel	15.2	1 500	5.8[a]	6.27
Potassium	3 410	n/a	983[a]	877
Selenium	1.7	380	0.29(U)[a]	0.284(U)
Silver	NA	380	0.578(U)[a]	0.581(U)
Sodium	915	n/a	144(U)[a]	132(U)
Thallium	1	5.4	0.232(U)[a]	0.228(U)
Vanadium	41.9	540	14.3[a]	13.2
Zinc	50.8	23 000	62.3[a]	102

TABLE 5.2.4-1 (CONTINUED)

RESULTS OF CONFIRMATION SAMPLING AT THE PRS 32-004 DRAIN LINE

		LOCATION ID	32-06363	32-06364
		SAMPLE ID	0132-96-0621	0132-96-0622
		DEPTH (in.)	0–6	0–6
ANALYTE	UTL	SAL		
ORGANICS (mg/kg)				
Acetone	n/a	2 000	0.02(U)	0.002(J)[d]
Benzo[a]anthracene	n/a	0.61	0.38(U)	0.17(J)
Benzo[a]pyrene	n/a	0.061	0.38(U)	0.21(J)
Benzo[b]fluoranthene	n/a	0.61	0.12(J)	0.31(J)
Benzo[g,h,i]perylene	n/a	n/a	0.38(U)	0.15(J)
Benzo[k]fluoranthene	n/a	6.1	0.38(U)	0.15(J)
Butyl benzyl phthalate	n/a	13 000	0.38(U)	0.18(J)
Chrysene	n/a	24	0.38(U)	0.25(J)
Di-n-octyl phthalate	n/a	1 300	0.38(U)	0.097(J)
Fluoranthene	n/a	2 600	0.18(J)	0.48
Indeno[1,2,3-cd]pyrene	n/a	0.61	0.38(U)	0.16(J)
Methylene chloride	n/a	11	0.005(U)	0.005
Phenanthrene	n/a	n/a	0.1(J)	0.24(J)
Pyrene	n/a	2 000	0.15(J)	0.37(J)

[a] Value represents the maximum of a sample concentration and its laboratory duplicate.
[b] U = Undetected (see Appendix A).
[c] n/a = No applicable value is available.
[d] J = Estimated quantity (see Appendix A).

The influent drain line was located on the mesa top, which could potentially be developed for residential use. In order to determine if additional clean up was required, the average concentration of benzo(a)pyrene was used to estimate lifetime excess cancer risk by ratio to SAL. The ratio of the average concentration of benzo(a)pyrene (0.2 mg/kg) to the SAL (0.061 mg/kg) is 3. Therefore, if the average concentration of benzo(a)pyrene were present throughout a residential exposure area, it would be associated with a lifetime excess cancer risk of 3 in one million. The risk level of 3 in one million is within the acceptable risk range specified by NCP and proposed in RCRA Subpart S (1 in 10 000 to 1 in 1 000 000) (EPA 1990, 0559; EPA 1990, 1358). Therefore, benzo(a)pyrene is eliminated as a COPC.

The remaining PAHs, benzo(g,h,i)perylene and phenanthrene, have no published toxicity values. It is assumed that PAHs with toxicity values are an indicator of toxicity for those PAHs without toxicity values. Because none of the other PAHs at this site pose an unacceptable risk to human health, it is unlikely that the detected benzo(g,h,i)perylene and phenanthrene will result in an unacceptable human health risk. Therefore, benzo(g,h,i,)perylene and phenanthrene are eliminated as COPCs.

5.2.5 Conclusions for the PRS 32-004 Drain Line

The results of confirmation samples collected in the PRS 32-004 drain line area indicate that no hazardous or radioactive chemicals remain at the site at levels that pose an unacceptable risk to human health.

5.3 PRS 32-004 Outfall Area

5.3.1 Rationale for Phase II Investigation of the PRS 32-004 Outfall Area

A Phase II investigation was recommended for the PRS 32-004 outfall area to determine the nature and extent of contamination, if any.

5.3.2 Phase II Field Investigation at the PRS 32-004 Outfall Area

The Phase II investigation in the PRS 32-004 outfall area addressed the drainage pathway from the mesa edge to the bottom of the hillside in Los Alamos Canyon, focusing primarily on the upper portion of the hillside near the mouth of the outfall pipe. The objective of the Phase II investigation in the PRS 32-004 outfall area was to determine the nature and extent of contamination, if any. Fifteen samples were collected from 15 different locations for screening purposes. Thirteen of the samples were collected from locations below and near the outfall pipe on the upper portion of the hillside, in the drainage channels on either side of the primary drainage pathway, and within sediment accumulation areas below the outfall. The remaining

two were collected toward the base of the hillside (Fig. 5.1.2-1). Fourteen of the 15 samples were collected from a depth of 0–12 in., and one was collected from a depth of 17–24 in. All samples were screened for radiation using an Eberline ESP-1™ with a Geiger-Mueller™ pancake probe. Samples were also analyzed at the MCAL for XRF metals and at the MRAL for gross alpha, beta, and gamma radiation and tritium.

Field screening, MCAL, and MRAL data were then used to select sample locations for off-site fixed-laboratory analysis. Samples were selected for fixed-laboratory analysis from areas where the presence of elevated metals was indicated. To bound the extent of contamination, samples were also selected for fixed-laboratory analysis from areas where elevated metals concentrations were not detected. A total of seven samples were collected from five of the original 15 sampling locations and submitted for off-site analysis for TAL metals, SVOCs, isotopic plutonium, isotopic uranium, americium-241, and tritium. Five of the seven samples were collected from a depth of 0–6 in. and two samples were collected from a depth of 6–12 in.

It was recognized during initial site reconnaissance that there was a potential source of contamination from an industrial area situated northwest of the site along Knecht Street. The potential sources of contamination include two auto repair shops, a car wash, a paint and body shop, and a gas station. This area may have currently and/or historically impacted the PRS 32-004 outfall area. Storm water from the Knecht St. area is collected by a storm drain that discharges onto the hill slope near the outfall of the PRS 32-004 septic system drain line. The Knecht St. discharge area and the PRS 32-004 outfall area converge into a common drainage channel. Contaminants that could result from these industries and businesses include organic compounds and metals.

To address potential contamination, if any, from the Knecht St. area, samples were collected from two locations upgradient from the outfall pipe (locations 32-06339 and 32-06340). These two locations were within the area affected by the Knecht St. drainage. Two samples (0132-96-0070 and 0132-96-0351) were collected from location 32-06340. Sample 0132-96-0070 was analyzed for metals using XRF and for gross alpha, beta, and gamma radiation and tritium in the MRAL. Sample 0132-96-0351 was sent to a fixed laboratory for analysis of TAL metals and SVOCs. One sample (0132-96-0069) was collected from location 32-06339. Sample 0132-96-0069 was analyzed for metals using XRF and for gross alpha, beta, gamma radiation and tritium in the MRAL.

5.3.3 Background Comparisons for Phase II Samples in the PRS 32-004 Outfall Area

Inorganics. The seven soil samples collected in the PRS 32-004 outfall area were analyzed for TAL metals. Six inorganics were detected above their background screening values: chromium, copper, lead, mercury, silver, and zinc. Mercury and silver were not subjected to further background comparisons because the background data for these metals are inadequate to support other statistical tests. Mercury and silver are therefore carried forward to the screening assessment.

Further background comparisons were performed for chromium, copper, lead, and zinc. These comparisons were conducted according to "Application of LANL Background Data to ER Project Decision-Making" (Ryti et al. 1996, 1208). Because the data for these metals do not appear to satisfy normality assumptions, nonparametric tests were used for further background comparisons. The Gehan modification to the Wilcoxon Rank Sum test and the Quantile test were used for these evaluations. The Gehan test is best suited for assessing complete shifts in distribution, whereas the Quantile test is better suited for assessing partial shifts. These two tests can detect most types of differences between distributions. Observed significance levels (P-values) for these tests are presented in Table 5.3.3-1. If a P-value is less than some small probability, typically 0.05, 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 for chromium, copper, and zinc are indicative of site concentrations that are not statistically elevated above background. The results for lead, however, are indicative of site concentrations that are greater than background.

Based on the background comparisons and further statistical tests, lead, mercury, and silver are carried forward to the screening assessment. The analyte concentrations for each sample that has at least one value above background screening values are presented in Table 5.3.3-2.

TABLE 5.3.3-1

STATISTICAL TESTS FOR BACKGROUND COMPARISON IN CHARACTERIZATION SAMPLES FROM THE PRS 32-004 OUTFALL AREA

ANALYTE	GEHAN TEST P-VALUE	QUANTILE TEST P-VALUE
Chromium	0.92	0.35
Copper	0.74	0.34
Lead	0.01	0.02
Zinc	0.30	0.09

TABLE 5.3.3-2

INORGANICS WITH CONCENTRATIONS ABOVE BACKGROUND SCREENING VALUES IN CHARACTERIZATION SAMPLES FROM THE PRS 32-004 OUTFALL AREA

LOCATION ID	SAMPLE ID	DEPTH	LEAD (mg/kg)	MERCURY (mg/kg)	SILVER (mg/kg)
UTL	N/A[a]	N/A	23.3	0.1	NA[b]
SAL	N/A	N/A	400	23	380
32-06338	0132-96-0352	0–6	89	0.137[c]	3.3
32-06338	0132-96-0353	6–12	21	0.11	2.2(U)[d]
32-06326	0132-96-0354	0–6	53	0.11	2.2(U)
32-06326	0132-96-0355	6–12	9.5	0.12	2.4(U)
32-06331	0132-96-0356	0–5	34	0.1	2(U)
32-06336	0132-96-0357	0–6	11	0.1(U)	2.1(U)

[a] N/A = Not applicable.
[b] NA = Not available. Detection limit was used as the background screening value.
[c] Value is the maximum of a sample and its laboratory duplicate.
[d] U = Undetected quantity.

Radionuclides. Six soil samples collected from the PRS 32-004 outfall area were analyzed for americium-241, isotopic plutonium, isotopic uranium, and tritium. None of these analytes were detected above their respective background screening values. Therefore, no radionuclides are carried forward to the screening assessment.

Evaluation of Organics. Seven soil samples collected from the PRS 32-004 outfall area were analyzed for semivolatiles. Fifteen organics [acenaphthene, anthracene, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[g,h,i]perylene, benzo[k]fluoranthene, bis(2-ethylhexyl)phthalate, butyl benzyl phthalate, chrysene, fluoranthene, indeno[1,2,3-cd]pyrene, naphthalene, phenanthrene, and pyrene) were detected in one or more samples. These fifteen organics are carried forward to the screening assessment. The concentrations for each sample that has at least one detected value for these analytes are presented in Table 5.3.3-3.

5.3.4 Screening Assessment for Phase II Samples in the PRS 32-004 Outfall Area

This subsection discusses the comparison with SALs for COPCs detected at levels greater than background screening values or with no background data for comparison in the PRS 32-004 outfall area. The chemicals included in the screening assessment include three inorganics (lead, mercury, and silver) and fifteen organics [acenaphthene, anthracene, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[g,h,i]perylene, benzo[k]fluoranthene, bis(2-ethylhexyl)phthalate, butyl benzyl phthalate, chrysene, fluoranthene, indeno[1,2,3-cd]pyrene, naphthalene, phenanthrene, and pyrene].

Greater than or equal to SAL. Four chemicals, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3)pyrene, were detected at levels greater than or equal to SALs.

No SAL. Two chemicals, benzo(g,h,i)perylene and phenanthrene, had no SALs.

Less than SAL. Twelve chemicals, acenaphthene, anthracene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, butyl benzyl phthalate, chrysene, fluoranthene, lead, mercury, naphthalene, pyrene, and silver, were detected at concentrations below their 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). SALs for all chemicals were normalized and summed as described in Section 3.0 of the RFI Report (LANL 1995, 06-0128). The results of the analysis are shown in Table 5.3.4-1.

TABLE 5.3.3-3

ORGANIC COMPOUNDS DETECTED IN CHARACTERIZATION SAMPLES FROM THE PRS 32-004 OUTFALL AREA

	LOCATION ID	32-06338	32-06338	32-06326	32-06326	32-06331	32-06336
	SAMPLE ID	0132-96-0352	0132-96-0353	0132-96-0354	0132-96-0355	0132-96-0356	0132-96-0357
	DEPTH (in.)	0–6	6–12	0–6	6–12	0–5	0–6
ANALYTE	SAL	ANALYTE VALUE (mg/kg)					
Acenaphthene	360	0.53(U)[a]	0.18(U)	0.17(U)	0.19(U)	0.19	0.16(U)
Anthracene	19	0.53(U)	0.18(U)	0.32	0.19(U)	0.32	0.16(U)
Benzo[a]anthracene	0.61	1.7	0.18(U)	1.4	0.19(U)	0.89	0.16(U)
Benzo[a]pyrene	0.061	1.9	0.18(U)	1.5	0.19(U)	0.91	0.16(U)
Benzo[b]fluoranthene	0.61	2.2	0.18(U)	1.6	0.19(U)	0.96	0.16(U)
Benzo[g,h,i]perylene	n/a	1.4	0.18(U)	0.65	0.19(U)	0.42	0.16(U)
Benzo[k]fluoranthene	6.1	1.7	0.18(U)	1.4	0.19(U)	1.1	0.16(U)
Bis(2-ethylhexyl)phthalate	32	0.69	0.18(U)	0.88	0.19(U)	0.25	0.16(U)
Butyl benzyl phthalate	13 000	3.1	0.3	2.4	0.19(U)	0.96	0.16(U)
Chrysene	240	3.5	0.21	2.4	0.19(U)	1.6	0.16(U)
Fluoranthene	2 600	4.8	0.2	3.4	0.19(U)	2.3	0.18
Indeno[1,2,3-cd]pyrene	0.61	1.3	0.18(U)	0.67	0.19(U)	0.42	0.16(U)
Naphthalene	800	0.53(U)	0.18(U)	0.17(U)	0.19(U)	0.23	0.16(U)
Phenanthrene	n/a	2.2	0.18(U)	1.7	0.19(U)	1.7	0.16(U)
Pyrene	2 000	3.8	0.2	2.7	0.19(U)	1.8	0.16(U)

[a] U = Undetected quantity (see Appendix A).

TABLE 5.3.4-1

MULTIPLE CHEMICAL EVALUATION CHARACTERIZATION SAMPLES FROM THE PRS 32-004 OUTFALL AREA

CHEMICAL	SAMPLE VALUE (mg/kg)	SAL (mg/kg)	NORMALIZED VALUE
SAL BASED ON NONCARCINOGENIC EFFECTS			
Acenaphthene	0.19	360	5×10^{4}
Anthracene	0.32	19	0.02
Butyl benzyl phthalate	3.1	13 000	2.4×10^{04}
Fluoranthene	4.8	2 600	0.002
Lead	89	400	0.223
Mercury	0.14	23	0.006
Naphthalene	0.23	800	3×10^{04}
Pyrene	3.8	2 000	0.002
Silver	3.3	380	0.009
NORMALIZED SUM			0.26
SAL BASED ON CARCINOGENIC EFFECTS			
Benzo(k)fluoranthene	1.7	6.1	0.28
Bis(2-ethylhexyl)phthalate	0.88	32	0.028
Chrysene	3.5	24	0.15
NORMALIZED SUM			0.46

The results of the multiple chemical evaluations based on carcinogenic and noncarcinogenic effects are less than one, indicating that potential resultant adverse human health effects from exposure are unlikely. Therefore, all chemicals with concentrations less than their SALs are eliminated as COPCs.

Four chemicals detected at concentrations greater than or equal to SALs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3)pyrene), and two chemicals with no SALs (benzo(g,h,i)perylene and phenanthrene) remain as COPCs. All of these chemicals are PAHs.

There is no archival evidence to indicate that PAHs were used or generated at the medical research laboratory that PRS 32-004 served. Therefore, it is highly unlikely that PAHs are attributable to releases from PRS 32-004. The mesa top where the PRS 32-004 drain line was located is covered by an asphalt parking lot associated with the current Los Alamos County Public Works Department Pavement Management Division. This parking lot covers the mesa top from the Public Works Department buildings to the edge of Los Alamos Canyon. In addition, there is a storm drain located upgradient from PRS 32-004 that drains directly onto the outfall area. Therefore, the PAHs detected in the outfall area are likely a result of runoff from the asphalt parking lot and the storm drain.

While the PAHs at the site are not likely attributable to Laboratory activities, risk estimates were calculated based on the average PAH concentrations as a ratio to SAL. The results indicate that site levels of PAHs would be associated with a 1×10^{-5} lifetime cancer risk. This risk level is within the acceptable risk range of 1×10^{-4} to 1×10^{-6} specified by NCP and proposed in RCRA Subpart S (EPA 1990, 0559; EPA 1990, 1358). Therefore, PAHs are eliminated as COPCs.

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

5.3.5 Evaluation of Samples Collected to Determine the Source of Contamination in the PRS 32-004 Outfall Area

Several possible sources of contamination located upgradient of TA-32 along Trinity Drive were anticipated to have an impact on the organic and metal concentrations detected in the PRS 32-004 outfall area. These sources include two auto repair shops, a car wash, a paint and body shop, and a gas station. To determine whether the contaminant levels in the outfall area are associated with PRS 32-004, samples were collected from two locations upgradient from the outfall pipe (locations 32-06339 and 32-06340). Two samples (0132-96-0070 and 0132-96-0351) were collected from location 32-06340. Sample 0132-96-0070 was analyzed for metals using XRF and for gross alpha, beta, and gamma radiation and tritium in the MRAL. Sample 0132-96-0351 was sent to a fixed laboratory for analysis of TAL metals and SVOCs. One sample (0132-96-0069) was collected from location 32-06339. Sample 0132-96-0069 was analyzed for metals using XRF and for gross alpha, beta, and gamma radiation and tritium in the MRAL.

Table 5.3.5-1 presents a comparison of the laboratory analytical results from samples collected upgradient from the PRS 32-004 outfall pipe, at the mouth of the pipe, and downgradient from the pipe. This comparison shows that the concentrations of organic and inorganic chemicals are significantly greater upgradient from the mouth of the PRS 32-004 outfall pipe. These data support the existence of a contaminant source unrelated to PRS 32-004. This contaminant source is likely current and historical activities in the industrial area along Knecht Street.

5.3.6 Remedial Activities in the PRS 32-004 Outfall Area

The Phase II investigation in the PRS 32-004 outfall area did not indicate the presence of radiological or hazardous contamination at concentrations that pose an unacceptable human health risk. Therefore, the mouth of the PRS 32-004 outfall pipe was grouted as a best management practice, and no further remediation was conducted in the outfall area.

5.3.7 Conclusions for the PRS 32-004 Outfall Area

The results from the screening assessment conducted on the Phase II data indicate that COPCs are not present at this site at levels that pose an unacceptable human health risk.

5.4 Preliminary Ecological Assessment for PRS 32-004

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 32-004 will be deferred until this site can be assessed as part of the ecological exposure unit methodology currently being developed.

5.5 Recommendations for PRS 32-004

Based on the results of Phase II and VCA activities in the outfall, radioactive source vault, and drain line areas, PRS 32-004 is recommended for NFA. This recommendation is based on LANL's No Further Action Criteria Policy, criterion 4, which states that the PRS has been characterized or remediated in accordance with current applicable state or federal regulations, and available data indicate that chemicals of concern are either not present or are present in concentrations that pose an acceptable level of risk. A Class III permit modification will be requested to remove this site from the HSWA Module of LANL's Hazardous Waste Facility Permit (Environmental Restoration Project 1995, 1173).

TABLE 5.3.5-1

COMPARISON OF RESULTS FOR SAMPLES COLLECTED UPGRADIENT, AT, AND DOWNGRADIENT FROM THE MOUTH OF THE PRS 32-004 OUTFALL PIPE

LOCATION ID		32-06340	32-06338	32-06338	32-06326	32-06326	32-06331	32-06336
		Upgradient from mouth of outfall	Mouth of outfall	Mouth of outfall	Downgradient from mouth of outfall	Downgradient from mouth of outfall	Downgradient from mouth of outfall	Downgradient from mouth of outfall
SAMPLE ID		6132-96-0351	6132-96-0352	6132-96-0353	6132-96-0354	6132-96-0355	6132-96-0356	6132-96-0357
DEPTH (in.)		0–6	0–6	6–12	0–6	6–12	0–5	0–6
ANALYTE	SAL	ANALYTE VALUE (mg/kg)						
Acenaphthene	360	0.69(U)[a]	0.53(U)	0.18(U)	0.17(U)	0.19(U)	0.19	0.16(U)
Anthracene	19	2.3	0.53(U)	0.18(U)	0.32	0.19(U)	0.32	0.16(U)
Benzo(a)anthracene	0.61	**8.2**[b]	1.7	0.18(U)	1.4	0.19(U)	0.59	0.16(U)
Benzo(a)pyrene	0.061	**8.4**	1.9	0.18(U)	1.5	0.19(U)	0.91	0.16(U)
Benzo(b)fluoranthene	0.61	**7.8**	2.2	0.18(U)	1.6	0.19(U)	0.96	0.16(U)
Benzo(g,h,i)perylene	n/a[c]	4.9	1.4	0.18(U)	0.65	0.19(U)	0.42	0.16(U)
Benzo(k)fluoranthene	6.1	**7.9**	1.7	0.18(U)	1.4	0.19(U)	1.1	0.16(U)
Bis(2-ethylhexyl)phthalate	32	1.8	0.69	0.18(U)	0.88	0.19(U)	0.25	0.16(U)
Butyl benzyl phthalate	13 000	8.3	3.1	0.3	2.4	0.19(U)	0.96	0.16(U)
Chrysene	240	14	3.5	0.21	2.4	0.19(U)	1.6	0.16(U)
Fluoranthene	2 600	18	4.8	0.2	3.4	0.19(U)	2.3	0.18
Indeno(1,2,3-cd)pyrene	0.61	4.8	1.3	0.18(U)	0.67	0.19(U)	0.42	0.16(U)
Naphthalene	800	0.69(U)	0.53(U)	0.18(U)	0.17(U)	0.19(U)	0.23	0.16(U)
Phenanthrene	n/a	11	2.2	0.18(U)	1.7	0.19(U)	1.7	0.16(U)
Pyrene	2 000	15	3.8	0.2	2.7	0.19(U)	1.8	0.16(U)
Lead	400	200	69	21	53	9.5	34	11
Mercury	23	0.11	0.137[d]	0.11	0.11	0.12	0.1	0.1(U)
Silver	380	2.1(U)	3.3	2.2(U)	2.2(U)	2.4(U)	2(U)	2.1(U)

[a] U = Undetected quantity.
[b] Values in bold exceed the SAL.
[c] n/a = No applicable value is available.
[d] Value is the maximum of a sample and its laboratory duplicate.

6.0 WASTE MANAGEMENT

The following subsections describe the waste management activities implemented at TA-32 and the wastes generated during remediation at each of the PRSs. Waste segregation and minimization was carried out during removal of the influent drain lines at PRSs 32-002(a,b) and 32-004 to minimize the potential for generation of mixed waste. A dry decontamination procedure was used to eliminate the generation of liquid waste.

6.1 Deviations

All waste management procedures were followed as described in the VCA plans, the waste management plan, and the spill prevention plan developed for the site. No deviations to these plans occurred.

6.2 Waste Characterization Data

This section discusses the characterization of wastes generated at each PRS. Samples of waste material collected from each PRS were, at a minimum, screened with a PID for VOCs and with instruments for measuring alpha, beta, and gamma radiation. Table 6.2-1 provides a summary of the type, volume, and final disposition of all wastes generated at each PRS.

PRS 32-001. A small quantity (less than 3 ft^3) of waste consisting of personal protective equipment such as gloves and disposable Tyvek™ was generated during characterization activities at PRS 32-001. This material was classified as municipal waste and disposed of at the Los Alamos County landfill.

PRS 32-002(a,b). Four waste streams were generated during the VCA performed at PRSs 32-002(a,b). The first waste stream consisted of 271 linear feet of drain line. As the drain line was removed from the trenches, individual pipe sections were cleaned using a dry decontamination procedure. Swipe samples were then collected from the interior and exterior of each 3-ft pipe section and analyzed using a Ludlum™ Model 139 for alpha radioactivity and an Eberline™ Model ESP-1 for beta and gamma radioactivity. The drain line was composed of approximately 131 ft of VCP, approximately 55 ft of cast iron pipe, and approximately 85 ft of orangeburg, a tar paper-like material. The total volume of drain line materials constituted approximately 6 yds^3 and was managed in two B-25 boxes (Table 6.2-1). This material was characterized as low-level radioactive waste and was disposed of at TA-54, Area G.

The second waste stream consisted of approximately 4 ft^3 of sludge collected from the interior of the influent drain lines. This material was classified as mixed waste, managed in a 55-gallon drum, and transported to TA-54, Area G.

The third waste stream consisted of approximately 4 yds^3 of contaminated soil generated from the 32-002(a) footprint excavation. This material was characterized as low-level radioactive waste, stored in a B-25 box, and disposed of at TA-54, Area G. Also, a small amount (1 ft^3) of nonradioactive soil potentially contaminated with PCBs was collected from below the mouth of the 32-002(a) outfall pipe. This material was disposed of in a roll-off bin containing PCB-contaminated soil from PRS 32-003.

A small quantity of waste consisting of personal protective equipment was generated during characterization activities at PRSs 32-002(a,b). Due to the potential for radioactive contamination, this material was characterized as low level radioactive waste and disposed of at TA-54, Area G.

PRS 32-003. Two waste streams were generated during the VCA performed at PRS 32-003. The first waste stream consisted of approximately 100 yds^3 of soil contaminated with PCBs. Field screening and analytical results for this soil did not indicate the presence of any other contaminants. The soil and approximately 2 ft^3 of personal protective equipment were disposed of in five roll-off bins (20 yds^3 capacity) and two B-25 boxes (4 yds^3 capacity). This material was characterized as PCB soil, and transported for disposal.

The second waste stream consisted of one drum (approximately 0.3 yds^3) of PCB-contaminated wood from the wood debris pile. This material was classified as PCB debris and shipped offsite for treatment and disposal.

PRS 32-004. The waste stream generated from PRS 32-004 consisted of 41 ft of VCP drain line and 4 ft of cast iron drain line. No sludge was found inside the pipe. This material was disposed of as low-level radioactive waste at TA-54, Area G. A small quantity of waste (0.6 yds^3) consisting of personal protective equipment was also generated. This material was classified as low level radioactive waste and disposed of at TA-54, Area G with the personal protective equipment from the investigation at PRSs 32-002(a,b).

TABLE 6.2-1

WASTE MANAGEMENT SUMMARY

PRS	WASTE TYPE	VOLUME	WASTE CLASSIFICATION	COSTS
32-001	Personal protective equipment	Approximately 3 ft^3	Municipal waste	$0
32-002 (a,b)	Drain line pipe	6 yds^3 (271 linear foot of pipe)	Low-level radioactive waste	$900
	Soil	4 yds^3	Low-level radioactive waste	$600
	Sludge	4 ft^3 (less than one drum)	Mixed waste	$1 600
	Personal protective equipment	0.6 yds^3	Low-level radioactive waste	$90
32-003	Soil, Personal protective equipment	Approximately 100 yds^3	PCB soil	$65 000
	Wood	0.3 yds^3	PCB debris	$260
32-004	Drain line pipe	1 yds^3	Low-level radioactive waste	$150
	Personal protective equipment	0.6 yds^3	Low-level radioactive waste	$0

7.0 REFERENCES

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APPENDIX A RESULTS OF QUALITY ASSURANCE/QUALITY CONTROL ACTIVITIES

The following sections discuss the quality assurance/quality control (QA/QC) activities associated with Phase II samples, confirmation samples, and waste characterization samples collected during the Phase II and VCA activities at Technical Area (TA) 32. All samples were validated at baseline or routine levels unless a problem was noted that required more focused validation.

Inorganic Analyses

In requests 2022 and 2055, samples were analyzed for target analyte list (TAL) metals, and in request 2076 samples were analyzed for toxicity characteristic leaching procedures (TCLP) metals. There were no QC problems with these requests. All data are valid and usable without qualification.

In request 1895, one sample was analyzed for TAL metals. Silver and selenium had recoveries of 72% and 74%, respectively, in the matrix spike sample for this request. These analytes are qualified UJ, estimated undetected quantities. All other data are valid and usable without qualification.

In request 1904, one sample was analyzed for TAL metals. Arsenic, thallium, and selenium had recoveries of 68%, 61%, and 51%, respectively, in the matrix spike sample for this request. Arsenic data are qualified J, estimated quantities, and thallium and selenium data are qualified UJ. All other data are valid and usable without qualification.

In requests 1921 and 1928, soil samples were analyzed for TAL metals. Arsenic, antimony, and copper had recoveries of 33%, 56%, and 137%, respectively, in the matrix spike sample for these requests. Arsenic data are qualified J, antimony data are qualified UJ, and copper data are qualified J+, estimated quantities with a high bias. The estimated quantitation limit (EQL) for nickel was raised in several of the samples because of contamination in the method blank. All other data are valid and usable without qualification.

In request 1995, samples were analyzed for TAL metals. Selenium had a low recovery in the matrix spike sample (54%) for this request. Therefore, the selenium data are qualified UJ. All other data are valid and usable without qualification.

In request 2004, samples were analyzed for TAL metals. Antimony and zinc had recoveries of 41% and 45%, respectively, in the matrix spike sample for this request. Antimony and zinc data are qualified J-, estimated quantities with a low bias, where detected, and UJ where not detected. All other data are valid and usable without qualification.

In request 2018, samples were analyzed for TAL metals. Arsenic and mercury had recoveries of 39% and 48%, respectively, in the matrix spike sample for this request. Arsenic and mercury data are qualified UJ. All other data are valid and usable without qualification.

In request 2026, samples were analyzed for TAL metals. Antimony had a low recovery in the matrix spike sample (39%) for this request. Therefore, the antimony data are qualified UJ. All other data are valid and usable without qualification.

In request 2037, one sample was analyzed for TAL metals. Arsenic, lead, selenium, and antimony had recoveries between 40% and 75% in the matrix spike sample for this request. Detected values for these analytes are qualified J-, and nondetected values are qualified UJ. All other data are valid and usable without qualification.

In request 2051, soil samples were analyzed for TAL metals. Thallium, selenium, and lead had recoveries of 64%, 64%, and greater than 120%, respectively, in the matrix spike sample for this request. Thallium and selenium data are qualified UJ and lead data are qualified J+. All other data are valid and usable without qualification.

In request 2068, soil samples were analyzed for TAL metals. Zinc, antimony, and lead had recoveries of 51%, 39%, and 54%, respectively, in the matrix spike sample for this request. Detected values for these analytes are qualified J-, and nondetected values are qualified UJ. All other data are valid and usable without qualification.

Organic Analyses

In requests 1894, 1903, 1994, 2003, and 2017, samples were analyzed for volatile organic compounds (VOCs). There were no QC problems with these requests. All data are valid and usable without qualification.

In request 2021, samples were analyzed for VOCs. Acetone and methylene chloride were found in the method blank at 3 ug/kg and 2 ug/kg, respectively, in this request. For samples in which these analytes were detected at levels less than 10 times the concentrations in the blank, the EQL for the analyte was raised to the detected level and qualified U. All other data are valid and usable without qualification.

In requests 2025 and 2036, samples were analyzed for VOCs. There were high surrogate recoveries (greater than 120%) in these requests. Because of the high recoveries, all detected values are qualified J+. Nondetected values are not affected by the high recoveries. All other data are valid and usable without qualification.

In requests 2049 and 2054, samples were analyzed for VOCs. There were several QC problems with these requests. There was one high surrogate recovery (greater than 120%) and one low surrogate recovery (68%). In addition, the internal standards were below allowable limits in all of the samples. Therefore, all of the data are qualified J or UJ.

In request 2075, samples were analyzed for VOCs. The internal standards were all below the allowable limits in all of the samples. In addition, methylene chloride was found in the method blank at 9 ug/kg. For samples in which this analyte was detected at levels less than 10 times the concentration in the blank, the EQL for the analyte was raised to the detected level and qualified UJ. All other data are qualified UJ because of the low internal standards.

In requests 1894, 1903, 1920, 1927, 1994, 2003, 2025, 2036, 2049, 2054, 2067, and 2075, samples were analyzed for semivolatile organic compounds (SVOCs). There were no QC problems with these requests. All data are valid and usable without qualification.

In requests 2017 and 2021, samples were analyzed for SVOCs. Bis-2-ethylhexylphthalate was found in the method blank at 69 ug/kg. For samples in which this analyte was detected at levels less than 10 times the concentration in the blank, the EQL for the analyte was raised to the detected level and qualified U. All other data are valid and usable without qualification.

In request 2081, 2083 and 2106, samples were analyzed for polychlorinated biphenyls (PCBs). Requests 2081 and 2106 were analyzed in the mobile chemistry analytical laboratory (MCAL) with reduced QC measures. However, there were no QC problems with any of these requests. All data are valid and usable without qualification.

Radiochemical Analyses

The radiochemical analyses and techniques used for all of the requests below are as follows: isotopic plutonium was analyzed using alpha spectroscopy, isotopic uranium was analyzed using alpha spectroscopy or inductively coupled plasma/mass spectrometry (ICP/MS), americium-241 was analyzed using alpha spectroscopy or gamma spectroscopy, tritium was analyzed using liquid scintillation, percent moisture was analyzed using gravimetric procedures, and gamma radiation was analyzed using gamma spectroscopy.

In requests 1996, 2023, 2038, 2052, 2057, and 2069, radiochemical analyses were performed. There were no QC problems with these requests. All data are valid and usable without qualification.

In request 1922, radiochemical analyses were performed. Americium-241 data are qualified UJ because of low tracer recovery (less than 30%). Tritium, plutonium-238, and plutonium-239 data are all qualified U because the levels detected in the samples were the same as in the method blank. All other data are valid and usable without qualification.

In request 1929, radiochemical analyses were performed. Americium-241 data are qualified UJ because of low tracer recovery (less than 30%). Tritium data are qualified U because the levels detected in the samples were the same as in the method blank. Uranium-234 and uranium-238 data are qualified J because the difference in the duplicate and sample values was greater than 3 times the uncertainty of the measurements. All other data are valid and usable without qualification.

In requests 2005, 2019, and 2027, radiochemical analyses were performed. In samples 0132-96-0608, 0132-96-0610, and 0132-96-0611, plutonium-238 and plutonium-239 data are qualified J for low carrier recoveries (27%, 21%, and 25%, respectively). All other data are valid and usable without qualification.

TABLE A-1

SUMMARY OF QUALITY ASSURANCE/QUALITY CONTROL RESULTS FOR TA-32

REQUEST NUMBER	SAMPLE ID	ANALYTE SUITE	QUALITY CONTROL (QC) COMMENTS
1895	0132-96-0209	TAL metals[a]	Silver and selenium are qualified UJ[b] for low recoveries in the matrix spike sample (less than 75%).
1904	0132-96-0210	TAL metals	Arsenic qualified J-[c] for low matrix spike recovery (less than 75%). Thallium and selenium are qualified UJ for low recoveries in the matrix spike sample (less than 75%).
1921	0132-96-0321	TAL metals	Antimony and arsenic are qualified UJ for low recoveries in the matrix spike sample (less than 75%). Copper qualified J+[d] for high recovery in matrix spike sample (137%).
1921	0132-96-0322	TAL metals	Antimony and arsenic are qualified UJ for low recoveries in the matrix spike sample (less than 75%). Copper qualified J+ for high recovery in matrix spike sample (137%).
1921	0132-96-0323	TAL metals	Antimony and arsenic are qualified UJ for low recoveries in the matrix spike sample (less than 75%). Copper qualified J+ for high recovery in matrix spike sample (137%). Nickel EQL[e] raised and data qualified UJ[f] because of method blank contamination.
1921	0132-96-0324	TAL metals	Antimony and arsenic are qualified UJ for low recoveries in the matrix spike sample (less than 75%). Copper qualified J+ for high recovery in matrix spike sample (137%).
1921	0132-96-0325	TAL metals	Antimony and arsenic are qualified UJ for low recoveries in the matrix spike sample (less than 75%). Copper qualified J+ for high recovery in matrix spike sample (137%). Nickel EQL raised and qualified U because of method blank contamination.
1921	0132-96-0326	TAL metals	Antimony and arsenic are qualified UJ for low recoveries in the matrix spike sample (less than 75%). Copper qualified J+ for high recovery in matrix spike sample (137%).
1921	0132-96-0327	TAL metals	Antimony and arsenic are qualified UJ for low recoveries in the matrix spike sample (less than 75%). Copper qualified J+ for high recovery in matrix spike sample (137%).
1922	0132-96-0321	Radionuclides[g]	Americium-241 qualified J[h] for low tracer recovery (less than 30%). Tritium, plutonium-238, and plutonium-239 qualified U because detected levels were the same as in the method blank.
1922	0132-96-0322	Radionuclides	Americium-241 qualified J for low tracer recovery (less than 30%). Tritium, plutonium-238, and plutonium-239 data qualified U because detected levels were the same as in the method blank.

TABLE A-1 (CONTINUED)

SUMMARY OF QUALITY ASSURANCE/QUALITY CONTROL RESULTS FOR TA-32

REQUEST NUMBER	SAMPLE ID	ANALYTE SUITE	QUALITY CONTROL (QC) COMMENTS
1922	0132-96-0323	Radionuclides	Americium-241 qualified J for low tracer recovery (less than 30%). Tritium, plutonium-238, and plutonium-239 all qualified U because detected levels were the same as in the method blank.
1922	0132-96-0324	Radionuclides	Americium-241 qualified J for low tracer recovery (less than 30%). Tritium, plutonium-238, and plutonium-239 data qualified U because detected levels were the same as in the method blank.
1922	0132-96-0325	Radionuclides	Americium-241 qualified J for low tracer recovery (less than 30%). Tritium, plutonium-238, and plutonium-239 data qualified U because detected levels were the same as in the method blank.
1922	0132-96-0326	Radionuclides	Americium-241 qualified J for low tracer recovery (less than 30%). Tritium, plutonium-238, and plutonium-239 data qualified U because detected levels were the same as in the method blank.
1922	0132-96-0327	Radionuclides	Americium-241 qualified J for low tracer recovery (less than 30%). Tritium, plutonium-238, and plutonium-239 data qualified U because detected levels were the same as in the method blank.
1928	0132-96-0351	TAL metals	Antimony and arsenic are qualified UJ for low recoveries in the matrix spike sample (less than 75%). Copper qualified J+ for high recovery in matrix spike sample (137%).
1928	0132-96-0352	TAL metals	Antimony and arsenic are qualified UJ for low recoveries in the matrix spike sample (less than 75%). Copper qualified J+ for high recovery in matrix spike sample (137%). Nickel EQL raised and data qualified U because of method blank contamination.
1928	0132-96-0353	TAL metals	Antimony and arsenic are qualified UJ for low recoveries in the matrix spike sample (less than 75%). Copper qualified J+ for high recovery in matrix spike sample (137%).
1928	0132-96-0354	TAL metals	Antimony and arsenic are qualified UJ for low recoveries in the matrix spike sample (less than 75%). Copper qualified J+ for high recovery in matrix spike sample (137%). Nickel EQL raised and data qualified U because of method blank contamination.
1928	0132-96-0355	TAL metals	Antimony and arsenic are qualified UJ for low recoveries in the matrix spike sample (less than 75%). Copper qualified J+ for high recovery in matrix spike sample (137%).
1928	0132-96-0356	TAL metals	Antimony and arsenic are qualified UJ for low recoveries in the matrix spike sample (less than 75%). Copper qualified J+ for high recovery in matrix spike sample (137%). Nickel EQL raised and data qualified U because of method blank contamination.

TABLE A-1 (CONTINUED)

SUMMARY OF QUALITY ASSURANCE/QUALITY CONTROL RESULTS FOR TA-32

REQUEST NUMBER	SAMPLE ID	ANALYTE SUITE	QUALITY CONTROL (QC) COMMENTS
1928	0132-96-0357	TAL metals	Antimony and arsenic are qualified UJ for low recoveries in the matrix spike sample (less than 75%). Copper qualified J+ for high recovery in matrix spike sample (137%).
1929	0132-96-0352	Radionuclides	Americium-241 qualified J for low tracer recovery (less than 30%). Tritium qualified U because detected levels were the same as in the method blank. Uranium-234 and uranium-238 qualified J for greater than 3 sigma difference in duplicate and sample values.
1929	0132-96-0353	Radionuclides	Americium-241 qualified UJ for low tracer recovery (less than 30%). Tritium, plutonium-238, plutonium-239, and uranium-235 all qualified U because detected levels were the same as in the method blank. Uranium-234 and uranium-238 qualified J for greater than 3 sigma difference in duplicate and sample values.
1929	0132-96-0354	Radionuclides	Americium-241 qualified UJ for low tracer recovery (less than 30%). Tritium, plutonium-238, plutonium-239 and uranium-235 all qualified U because detected levels were the same as in the method blank. Uranium-234 and uranium-238 qualified J for greater than 3 sigma difference in duplicate and sample values.
1929	0132-96-0355	Radionuclides	Americium-241 qualified UJ for low tracer recovery (less than 30%). Uranium-234 and uranium-238 qualified J for greater than 3 sigma difference in duplicate and sample values.
1929	0132-96-0356	Radionuclides	Americium-241 qualified UJ for low tracer recovery (less than 30%). Uranium-234 and uranium-238 qualified J for greater than 3 sigma difference in duplicate and sample values.
1929	0132-96-0357	Radionuclides	Americium-241 qualified UJ for low tracer recovery (less than 30%). Tritium, plutonium-238, plutonium-239 and uranium-235 qualified U because detected levels were the same as in the method blank. Uranium-234 and uranium-238 qualified J for greater than 3 sigma difference in duplicate and sample values.
1995	0132-96-0621	TAL metals	Selenium qualified UJ for low recovery in the matrix spike sample (<75%).
1995	0132-96-0622	TAL metals	Selenium qualified UJ for low recovery in the matrix spike sample (<75%).
2004	0132-96-0611	TAL metals	Antimony and zinc qualified J or UJ for low recovery in the matrix spike sample (<75%).
2004	0132-96-0612	TAL metals	Antimony and zinc qualified J or UJ for low recovery in the matrix spike sample (<75%).
2005	0132-96-0611	Radionuclides	Plutonium-239 and plutonium-238 qualified J for low carrier recovery (25%).

TABLE A-1 (CONTINUED)

SUMMARY OF QUALITY ASSURANCE/QUALITY CONTROL RESULTS FOR TA-32

REQUEST NUMBER	SAMPLE ID	ANALYTE SUITE	QUALITY CONTROL (QC) COMMENTS
2017	0132-96-0601	SVOCs[j]	Bis-2-ethylhexylphthalate found in blank. EQLs were raised appropriately.
2017	0132-96-0602	SVOCs	Bis-2-ethylhexylphthalate found in blank. EQLs were raised appropriately.
2017	0132-96-0610	SVOCs	Bis-2-ethylhexylphthalate found in blank. EQLs were raised appropriately.
2018	0132-96-0601	TAL metals	Arsenic and mercury qualified UJ for matrix spike recoveries of less than 75%.
2018	0132-96-0602	TAL metals	Arsenic and mercury qualified UJ for matrix spike recoveries of less than 75%.
2018	0132-96-0610	TAL metals	Arsenic and mercury qualified UJ for matrix spike recoveries of less than 75%.
2019	0132-96-0610	Radionuclides	Plutonium-239 and plutonium-238 qualified UJ for low carrier recovery (21%).
2021	0132-96-0603	VOCs[j]	Acetone and methylene chloride found in blank. EQLs were raised appropriately.
2021	0132-96-0604	VOCs	Acetone and methylene chloride found in blank. EQLs were raised appropriately.
2021	0132-96-0605	VOCs	Acetone and methylene chloride found in blank. EQLs were raised appropriately.
2021	0132-96-0606	VOCs	Acetone and methylene chloride found in blank. EQLs were raised appropriately.
2021	0132-96-0603	SVOCs	Bis-2-ethylhexylphthalate found in blank. EQLs were raised appropriately.
2021	0132-96-0604	SVOCs	Bis-2-ethylhexylphthalate found in blank. EQLs were raised appropriately.
2021	0132-96-0605	SVOCs	Bis-2-ethylhexylphthalate found in blank. EQLs were raised appropriately.
2021	0132-96-0606	SVOCs	Bis-2-ethylhexylphthalate found in blank. EQLs were raised appropriately.
2025	0132-96-0607	VOCs	All detects are qualified J+ for high surrogate recovery (greater than 120%).
2025	0132-96-0608	VOCs	All detects are qualified J+ for high surrogate recovery (greater than 120%).
2026	0132-96-0607	TAL metals	Antimony qualified UJ for low recovery in the matrix spike sample (less than 75%).
2026	0132-96-0608	TAL metals	Antimony qualified UJ for low recovery in the matrix spike sample (less than 75%).
2026	0132-96-0631	TAL metals	Antimony qualified UJ for low recovery in the matrix spike sample (less than 75%).

TABLE A-1 (CONTINUED)

SUMMARY OF QUALITY ASSURANCE/QUALITY CONTROL RESULTS FOR TA-32

REQUEST NUMBER	SAMPLE ID	ANALYTE SUITE	QUALITY CONTROL (QC) COMMENTS
2027	0132-96-0608	Radionuclides	Plutonium-239 data qualified J and plutonium-238 data qualified UJ for low carrier recovery (27%).
2036	0132-96-0609	VOCs	All detects qualified J+ for high surrogate recovery (greater than 120%).
2037	0132-96-0609	TAL metals	Arsenic, lead, and selenium qualified J- for low recovery in the matrix spike sample (less than 75%). Antimony qualified UJ for low recovery in the matrix spike sample.
2049	0132-96-0613	VOCs	All data qualified J or UJ for low internal standards, and one high and one low surrogate recovery.
2049	0132-96-0614	VOCs	All data qualified J or UJ for low internal standards, and one high and one low surrogate recovery.
2051	0132-96-0613	TAL metals	Selenium and thallium qualified UJ for low recovery in the matrix spike sample (less than 75%). Lead qualified J+ for high recovery in the matrix spike sample (greater than 120%).
2051	0132-96-0614	TAL metals	Selenium and thallium qualified UJ for low recovery in the matrix spike sample (less than 75%). Lead qualified J+ for high recovery in the matrix spike sample (greater than 120%).
2054	0132-96-0615	VOCs	All data qualified UJ for low internal standards, and one high and one low surrogate recovery.
2054	0132-96-0616	VOCs	All data qualified UJ for low internal standards, and one high and one low surrogate recovery.
2068	0132-96-0751	TAL metals	Lead and zinc qualified J- for low recovery in the matrix spike sample (less than 75%). Antimony qualified UJ for low recovery in the matrix spike sample.
2068	0132-96-0752	TAL metals	Lead and zinc qualified J- for low recovery in the matrix spike sample (less than 75%). Antimony qualified UJ for low recovery in the matrix spike sample.
2068	0132-96-0753	TAL metals	Lead and zinc qualified J- for low recovery in the matrix spike sample (less than 75%). Antimony qualified UJ for low recovery in the matrix spike sample.
2068	0132-96-0754	TAL metals	Lead and zinc qualified J- for low recovery in the matrix spike sample (less than 75%). Antimony qualified UJ for low recovery in the matrix spike sample.
2068	0132-96-0755	TAL metals	Lead and zinc qualified J- for low recovery in the matrix spike sample (less than 75%). Antimony qualified UJ for low recovery in the matrix spike sample.
2068	0132-96-0801	TAL metals	Lead and zinc qualified J- for low recovery in the matrix spike sample (less than 75%). Antimony qualified UJ for low recovery in the matrix spike sample.

TABLE A-1 (CONTINUED)

SUMMARY OF QUALITY ASSURANCE/QUALITY CONTROL RESULTS FOR TA-32

REQUEST NUMBER	SAMPLE ID	ANALYTE SUITE	QUALITY CONTROL (QC) COMMENTS
2068	0132-96-0802	TAL metals	Lead and zinc qualified J- for low recovery in the matrix spike sample (less than 75%). Antimony qualified UJ for low recovery in the matrix spike sample.
2068	0132-96-0807	TAL metals	Lead and zinc qualified J- for low recovery in the matrix spike sample (less than 75%). Antimony qualified UJ for low recovery in the matrix spike sample.
2075	0132-96-0851	VOCs	All data qualified UJ for low internal standards. Methylene chloride found in method blank. All EQLs were raised appropriately.
2075	0132-96-0852	VOCs	All data qualified UJ for low internal standards. Methylene chloride found in method blank. All EQLs were raised appropriately.
2075	0132-96-0872	VOCs	All data qualified UJ for low internal standards. Methylene chloride found in method blank. All EQLs were raised appropriately.

[a] TAL metals = Target analyte list metals.
[b] UJ = Estimated undetected quantities.
[c] J - = Estimated low.
[d] J+ = Estimated high.
[e] EQL = Estimated quantitation limit.
[f] U = Undetected
[g] Radionuclides = americium-241, gamma scan, tritium, percent moisture, plutonium-238, plutonium-239, strontium-90, and total uranium.
[h] J = Estimated.
[i] SVOCs = Semivolatile organic compounds.
[j] VOCs = Volatile organic compounds.

APPENDIX B ANALYTICAL RESULTS

All analytical data are available in the Facility for Information Management, Analysis, and Display (FIMAD) database. If the FIMAD database is not accessible, data will be provided upon request.

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APPENDIX C COST COMPARISON

TABLE C-1

APPROXIMATE COSTS OF THE VCA ACTIVITIES AT TA-32

	PRSs 32-001 and 32-003	PRSs 32-002(a,b) and 32-004
Pre-field activities:	$15 366	$38 061
Field activities:	$45 475	$88 888
Waste disposal:	$12 975	$40 633
Sampling/analytical:	$20 361	$66 636
Post-field activities:	$12 679	$22 902
Total estimated cost:	$106 856	$257 120

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APPENDIX D RISK ASSESSMENT DATA AND EQUATIONS

1.0 INTRODUCTION

This appendix presents information supporting the risk assessment conducted for the outfall area at Potential Release Sites (PRSs) 32-002(a,b). The data, exposure parameters, toxicity values and profiles, and risk assessment equations are presented in the following sections.

1.1 Risk Assessment Data

In the risk assessment for the outfall area at PRSs 32-002(a,b), the mean was used as the most likely exposure (MLE), and the 95% upper confidence limit (UCL) of the mean was used as the reasonable maximum exposure (RME). Both of these values were calculated for mercury, cadmium, total chromium, silver, and thallium. The data were aggregated into one exposure unit, which represents the area directly below the outfall pipe. In calculating both the MLE and RME, nondetected values were replaced by one-half the reported detection limit. Multiple values for a specific location were averaged before estimating statistics. The mean and the 95% UCL of the mean for each chemical of potential concern (COPC) were then multiplied by the dust loading factor of 9×10^{-5} g/m^3 to yield the input value for dust (Dorries 1996, 1297). Table D-1 presents the data used in the risk assessment for the outfall area at PRSs 32-002(a,b).

Mercury. Data were log-normally distributed, and statistics were calculated using the equations presented in "Statistical Methods for Environmental Pollution Monitoring" (Gilbert 1987, 0312). The mean was estimated by equation 13.3 and the variance (standard deviation) was estimated by equation 13.5 (Gilbert 1987, 0312). The 95% UCL of the mean was estimated using the Crystal Ball™ simulator, which is an add-on to Microsoft Excel™. Crystal Ball allows for simulations with a variety of statistical distributions, including the lognormal. The estimated mean and standard deviation of the lognormal distribution in Crystal Ball™ simulations were used. The calculation of the mean of 13 samples was simulated in each Crystal Ball™ run, and these simulations were repeated 10 000 times. The 95th percentile of the simulations is reported as the RME concentration.

Cadmium. Eight of 16 results were reported as nondetected values, which precluded estimation of a distribution. Normality was assumed for calculation of the mean. The RME was estimated as the maximum detected value of cadmium.

TABLE D-1

CONCENTRATIONS USED IN RISK ASSESSMENT CALCULATIONS FOR THE OUTFALL AREA AT PRSs 32-002(a,b)

CHEMICAL	SOIL		DUST	
	MEAN (mg/kg)	95% UCL OF THE MEAN (mg/kg)	MEAN ($\mu g/m^3$)	95% UCL OF THE MEAN ($\mu g/m^3$)
Cadmium	1.1	5.6[a]	1×10^{-4}	5×10^{-4}
Chromium (total)	61.3	129	5×10^{-3}	1.9×10^{-3}
Chromium III	52.5	110.6	5×10^{-3}	0.01
Chromium VI	8.8	18.4	8×10^{-4}	2×10^{-3}
Mercury	52.2	139	5×10^{-3}	0.01
Silver	13.6	26.4	1×10^{-3}	2×10^{-3}
Thallium	0.8	2.4	7×10^{-5}	5×10^{-4}

[a] The UCL of the mean for cadmium was estimated as the maximum reported value.

Total Chromium. Data were lognormally distributed, and statistics were calculated using the equations presented in "Statistical Methods for Environmental Pollution Monitoring" (Gilbert 1987, 0312). The mean was estimated by equation 13.3 and the variance (standard deviation) was estimated by equation 13.5. The 95% UCL of the mean was estimated using the Crystal Ball™ simulator.

Total chromium is composed of one part chromium VI and six parts chromium III, for a total of 7 parts according to the Health Effects Assessment Summary Tables (HEAST), a standard risk assessment tool (Miller 1994, 1169). The mean and the 95% UCL of the mean of total chromium were both multiplied by one-seventh in order to estimate the mean and 95% UCL of the mean of chromium VI, and by six-sevenths in order to estimate the mean and 95% UCL of the mean of chromium III.

Silver. Data were lognormally distributed, and statistics were calculated using the equations presented in "Statistical Methods for Environmental Pollution Monitoring" (Gilbert 1987, 0312). The mean was estimated by equation 13.3 and the variance (standard deviation) was estimated by equation 13.5. The 95% upper confidence limit of the mean was estimated using the Crystal Ball™ simulator.

Thallium. Twelve of 16 results were reported as nondetects, which precluded estimation of a distribution. Normality was assumed for calculation of the mean. The RME was estimated as the maximum detected value of thallium.

1.2 Recreational Scenario Exposure Parameters

Recreational scenario exposure parameters listed in the document "Risk-Based Corrective Action Process" were used in the risk assessment for the outfall area at PRSs 32-002(a,b) (Dorries 1996, 1297). Table D-2 presents these recreational scenario exposure parameters.

1.3 Toxicity Values

The toxicity value used to evaluate noncarcinogenic effects for a COPC is the reference dose (RfD). The RfD has been developed based on the concept that a threshold dose exists below which adverse effects are not likely to be observed. RfDs exist for both chronic and subchronic exposures; chronic exposure reference doses were used in this risk assessment because of the length of the exposure periods involved (9 and 30 years). The Environmental Protection Agency's (EPA's) Integrated Risk Information System (IRIS) and HEAST were used, in this order, to identify RfD values.

For COPCs with carcinogenic effects, the slope factor and accompanying weight-of-evidence is used to evaluate toxicity. The slope factor is derived based upon the concept that there is no threshold of exposure below which a carcinogenic response may not occur. The slope factor is used to estimate the upper-bound lifetime probability of cancer induction as a result of exposure to a certain level of a suspected or known carcinogen. Weight-of-evidence carcinogenicity classifications are:

A = human carcinogen,

B1 = probable human carcinogen, but limited human data are available,

B2 = probable human carcinogen with sufficient evidence in animals and inadequate or no evidence in humans,

C = possible human carcinogen,

D = not classifiable as to human carcinogenicity, and

E = evidence of noncarcinogenicity for humans.

Table D-3 presents the toxicity values used in the risk assessment for the outfall area at PRSs 32-002(a,b) and the reference material in which those values are listed.

TABLE D-2

EXPOSURE PARAMETERS USED IN THE RECREATIONAL RISK ASSESSMENT FOR THE OUTFALL AREA AT PRSs 32-002(a,b)

PATHWAY	PARAMETER (UNITS)	MOST LIKELY EXPOSURE	REASONABLE MAXIMUM EXPOSURE
Inhalation of dust	BW[a] (kg)	70	70
	IR[b] (m^3/hr)	1.3	3.5
	ET[c] (hr/day)	2	2
	EF[d] (days/yr)	10	170
	ED[e] (yr)	9	30
Ingestion of soil	BW (kg)	70	70
	IR (mg/day)	100	100
	FI[f] (unitless)	2.50×10^{-01}	2.50×10^{-01}
	EF (days/yr)	10	170
	ED (yr)	9	30
Dermal contact with soil	BW (kg)	70	70
	AF[g] (mg/cm^2)	2.00×10^{-01}	1
	SA[h] (cm^2/event)	2 000	5 300
	EF (events/yr)	10	170
	ED (yr)	9	30

[a] BW = Body weight.
[b] IR = Soil ingestion rate.
[c] ET = Exposure time.
[d] EF = Exposure frequency.
[e] ED = Exposure duration.
[f] FI = Fraction ingested.
[g] AF = Soil-to-skin adherence factor.
[h] SA = Skin surface area exposed.

TABLE D-3

TOXICITY VALUES USED IN THE RISK ASSESSMENT CALCULATIONS FOR THE OUTFALL AREA AT PRSs 32-002(a,b)

CHEMICAL	EPA CLASS	ORAL REFERENCE DOSE (CHRONIC) (mg/kg/day)	SOURCE	DERMAL REFERENCE DOSE (CHRONIC) (mg/kg/day)	SOURCE	INHALATION REFERENCE CONCENTRATION (CHRONIC) ($\mu g/m^3$)	SOURCE	ORAL SLOPE FACTOR [1/(mg/kg/day)]	SOURCE
Cadmium	B1[a]	1×10^{-3}	IRIS[b], September 1996	1×10^{-3}	IRIS[b], September 1996	N/A[c]	N/A	6.1	HEAST[d], FY[e] 1992
Chromium III	N/A	1	IRIS, September 1996	1	IRIS, September 1996	N/A	N/A	N/A	N/A
Chromium VI	A[f]	5×10^{-3}	IRIS, September 1996	5×10^{-3}	IRIS, September 1996	N/A	N/A	41	HEAST, FY 1993
Mercury	D[g]	3×10^{-4}	IRIS, September 1996	3×10^{-4}	IRIS, September 1996	3×10^{-4}	IRIS, September 1996	N/A	N/A
Silver	D	5×10^{-3}	IRIS, September 1996	5×10^{-3}	IRIS, September 1996	N/A	N/A	N/A	N/A
Thallium	D	8×10^{-5}	IRIS, September 1996	8×10^{-5}	IRIS, September 1996	N/A	N/A	N/A	N/A

[a] B1 = Probable human carcinogen, but limited human data are available.
[b] IRIS = Integrated Risk Information System.
[c] N/A = Not available.
[d] HEAST = Health Effects Assessment Summary Tables.
[e] FY = Fiscal year.
[f] A = Human carcinogen.
[g] D = Not classifable as to human carcinogenicity.

1.4 Toxicity Profiles for Chemicals of Potential Concern

Toxicity profiles are provided in this section for the COPCs cadmium, chromium, lead, mercury, silver, and thallium.

1.4.1 Toxicity Profile for Cadmium

Oral Reference Dose: IRIS lists the oral RfD for cadmium in water as 5.0×10^{-04} mg/kg/day, and in food as 1.0×10^{-03} mg/kg/day. Each of these values was derived with an uncertainty factor of 10.

Carcinogen Classification: Group B1, probable human carcinogen.

Uses: Cadmium is a metallic element, occurring primarily in zinc, copper, and lead ores. It is used in solders, dental amalgams, cathode material for nickel-cadmium storage batteries, as a color pigment for paints and plastics and in rustproof electroplating. A major nonoccupational source of respirable cadmium is cigarettes.

Health Effects: Exposure to high levels of cadmium via inhalation severely damages the lungs and can cause death. Inhalation of lower levels for a period of years results in accumulation of cadmium in the kidneys that can cause kidney disease. Long-term exposure to cadmium by inhalation may also cause fragile bones.

Long-term exposure of workers to cadmium via inhalation in an occupational setting may increase the risk of developing lung cancer. Experimental studies indicate that mice and hamsters exposed to cadmium by inhalation do not develop lung cancer; however, rats clearly do. Pregnant female rodents that inhaled high levels of cadmium produced fewer litters, and the pups exhibited more birth defects than usual. Inhalation of cadmium also causes liver damage and changes in the immune system in rats and mice. Currently, it is not known whether inhalation of cadmium affects the ability of humans to reproduce or has harmful effects on the fetus, liver, heart, nervous system, or immune system in humans (Life Systems, Inc. 1992, 1053).

Consumption of very high levels of cadmium in food or drink severely irritates the stomach and causes vomiting and diarrhea. Deaths from cadmium ingestion have only been documented in cases of suicide. Similar to exposure via inhalation, ingestion of lower levels of cadmium results in a build-up in the kidneys, resulting in kidney damage and fragile bones. Animals exposed to cadmium through the diet or in water, occasionally develop high blood pressure, iron-poor blood, liver disease, and nerve or brain damage. Proof that humans develop these

conditions is lacking. Studies in humans and animals have not indicated that eating or drinking cadmium increases the incidence of cancer. Dermal contact with cadmium is not known to cause adverse health effects in animals or humans (Life Systems, Inc. 1992, 1053).

Study Support: IRIS lists the oral reference dose for cadmium in water as 5.0×10^{-04} mg/kg/day and in food as 1.0×10^{-03} mg/kg/day. The reference dose is based on the highest level of cadmium in the human renal cortex (200 µg cadmium/g wet renal cortex) that is not associated with significant proteinuria, the critical effect of interest. A toxicokinetic model was used to determine the highest level of exposure associated with the lack of a critical effect. An uncertainty factor of 10 was applied to account for intrahuman variability to the toxicity of this chemical in the absence of specific data on sensitive individuals. The level of confidence in the RfD is high because of the many studies available on the toxicity of cadmium in both humans and animals.

The classification of cadmium as a Group B1 probable human carcinogen is based on limited evidence of its carcinogenicity in humans. This evidence is documented in several epidemiologic studies that demonstrated a possible association with lung and prostate cancers. There is also sufficient evidence of cadmium's carcinogenicity in rats and mice by the inhalation route (lung tumors), intratracheal instillation (mammary tumors in female rats, multiple sites in males), and intramuscular or subcutaneous injection (injection site and distant site tumors). The EPA has not established an oral slope factor for cadmium. The EPA has established an inhalation unit risk of 1.8×10^{-03} $(\mu g/m^3)^{-1}$ based primarily on an epidemiologic study of cadmium smelter workers in which an increased risk of lung, trachea, and bronchus cancer mortality was observed. The supporting study used a relatively large cohort, and smoking and concurrent arsenic exposures were accounted for in the quantitative analysis for cadmium.

1.4.2 Toxicity Profile for Chromium

Chromium is a naturally occurring element found in rocks, animals, plants, soil, and in volcanic dust and gases. It is important for glucose metabolism, and may be a cofactor for insulin. Chromium is present in the environment in several different forms, the most common of which are chromium 0, chromium III, and chromium VI. Chromium III occurs naturally in the environment, whereas chromium VI and Chromium 0 (metal chromium) are generally produced by industrial processes. Chromium III or chromium VI produced by the chemical industry are used for chrome plating, the manufacture of dyes and pigments, leather, wood preservatives, and treatment of cooling tower water. Smaller amounts are used in drilling muds, textiles, and toner for copying machines (Syracuse Research Corporation 1991, 1241).

1.4.2.1 Chromium III

Oral Reference Dose: 1 mg/kg/day. This reference dose was derived with an uncertainty factor of 100 and a modifying factor of 10.

Carcinogen Classification: Group D, not classifiable as to human carcinogenicity. Trivalent chromium (chromium III) is much less toxic and more abundant in nature than the hexavalent form (chromium VI). Chromium VI readily crosses all membranes and is reduced intracellularly to trivalent chromium. There is no evidence to suggest that chromium III is converted into chromium VI in biological systems (Amdur et al. 1991, 1239). For these reasons, the oral reference dose for chromium III may be used to estimate risk for ingestion of waterfowl and beef.

Health Effects: Respiratory effects have been observed in workers exposed to chromium III; however, other forms of chromium were present. The respiratory system is the primary target for injury following inhalation exposure in laboratory animals. Rats and mice inhaling various levels of chromium III oxide had increased lung weights, marked hyperplasia, interstitial fibrosis, and epithelial necrosis (Syracuse Research Corporation 1991, 1241).

Study Support: IRIS lists the chronic oral reference dose as 1 mg/kg/day, which is the same value listed in HEAST as the subchronic oral reference dose. These values are based on a chronic feeding study in rats. Even after feeding up to 5% of chromic oxide in the diet for 84 days, no adverse effects were observed at any dose level.

An uncertainty factor of 100 was applied to the oral RfD. This factor accounts for the interhuman and interspecies variability of the toxicity of chromium III. The oral RfD is limited to insoluble salts of chromium III. Confidence in the principal study is rated as low because of a lack of explicit detail on protocol and results. Low confidence in the database reflects the lack of high-dose supporting data. A modifying factor of 10 reflects uncertainty in the no-observable-effect level. An inhalation risk assessment for chromium III is under review by an EPA work group.

Chromium III is not believed to be carcinogenic at this time.

1.4.2.2 Chromium VI

Oral Reference Dose: 5×10^{-3} mg/kg/day. This reference dose was derived with an uncertainty factor of 500.

Carcinogen Classification: Group A, human carcinogen.

Health Effects: Chromate-sensitive workers acutely exposed to chromium VI develop asthma and other signs of respiratory distress. Symptoms include erythema of the face, nasopharyngeal pruritus, nasal blocking, coughing, and wheezing. In a retrospective mortality study, intermediate- to chronic-duration occupational exposure to chromium VI showed an increased risk of death due to noncancer respiratory disease. Occupational exposure has also been associated with adverse effects on the gastrointestinal system and severe liver injury. Additionally, chromium VI has been associated with an increased incidence of bronchogenic and nasal cancer following chronic occupational exposure.

Study Support: IRIS lists a chronic oral reference dose for chromium VI as 5×10^{-3} mg/kg/day. HEAST provides a subchronic oral reference dose of 2×10^{-2} mg/kg/day. These values are based on a year-long study in rats that were administered hexavalent and trivalent chromium in drinking water. No significant changes in appearance, weight gain, food consumption, or histologic lesions were observed in any of the treatment groups. An uncertainty factor of 500 accounts for the expected interhuman and interspecies variability in the toxicity of the chemical in lieu of specific data, and an additional factor of 5 to compensate for the less-than-lifetime exposure duration of the principal study. The oral RfD is limited to soluble salts of metallic chromium VI. Confidence in the principal study is low because of the small number of animals tested, the small number of parameters measured, and the lack of toxic effect at the highest dose tested. Confidence in the database is low because the supporting studies are of equally low quality, and teratogenic and reproductive endpoints are not well studied.

Chromium VI is considered to be carcinogenic only by inhalation and is classified as a Group A human carcinogen. IRIS lists an inhalation unit risk value of 1.2×10^{-2} $(\mu g/m^3)^{-1}$. The corresponding inhalation slope factor is 41 $(mg/kg/day)^{-1}$. The confidence in this unit risk factor is high because there is sufficient epidemiologic evidence in humans supporting this conclusion.

1.4.3 Toxicity Profile for Lead

Oral Reference Dose: Not determined. The risk assessment used EPA's Integrated Exposure Uptake Biokinetic Model (IEUBK) Blood Lead Model recommended per Office of Solid Waste and Emergency Response (OSWER) Directive 9355.4-12 (EPA 1994, 1178; EPA 1994, 1209).

Carcinogen Classification: Group B2, probable human carcinogen.

Uses: Lead, a naturally occurring metal, is found in nearly all phases of the environment and in most biologic systems. The most important use is in the production of lead-acid batteries. Other uses include the production of ammunition and some kinds of metal products (such as shoot lead, solder, and pipes). Tetraethyl lead and tetramethyl lead are used in gasoline additives. The principal route of exposure is in food, but other important sources include lead-based paints, auto exhaust, industrial emissions, lead glazed pottery used in food service, and cigarette smoke.

Health Effects: Children are known to absorb a greater percentage of lead from the diet than adults. Although lead produces a variety of toxic effects depending on the route of exposure and its chemical form, the most important effect of lead is its adverse effect on cognitive abilities and motor skills in young children. Low level exposure to lead during infancy and childhood increases the risk of irreversible neurobehavioral deficits at levels of internal exposure as low as 10–5 µg/dL in blood. Other target organs include the kidneys, red blood cells, and the gastrointestinal and reproductive tracts.

Much information about the health effects of lead has been obtained through decades of medical observation and scientific research. Therefore, the degree of uncertainty about the health effects of lead is quite low by comparison to most other environmental toxicants. The standard approach for quantifying the effects of a chemical relies on identifying the dose associated with adverse effects. This approach has not been successful for lead. Lead is found ubiquitously in the environment and, therefore, it is difficult (if not impossible) to isolate the route of exposure and characterize the effects of lead with varying dose. In addition, it appears that some of the health effects associated with lead, particularly those affecting children (neurobehavioral development) may essentially be without a threshold. The EPA's Reference Dose Work Group currently considers it inappropriate to develop a reference dose for inorganic lead. Reference dose methodologies are not flexible enough to incorporate site-specific information on lead exposure sources and demographic information because they are fundamentally route specific.

The EPA has classified lead as Group B2, a probable human carcinogen. Quantifying the cancer risk associated with lead involves many uncertainties, some of which may be unique to lead. Age, health, nutritional state, body burden, and exposure duration influence the absorption, release, and excretion of lead. Current knowledge of lead pharmacokinetics indicates that an estimate derived by standard procedures would not truly describe the potential risk. Therefore, a cancer slope factor has not been calculated for lead.

The use of mathematical and statistical models for environmental risk assessments has become increasingly widespread because of the many practical difficulties encountered in controlling human exposure to toxicants with subtle and long-lasting effects. The IEUBK Model is a computer simulation model available from the EPA that includes three components: 1) a biokinetic model for the absorption of lead from various environmental media, distribution of lead in the body, and its elimination from the fetus and children up to age 6; 2) a variety of input menus for estimating the absorption of lead from environmental media; and 3) a method for estimating the risk of elevated blood lead for individuals and for populations.

The IEUBK Model estimates the geometric mean blood lead concentration in children of different ages exposed to environmental lead. The model may then be used to calculate the probability that a blood lead level with the geometric mean calculated by the IEUBK Model exceeds a cutoff point specified by the user. Default values are provided for these parameters for which no data are available.

1.4.4 Toxicity Profile for Mercury

Oral Reference Dose: 3×10^{-4} mg/kg/day (HEAST, IRIS lists no oral reference). Inhalation RfD is 3×10^{-4} mg/kg/day (IRIS 9/96). This reference dose was derived using an uncertainty factor of 30.

Carcinogen Classification: Group D, not classifiable as to human carcinogenicity.

Uses: Mercury is a naturally occurring metal found throughout the environment. There are three forms of mercury: elemental (or metallic), inorganic compounds (combined with other elements such as chlorine or oxygen), and organic compounds (combined with carbon to form compounds such as methylmercury). Metallic mercury is mined and is also a waste product of gold mining. Chemical factories that make chlorine use mercury and may release metallic mercury into the air. Thermometers, barometers, batteries, and tooth fillings all contain metallic mercury. Inorganic mercury compounds are commonly used in electrical equipment (e.g. batteries, lamps), fungicides, and skin care and medicinal products. Organic mercury compounds were in some fungicides and paints and have banned (Clement International Corporation 1994, 1345).

Health Effects: The form of mercury, exposure level, duration, and route of exposure determine which adverse effects will predominate. Short-term exposure to high levels of metallic mercury in the air can cause lung damage, nausea, vomiting, diarrhea, increased blood pressure, increased heart rate, skin rashes, and damage to eyes. Long-term exposure

to metallic mercury causes memory loss and shakiness. Inhalation of metallic mercury at high exposure levels causes adverse respiratory, cardiovascular, and gastrointestinal effects.

Short- and long-term exposure to high levels of inorganic mercury can cause brain and kidney damage in humans. Exposure to high enough levels of metallic, inorganic, or organic mercury can permanently damage the brain, kidneys, and developing fetus.

Consumption of organic mercury in the form of contaminated fish or grains treated with organic mercury primarily affects the brain, kidneys, and the developing fetus. (Clement International Corporation 1994, 1345).

Study Support: A chronic and subchronic oral reference dose of 3.0×10^{-04} mg/kg/day is listed in HEAST for mercury. The chronic and subchronic inhalation reference concentration (RfC) is 3×10^{-4} mg/m^3. An uncertainty factor of 10 for sensitive human populations and 3 for the lack of developmental and reproductive studies was used.

The EPA has classified inorganic mercury as Group D, not classifiable as to human carcinogenicity. No human data are available and the animal data are inadequate to support classification. Classification of a chemical as Group D precludes quantitative toxicity assessment. Therefore, no slope factor was listed for mercury in either IRIS or HEAST.

1.4.5 Toxicity Profile for Silver

Oral Reference Dose: 5×10^{-3} mg/kg/day. This reference dose was derived using an uncertainty factor of 3.

Carcinogen Classification: Group D, not classifiable as to human carcinogenicity.

Uses: Silver is a metal. It is used in jewelry, silverware, electronic equipment, dental fillings, and photographs. Silver also occurs in compounds such as silver nitrate, silver chloride, silver sulfide, and silver oxide.

Health Effects: The most serious health effect resulting from silver exposure is believed to be argyria. Argyria is a gray or blue-gray coloration of the skin that is caused by eating or breathing silver compounds over time. Exposure to dust that contains silver compounds, such as silver nitrate or silver oxide, may cause breathing problems, lung and throat irritation, and stomach pain. Mild allergic reactions have been seen in humans due to skin exposure to silver compounds. One long-term animal study suggested that high levels of silver nitrate in drinking

water may have caused a slight effect on the brain. Another study found that exposure to silver nitrate or silver chloride led to enlargement of the heart. Animal studies, however, have not been complete enough to measure these effects adequately (Clement International Corporation 1994, 1344).

Study Support: The oral reference dose for silver is listed in IRIS as 5×10^{-03} mg/kg/day. This value is based on a 2- to 9-year human intravenous study. Argyria is the critical effect of silver ingestion in humans. It results in a bluish-gray discoloration of the skin from deposition of silver in the dermis and from silver-induced production of melanin. This deposition has not been associated with any adverse health effects. Data from 10 males and 2 females who were given intravenous injections of silver arsphenamine over a period of 2 to 9 years were collected. After a dose of 4, 7, or 8 g, argyria developed in some patients. Other patients developed argyria after 10, 15, or 20 g. Biospectrometric examination of skin biopsies showed a correlation between the degree of discoloration and the level of silver that was present. The lowest intravenous dose resulting in argyria was 1 g of metallic silver (an oral dose of 0.014 mg/kg/day). This was determined to be the lowest observable adverse effect level (LOAEL). A no observable adverse effect level (NOAEL) was not established. The subchronic oral reference dose is listed in HEAST as 5×10^{-3} mg/kg/day.

An uncertainty factor of 3 was used to account for sensitive individuals. An uncertainty factor was not assigned for the study duration because the dose was apportioned over a lifetime of 70 years. The confidence level in the oral reference dose is low. A NOAEL was not established because the study used individuals who were being treated for syphilis and may have been in bad health. Confidence in the database was low because the supporting studies were not controlled and the amount of silver ingestion was difficult to determine. The intravenous administration also required a dose conversion that introduces uncertainty. HEAST lists a chronic and subchronic reference dose of 3×10^{-03} that is based on the same study. Currently, no values are listed for an inhalation RfC.

Silver is classified as Group D, not classifiable as to human carcinogenicity. Induction of local sarcomas in animals after implantation of foils and discs of silver has been seen; however, the interpretation of these results is questionable. No evidence of human carcinogenicity has been reported even with the frequent therapeutic use of silver. Classification of a chemical as Group D precludes quantitative toxicity assessment. No slope factor is listed.

1.4.6 Toxicity Profile for Thallium

Oral Reference Dose: None listed in IRIS or HEAST. The oral reference dose for thallium carbonate, thallium chloride, and thallium sulfate is 8×10^{-5}.

Carcinogen Classification: Not listed in IRIS or HEAST.

Uses: Thallium is a metal. It is obtained as a by-product of the refining of iron, cadmium, and zinc. It is used as a catalyst, in certain alloys, optical lenses, jewelry, low-temperature thermometers, semiconductors, dyes and pigments, and scintillation counters. Medically, it has been used as a depilatory. Thallium is a component in cigarette smoke. Thallium forms complexes in solution with halogens, nitrogen, oxygen, and sulfur. Thallous sulfate has been used as rat poison and an insecticide.

Health Effects: Thallium can affect the central and peripheral nervous systems, cardiovascular system, gastrointestinal tract, lungs, liver, and kidneys if large amounts are ingested over short periods of time. The lethal oral dose of thallium acetate for humans is 12 mg/kg body weight (see E. Browning's "Toxicity of Industrial Metals" in *Chemical Hazards in the Workplace* [Proctor et. al 1988, 1346]). Death has been reported following a single estimated dose of 54 to 110 mg/kg (as thallium nitrate). Temporary hair loss has been associated with ingestion of thallium in humans. Soluble thallium compounds are extremely toxic and intoxication is cumulative; this primarily affects the nervous system and body hair.

Study Support: There are no data on the effects of acute-duration or intermediate-duration inhalation exposure to thallium in humans or animals. Information on the effects of chronic-duration inhalation exposure in humans was not quantitative. Limited data on human and animal acute oral exposure to thallium suggests that the nervous system may be the target organ, but reliable dose-duration data were not available. Data on the effects of intermediate-duration oral exposure in animals do not reliably identify the most sensitive target organ or the threshold for adverse effects. No data on effects of chronic-duration oral exposure to thallium were located. No studies were located regarding carcinogenicity in humans or animals after inhalation, oral ingestion, or dermal exposure to thallium. In the absence of epidemiological studies or long-term animal bioassays, the potential for thallium to cause cancer in humans cannot be determined (Clement International Corporation 1992,1343).

1.5 Risk Assessment Equations

Intake equations used in risk assessment calculate the intake of COPCs via various pathways by combining the concentration of the COPC in a particular environmental media with exposure parameters for the recreational scenario. The results of those equations are used in subsequent equations along with toxicity parameters to evaluate carcinogenic risk and the potential for noncarcinogenic health effects.

1.5.1 Intake Equations

Intake of COPCs via soil ingestion is calculated according to equation Eq. D-1.

$$\text{Intake}_{ing} = \frac{C \times IR \times EF \times ED}{BW \times AT} \qquad \text{Eq. D-1}$$

where,

Intake_{ing} = amount of soil ingested daily (mg/kg/day),

C = COPC concentration in soil (mg/kg),

IR = soil ingestion rate (mg/day),

EF = exposure frequency (days/yr),

ED = exposure duration (yr),

BW = body weight (kg), and

AT = averaging time (yr x 365 days/yr).

Intake of COPCs via inhalation of fugitive dust is calculated according to equation Eq. D-2.

$$\text{Intake}_{inh} = \frac{C \times PC \times IR \times ET \times EF \times ED}{BW \times AT} \qquad \text{Eq. D-2}$$

where,

Intake_{inh} = amount of soil inhaled daily (mg/kg/day),

C = COPC concentration in soil (mg/kg),

PC = particulate concentration in air [(0.09 mg/m3 x (1×10^{-3})],

IR = inhalation rate (m^3/hr),

ET = exposure time (hr/day),

EF = exposure frequency (days/yr),

ED = exposure duration (yr),

BW = body weight (kg), and

AT = averaging time (yr x 365 days/yr).

Intake of COPCs via dermal absorption is calculated according to equation Eq. D-3.

$$\text{Intake}_{derm} = \frac{C \times ABS \times AF \times SA \times EF \times ED \times CF}{AT \times BW} \qquad \text{Eq. D-3}$$

where,

Intake_{derm} = amount of COPC absorbed daily (mg/kg/day),

C = COPC concentration in soil (mg/kg),

ABS = absorption factor (unitless),

AF = soil-to-skin adherence factor (mg/cm^2-event),

SA = skin surface area exposed (cm^2),

EF = exposure frequency (days/yr),

ED = exposure duration (yr),

CF = unit conversion factor (1×10^{-06} kg/mg),

AT = averaging time (yr x 365 days/yr), and

BW = body weight (kg).

Child resident intake of lead is calculated according to equation Eq. D-4.

$$\text{Intake}_{lead} = \frac{CS \times IR \times ED \times EF \times 10E\text{-}06\ kg/mg \times 1000\ \mu g/mg}{24\ hrs/day \times 365\ days/yr} \qquad \text{Eq. D-4}$$

where,

Intake_{lead} = amount of lead ingested daily (µg/day),

CS = lead concentration in soil (1 600 mg/kg),

IR = ingestion rate (200 mg soil/day),

ED = exposure duration (2 hours/day), and

EF = exposure frequency (170 days/year).

1.5.2 Carcinogenic Risk and Noncarcinogenic Health Effects Equations

Carcinogenic risks are estimated as the incremental probability of an individual developing cancer as the result of exposure to a carcinogen. Excess cancer risks are calculated according to equation Eq. D-5.

$$\text{Risk} = CDI \times SF \qquad \text{Eq. D-5}$$

Where:

CDI = chronic daily intake (mg/kg/day), and

SF = carcinogenic slope factor.

A hazard quotient of one is used to evaluate potential noncarcinogenic health effects from exposure. At this value, COPC intake is equal to the reference dose, the dose at which adverse effects are not likely to be seen. Hazard quotients were calculated according to equation Eq. D-6.

$$HQ = \frac{\text{Intake (mg/kg-d)}}{RfD\ (mg/kg\text{-}d)} \qquad \text{Eq. D-6}$$

where,

HQ = Hazard quotient, and

RfD = Reference dose.

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APPENDIX E CERTIFICATE OF COMPLETION

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CERTIFICATION OF COMPLETION

I certify that all the work pertaining to the Voluntary Corrective Action Report has been completed in accordance with the Department of Energy approved VCA plan entitled VCA Plan for Potential Release Site 32-002(a,b), 32-003, 32-004. Based on my personal involvement or inquiry of the person or persons who managed this cleanup, a review of all data gathered and a visit to the site, to the best of my knowledge and belief, all criteria of the plan have been met or exceeded. I believe that the completion of this VCA is both protective to human health and the environment. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

GR Allen

Field Unit 1 Field Project Leader
Environmental Restoration Project
Los Alamos National Laboratory

30 Sept 96

Date Signed