

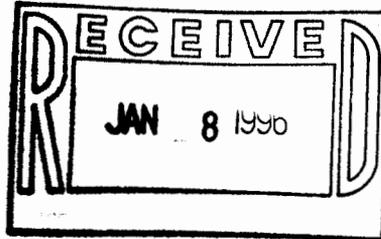
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ENVIRONMENTAL RESTORATION

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Date: December 22, 1995
Refer to: EM/ER:95-711

Mr. David Neleigh
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SUBJECT: SUBMITTAL OF RESOURCE CONSERVATION AND RECOVERY ACT FACILITY INVESTIGATION (RFI) REPORT FOR POTENTIAL RELEASE SITES (PRSs) IN TECHNICAL AREA 33

Dear Mr. Neleigh:

Enclosed are two copies of Los Alamos National Laboratory's RFI Report concerning PRSs 33-004(b,c,j,m), 33-006(a,b), 33-007(a,b), 33-010(a-d,g,h), 33-011(b,c), and 33-014 in Technical Area 33. The report documents the field work performed as detailed in the approved RFI Work Plan for Operable Unit 1122 and the sampling results.

Please ask your office to contact Brad Martin at (505) 667-6080 or Joe Mose at (505) 667-5808, if you have any questions.

Sincerely,

Handwritten signature of Jorg Jansen in black ink.

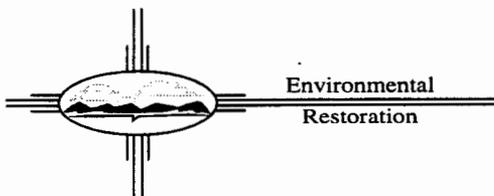
Jorg Jansen, Program Manager
Environmental Restoration

Sincerely,

Handwritten signature of Theodore J. Taylor in black ink.

Theodore J. Taylor, Program Manager
Los Alamos Area Office

JJ/TT/bp



Environmental
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4726



TL

Enclosures: Two copies of RFI Report Concerning PRSs 33-004(b,c,j,m), 33-006(a,b), 33-007(a,b), 33-010(a-d,g,h), 33-011(b,c), and 33-014

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CERTIFICATION

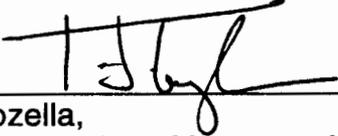
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Document Title: RFI Report Concerning PRSs 33-004(b,c,i,m), 33-006(a,b), 33-007(a,b), 33-010(a-d,g,h), 33-011(b,c), and 33-014

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RFI Report for Potential Release Sites

33-004(b)	33-004(c)
33-004(j)	33-004(m)
33-006(a)	33-006(b)
33-007(a)	33-007(b)
33-010(a)	33-010(b)
33-010(c)	33-010(d)
33-010(g)	33-010(h)
33-011(b)	33-011(c)

33-014

Field Unit 3

Environmental
Restoration
Project

December 1995

A Department of Energy
Environmental Cleanup Program

Los Alamos
NATIONAL LABORATORY

LA-UR-95-4439

1132

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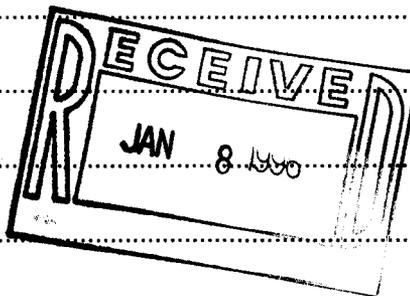
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EXECUTIVE SUMMARY

This Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) report discusses Phase I investigations, results, and recommendations for seventeen potential release sites (PRSs) located at Technical Area- (TA) 33 in the extreme southeastern section of Los Alamos National Laboratory (LANL). Experiments on initiators, a component of nuclear weapons, were conducted at TA-33 from 1948 until 1972. Subsequently, the site was used for offices and storage facilities for a geology group and offices and shops for an electronics development group. The groups moved out of TA-33 in 1995, but parts of TA-33 are currently used for short-term experiments.

The PRSs in this RFI report are located at South Site, East Site, and a storage site near the National Radioastronomy Observatory (NRAO). The three areas are located in separate, remote sections of TA-33. South Site was a firing area where aboveground high explosive (HE) tests were conducted from 1952 until the mid-1950s. East Site, operational between 1955 and 1972, was a firing site for testing experimental apparatus in nonexplosive projectiles. Prior to its use as a radiotelescope location, NRAO site was an unpaved surface storage area for equipment and material used at East Site. Except for storage and occasional short-term experiments, the firing sites have been inactive since 1972. NRAO site is now the site of a large radiotelescope.

Phase I sampling was conducted between May and August 1994 at the three sites. Sampling consisted of collecting surface and hand-augered subsurface samples. Trenching was performed at four PRSs with samples collected from the backhoe bucket. All samples were submitted to the Environmental Restoration Project's sample management operation. Analyses were performed for radionuclides, inorganic analytes, volatile and semivolatile organic compounds, pesticides, herbicides, and HE as specified in the RFI Work Plan. Missed holding times for the majority of HE samples resulted in serious data deficiencies for PRSs 33-006(a) and 33-007(b) at South Site where HE was of potential concern (Sections 5.5 and 5.8, respectively, of this RFI report).

Because few data were available concerning contamination at these sites, the objective of the Phase I investigation was to determine presence and nature of potential contamination. The PRSs discussed in this RFI report are listed in Table ES-1. Criteria for no further action (NFA) are listed in Section 3.6 of this RFI report. Summaries of the investigations and their results follow Table ES-1.

TABLE ES-1
SUMMARY OF PROPOSED ACTIONS

PRS	HSWA ^a	PROPOSED ACTION			
		NFA ^b CRITERION	FURTHER ACTION	RATIONALE	SECTION NUMBER
33-004(b)	Yes	4	None	No analytes above SALs ^c	5.1
33-004(c)	Yes	4	None	No analytes above SALs	5.2
33-004(j)	Yes	4	None	No analytes above SALs	5.3
33-004(m)	Yes	4	None	No analytes above SALs	5.4
33-006(a) ^d	Yes	N/A ^e	Phase II/VCA ^f	HE ^g assessment/remove shrapnel	5.5
33-006(b)	Yes	4	None	No analytes above SALs	5.6
33-007(a)	Yes	4	None	No analytes above SALs	5.7
33-007(b) ^d	Yes	4	VCA	Uranium contamination	5.8
33-010(a)	Yes	N/A	VCA	Remove contaminated debris	5.9
33-010(b)	Yes	N/A	VCA	Remove contaminated debris	5.10
33-010(c) ^d	Yes	4	VCA	Uranium contamination	5.11
33-010(d)	Yes	N/A	VCA	Remove contaminated debris	5.12
33-010(g)	Yes	N/A	VCA	Remove contaminated debris	5.13
33-010(h)	Yes	4	None	No analytes above SALs	5.14
33-011(b)	No	N/A	VCA	Remove contaminated debris	5.15
33-011(c)	Yes	4	None	No analytes above SALs	5.16
33-014	Yes	4	None	No analytes above SALs	5.17

^a HSWA = Hazardous and solid waste amendments of 1984.

^b NFA = No further action.

^c SALs = Screening action levels.

^d Possible VCA for uranium contamination only.

^e N/A = Not applicable.

^f VCA = Voluntary corrective action.

^g HE = High explosives.

A summary of each PRS follows:

33-004(b) is septic system TA-33-33 at South Site. Biased sampling—a sediment sample from the dry tank, surface/subsurface borehole samples adjacent to the tank, and surface samples at the outfalls—was performed to support a screening decision. Because only trace levels of contamination were detected, the system is recommended for NFA.

33-004(c) is septic tank TA-33-96 that served control bunker TA-33-87 at East Site. Biased sampling—a liquid sample from the tank and subsurface samples from boreholes in the drain field—was performed to support a screening decision. Because no contamination was detected above screening action levels (SALs) and only a few analytes were detected above LANL background upper tolerance limits (UTLs), the system is recommended for NFA.

33-004(j) is the outfall of a pipe draining the entrance to the South Site X-unit vault, TA-33-26. Biased sampling was performed at the outfalls to support a screening decision. Uranium detected above LANL UTLs is considered a result of shot pad activities associated with overlapping PRSs 33-006(a) and 33-010(c). Risk assessments performed for those PRSs indicate that uranium is not present at hazardous levels. PRS 33-004(j) is recommended for NFA.

33-004(m) is the septic system of the service building for the NRAO site radiotelescope. Biased sampling—a liquid sample from the tank and surface/subsurface samples from boreholes in the drain field—was performed to support a screening decision. Solvents were detected well below SALs. The system is recommended for NFA.

33-006(a) is the shot pad at South Site where implosion studies were conducted in the mid-1950s. Uranium and copper are widely distributed in soils. Risk assessment results indicate that these contaminants do not pose an unacceptable risk. Because of widespread shrapnel distribution and documented evidence that approximately 30% of shrapnel may be contaminated with uranium, a voluntary corrective action (VCA) to pick up shrapnel is recommended. HE analyses at South Site were compromised by missed holding times. Limited Phase II resampling for HE is proposed. South Site surface HE analyses for PRSs 33-007(b), 33-010(c), and 33-014 have been reassigned to PRS 33-006(a).

33-006(b) consists of two gun mounts in the large double berm at East Site. Biased sampling was performed to support a screening decision. Subsurface samples were collected by trenching and surface samples were collected near the gun mounts. One arsenic result was above background. After focused validation, HE results at this PRS are judged to be adequate for decisions. The PRS is proposed for NFA because arsenic is not widespread and no other contamination was detected above SALs.

33-007(a) is the firing area at East Site and covers a large percentage of the developed area. Samples were collected randomly at this PRS to support a screening decision. After focused validation, HE results at this PRS are judged to be adequate for decisions. The PRS is recommended for NFA because no contamination was detected above SALs.

33-007(b) consists of gun-firing areas, berms, and a catcher box at South Site. Uranium above SAL was detected in berm/barricade TA-33-63 and in the tower area. Because only uranium was detected at levels of concern, the PRS is recommended for a RCRA NFA. A VCA plan to reduce uranium concentrations to acceptable levels will be proposed to the Department of Energy (DOE). After focused validation, HE results were judged to be adequate for decisions.

33-010(a) is a canyonside disposal area at East Site. Lead was detected above SAL. The PRS is scheduled for a VCA cleanup in fiscal year 1996. A final report will be issued prior to September 30, 1996.

33-010(b) is a canyonside disposal area at East Site. Uranium, cadmium, and chromium were detected above SAL. Asbestos is present in the unit. The PRS is scheduled for a VCA cleanup in fiscal year 1996. A final report will be issued prior to September 30, 1996.

33-010(c) is a surface disposal area that received debris from the South Site shot pad. Biased sampling from surface to 1 ft deep was performed across the face of the PRS. A risk assessment indicates that risk posed by elevated levels of uranium and copper is acceptable. A VCA to stabilize and prevent debris from entering the drainage to Chaquehui Canyon and a RCRA NFA are proposed. HE analyses from surface samples attributed to this PRS have been assigned to PRS 33-006(a) (Section 5.5 of this RFI report).

33-010(d) is a canyonside disposal area at East Site. No contamination was found above SAL, but debris was not screened. The PRS is scheduled for a VCA cleanup in fiscal year 1996. A final report will be issued prior to September 30, 1996.

33-010(g) is a canyonside disposal area at South Site. The PRS is scheduled for a VCA cleanup in fiscal year 1996. A final report will be issued prior to September 30, 1996. HE analyses from surface samples attributed to this PRS have been assigned to PRS 33-006(a) (Section 5.5 of this RFI report)

33-010(h) is listed as a surface disposal area at South Site. Little surface debris was found in the area. No subsurface debris was found during trenching activities. The PRS is recommended for NFA because no contamination was detected above LANL background UTLs.

33-011(b) is a surface disposal area at NRAO. No contamination was detected above SAL but uranium-contaminated debris was found. The PRS is scheduled for a VCA cleanup in fiscal year 1996. A final report will be issued prior to September 30, 1996.

33-011(c) is the blivit storage area at South Site. Biased surface sampling for tritium was performed to support a screening decision. The PRS is proposed for NFA because no tritium was detected above SAL.

33-014 was a burn pit at South Site. Biased surface sampling at the location of the PRS was performed to support a screening decision. The PRS is proposed for NFA because no contaminants except uranium were detected above SAL. Uranium is addressed under overlapping PRS 33-006(a). HE analyses from surface samples attributed to this PRS have been assigned to PRS 33-006(a) (Section 5.5 of this RFI report)

1.0 INTRODUCTION

1.1 General Site History

Technical Area- (TA) 33 is located at the extreme southeastern section of the Los Alamos National Laboratory (LANL) (Figure 1.1-1, Figure 1.1-2). Development of TA-33 began in 1947 and continued into the mid-1950s. TA-33 is divided into five discontinuous sites (Figure 1.1-3). Area 6, South Site, and East Site were firing sites. Main Site was the location of offices, shops, and a warehouse. National Radioastronomy Observatory (NRAO) Site was an unpaved storage area that now houses a radiotelescope. TA-33 was used between 1947 and 1972 as a site to test a component of nuclear weapons called initiators. Subsequent operations at Main Site included offices and storage facilities for a geology group and offices and shops for an electronics development group. The firing sites have been inactive since 1972 except for storage and occasional short-term experiments. A tritium facility was operated at Main Site from 1955 until 1990. In 1995 all operational LANL groups moved from TA-33. A few buildings are in use for storage or short-term projects.

This Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) report evaluates potential release sites (PRSs) at South Site, East Site, and NRAO site. The firing sites were operational between 1948 and 1972. East Site was equipped with guns of various sizes that fired non-exploding projectiles containing experimental apparatus into berms and catcher boxes. Similar experiments, as well as aboveground explosive tests, were performed at South Site. Testing at South Site ended in 1955. Firing experiments at East Site extended from 1955 to 1972. Small antennae for atmospheric research were later located at both sites. NRAO site was a storage area for equipment and supplies used at East Site. Strategic metals, such as tungsten, were stored at the site until they could be shipped for recycling. A small detonation area used high explosives (HE) to separate strategic materials. A major cleanup of the three sites was conducted in 1984. A large radiotelescope antenna was built at NRAO in 1987.

Materials that may have contributed to contamination at the firing sites included uranium used for projectile casings; beryllium, cadmium, and lead used in the experimental apparatus; copper used for housing the experimental shots at South Site; propellant products used at both firing sites; and HE used at South Site. Small amounts of HE were used at NRAO for small-scale detonations. Cobalt-60 was used as a tracer at East Site. Tritium containers were set out to degas at South Site. Small volumes of other materials may have been used at any of these sites.

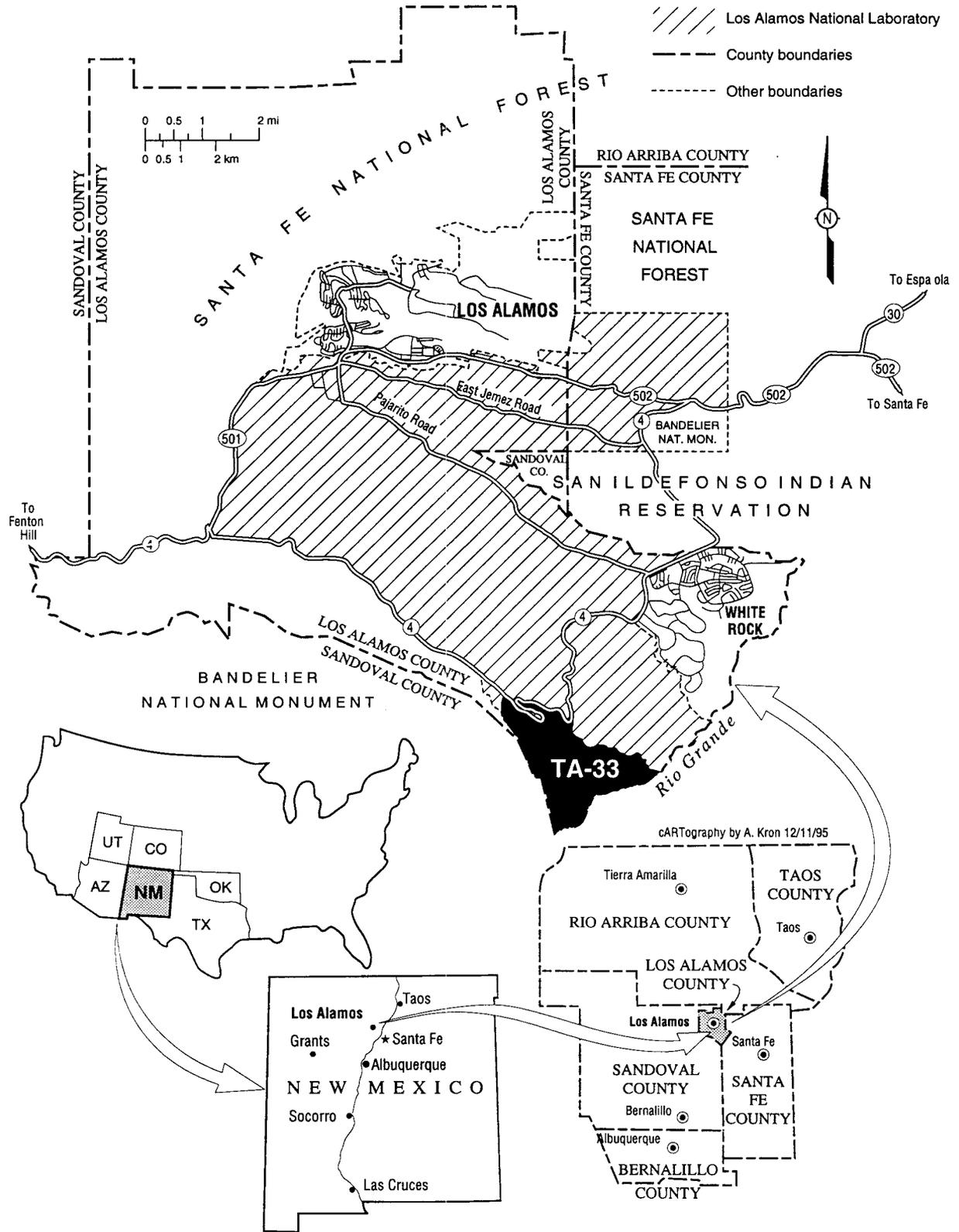


Fig. 1.1-1. Location of Los Alamos National Laboratory.

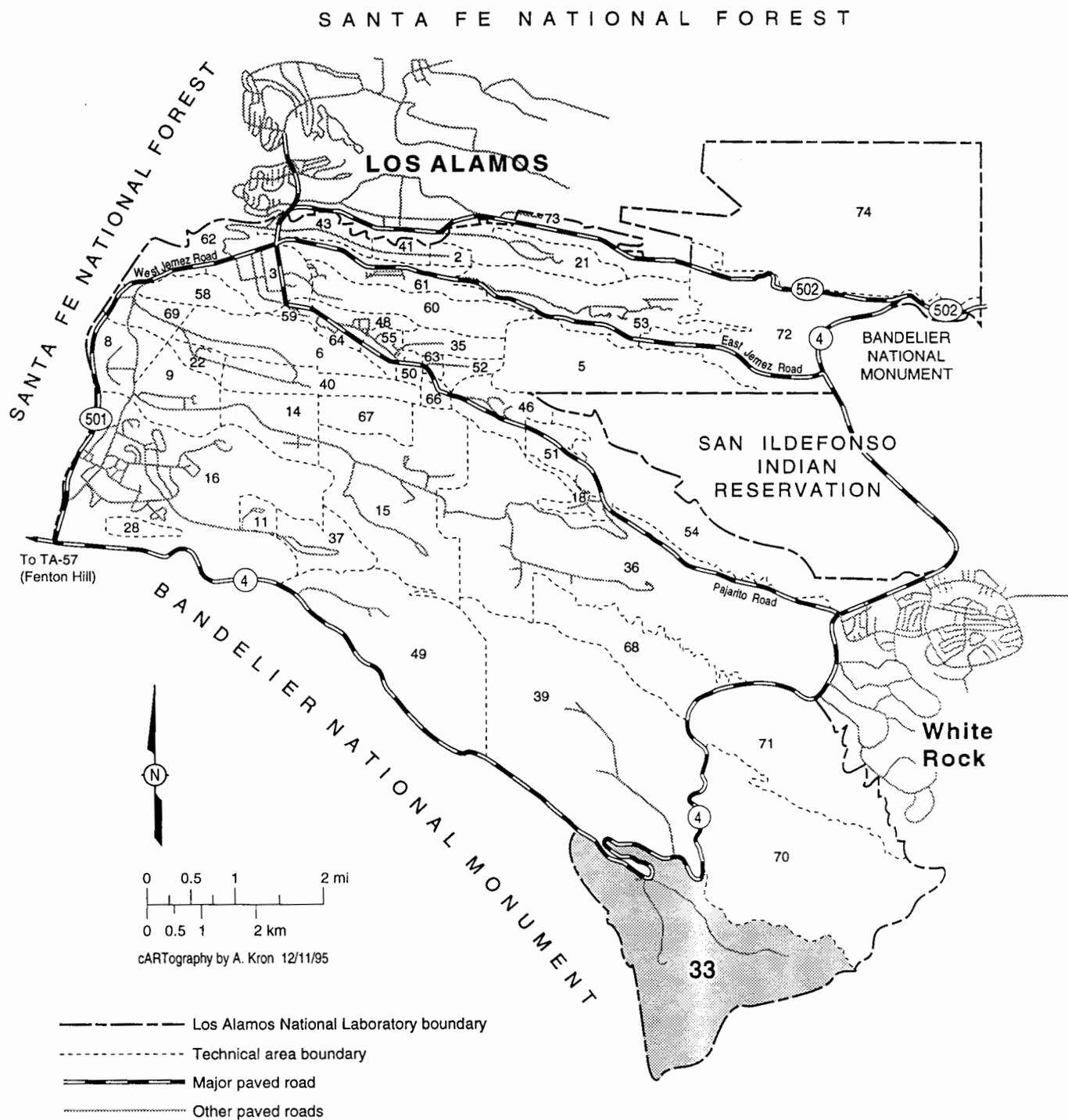


Fig. 1.1-2. Location of TA-33 with respect to Laboratory TAs and surrounding land holdings.

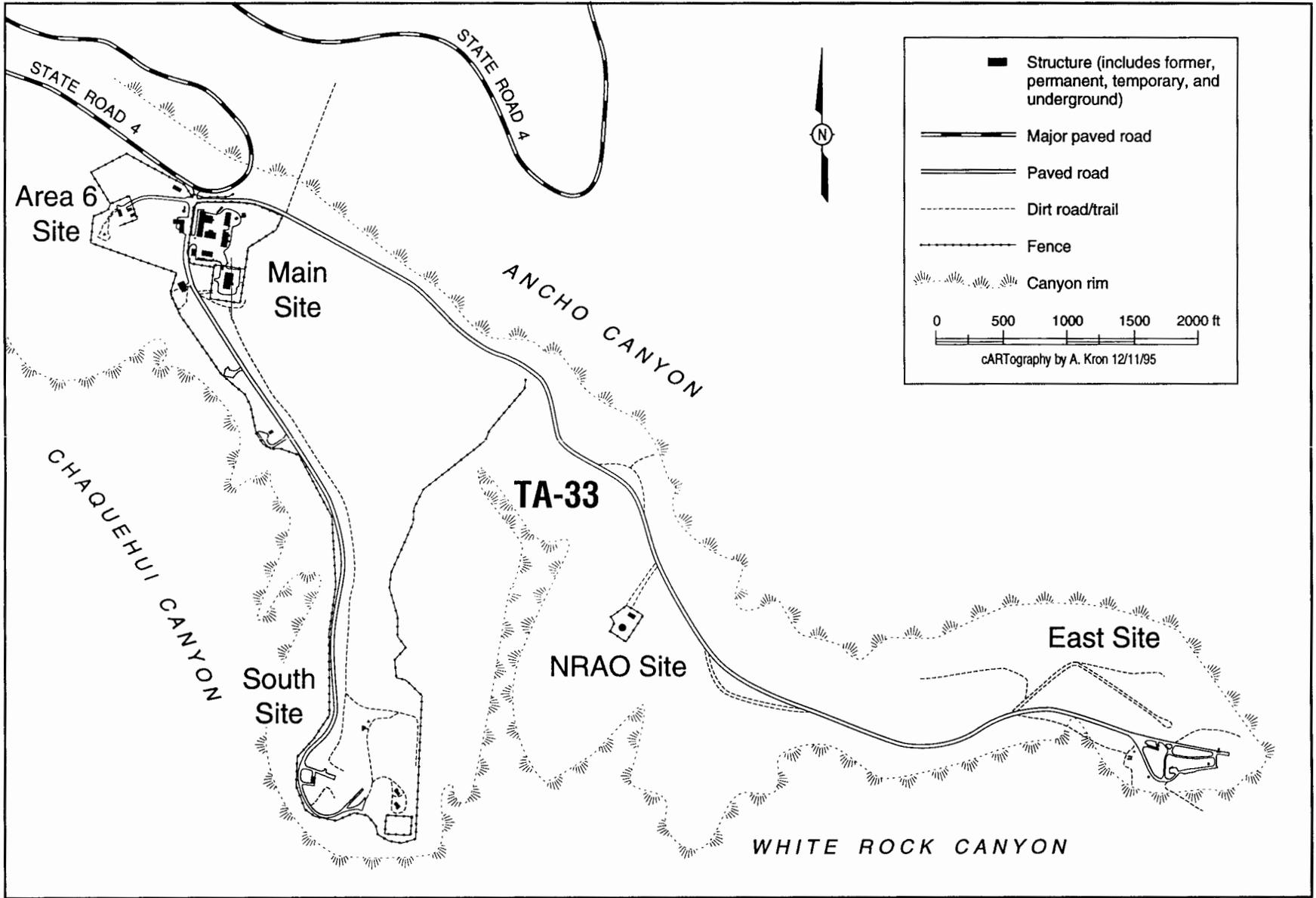


Fig. 1.1-3. The five sites at TA-33.

December 21, 1995

4

RFI Report for TA-33

1.2 RFI Overview

The TA-33 RFI work plan for the Environmental Restoration (ER) Project was submitted to the Environmental Protection Agency (EPA) Region 6 in May 1992 and was approved by EPA with minor modifications in July 1993 (EPA 1993, 02-090). The technical approach of the plan utilized phased sampling to locate the sources of any contamination associated with LANL activities. Contaminants detected during Phase I reconnaissance sampling may be subject to subsequent phases of sampling to ensure that contamination is investigated in compliance with the Hazardous and Solid Waste Amendments (HSWA) Module VIII of the LANL RCRA Facility Permit (EPA 1990, 0306).

Because little was known of contamination levels at TA-33, the objective of most RFI Phase I sampling plans was to ascertain whether contaminants were present at levels of concern. Conceptual models were developed for three different exposure scenarios (current use, recreational use, construction) as described in Subsection 3.1.2 of the RFI work plan for OU 1122. Primary release mechanisms at TA-33 include sediment transport and resuspension by wind. Other release mechanisms considered in the plan were landslide/erosion, biological activity, and dissolution in runoff (LANL 1992, 0784). RFI sampling plans were designed to support preliminary risk assessments should analyses indicate that contamination is present. For preliminary risk assessments described in this report, a recreational scenario was considered the most appropriate.

Options for subsequent actions for each PRS are based on analytical results of sampling activities. Options include:

- Voluntary corrective action (VCA),
- Expedited cleanup (EC),
- Phase II sampling to provide data for baseline risk assessment,
- Corrective measures study (CMS), or
- No further action (NFA) and request for removal of the PRS from the LANL HSWA permit.

1.3 Field Activities

For the PRSs in this RFI report, fieldwork was performed between May and August, 1994. The following field activities were implemented at the sites in this report.

- Selection of sampling locations
- Land, geophysical, and screening surveys
- Field sampling activities

1.3.1 Selection of Sampling Locations

The 1994 sampling campaign at TA-33 was conducted by ICF-Kaiser personnel (ICF-Kaiser 1995, 02-108). Sample locations at TA-33 were selected using the criteria outlined in the RFI Work Plan for OU 1122 (LANL 1992, 0784). The work plan identifies selection criteria for locating the following:

- Reconnaissance samples were selected specifically to maximize the likelihood of detecting any contamination that might be present.
- Characterization samples were selected within PRSs without regard to specific site characteristics. Random sample locations were selected using grid-based, area-based, and excavation-based randomization protocols.
- Collocated and neighbor samples were collected in the field to provide data for estimating spatial variability of contaminants in surface soils, subsurface soils, and sediments. Locations of the neighbor samples were determined using the grid-based randomization procedure. Collocated (duplicate) samples were collected one foot north of the primary sample.

1.3.2 Field Surveys

The following land surveys, radiation surveys, and geophysical surveys were conducted at East, NRAO, and South Sites.

- Geodetic control points and coordinates of sample locations were established. Grid systems were then established as required by the work

plan to identify measurement points for the radiation and geophysical surveys.

- Radiation surveys were conducted on a fixed grid as specified in the work plan. Sampling locations were chosen in areas that exhibit above-background levels of radioactive contamination.
- Geophysical electromagnetic induction and magnetometer/gradiometer surveys were performed at South and East Sites. The results of the surveys were used to design a sampling approach and determine subsequent sampling locations. East Site geophysical surveys assessed the location of geophysical anomalies that might indicate either the presence of buried projectiles (metal objects) or buried metallic and nonmetallic debris. The South Site geophysical surveys were performed to assess the location of geophysical anomalies at PRS 33-007(b) that might indicate the presence of buried projectiles.

1.3.3 Field Sampling Activities

Before each sample was taken, the undisturbed sample location was checked for the presence of above-background levels of radioactivity and volatile organic compounds (VOCs). All samples were collected using current standard operating procedures (SOPs) (LANL 1993, 0875). After collection, all samples were cooled with ice packs in portable ice chests and submitted to both LANL's mobile radiation laboratory and LANL's on-site laboratory. Chain of Custody/Request for Analysis forms were completed for each sample. All 1994 surface samples were taken from the surface to a depth of 6 in. within a diameter of approximately 6 to 8 in. Soil was collected from each sample location using a dedicated stainless steel spoon and bowl. Fluid and sludge samples were collected from septic tanks and sumps using a Mucksucker™ sampler.

Shallow hand-auger samples were recovered from depths up to 10 ft using a stainless steel hand-held auger manually driven into the soil. If the soil/tuff interface was encountered, a final sample was taken at the point of encounter. Therefore, the number of samples taken from any borehole was often limited to the depth of the soil/tuff interface (e.g., where the soil/tuff interface was encountered within 6 in. of the surface, only one sample was collected). A backhoe excavated trenches at berms, catcher boxes, and a disposal area.

1.3.4 Quality-Assessment Samples

Field quality assessment samples were collected during all 1994 field-sampling activities at TA-33. Rinsate blanks, performance evaluation (PE) samples, and field duplicates were collected during the investigation as specified and defined in the OU 1122 Site-Specific Quality Assurance/Quality Control (QA/QC) Plan. All assessment samples were collected at a frequency of 1 per 20 to 1 per 32 samples as specified in the plan (ICF Kaiser 1995, 02-108).

Rinsate samples were submitted to check for cross-contamination of samples from decontamination procedures. PE samples were used to check for contamination that may be introduced from improper field handling procedures, to check on laboratory recovery of metals and radioactive analytes in order to evaluate matrix effects, and to provide information on performance of the analytical procedures. Because the majority of the samples collected at TA-33 were soil, the PE blanks were of soil matrix. Material spiked with known concentrations of inorganic constituents for the PE soil samples were purchased from off-site sources. Idaho National Engineering Laboratory (INEL) provided soil spiked with known amounts of radioactive and metal constituents suspected to be present at TA-33. Collocated samples served as field duplicates and were collected one foot north of their respective sample locations.

1.3.5 Deviations from RFI Work Plan

The following sampling procedures deviated from those specified in the RFI Work Plan for OU 1122.

PRS 33-004(b) Sludge and liquid samples were not collected because the septic tank contained neither sludge nor liquid. A sediment sample was scraped from the bottom of the tank.

PRS 33-004(c) A sludge sample was not collected because the septic tank did not contain sludge.

PRS 33-006(a) An additional sample, which was not required by the RFI work plan, was collected from the top of the shot pad. The objective of collecting this sample was to further characterize potential contamination resulting from implosion experiments.

PRSS 33-006(b), 33-007(a), 33-007(b), and 33-010(h) The work plan specified trenching to depths of 4 ft and collecting samples from given depths within the 4-ft profile. Because of new archival information, the depths of the trenches were changed so that the vertical extent of excavation above ground surface was between 8 ft and 15 ft instead of 4-ft depths. The work plan also specified submitting samples of projectiles recovered in each pile for laboratory analysis. Rather than sampling projectiles recovered from the debris pile, soil surrounding the

projectiles was collected for analysis. The number of samples collected was equal to or greater than the number called for in the work plan.

Only random samples were collected from PRS 33-007(a) because no projectiles were located in the catcher box to bias sample locations. Two additional trenches were excavated on the north side of the double berm at PRS 33-006(b), where anomalies were detected during the geophysics survey. This additional excavation was conducted to determine if projectiles were present and were the cause of the anomalies. No projectiles were found; the anomalies were due to large tuff boulders.

PRS 33-007(b) Three additional samples, which were not required in the RFI work plan, were collected from the shallow drainage leading to Chaquehui Canyon. The objective of collecting these samples was to determine if uranium or other contaminants were being mobilized by runoff from the TA-33-63 berm.

PRS 33-010(c) The work plan specified trenching to a depth of 4 ft and collecting samples within the 4-ft profile. The work plan also specified submitting samples of each type of recovered material for laboratory analysis. Because uranium contamination was detected in previous studies, the objective of this investigation was to determine whether to conduct a corrective action or to recommend NFA based on a site risk assessment. The pile consisted largely of stone cobbles. Because of the difficulty of trenching through cobbles and debris, and because of the seemingly homogenous nature and shallow depth of the fill, six locations from surface to one foot, as opposed to one trench location, were collected to distribute sampling over the entire pile.

2.0 ENVIRONMENTAL SETTING

The environmental setting of the Laboratory is described in Subsection 2.4 of the Installation Work Plan (IWP) for Environmental Restoration (LANL 1995, 1164). A discussion of the environmental setting, including climate, geology, hydrology, and a conceptual hydrogeologic model for the area and surroundings, is presented in Subsection 2.5 of the RFI Work Plan for OU 1122 (LANL 1992, 0784). A summary is presented in the following sections.

2.1 Climate

Los Alamos County has a semiarid, temperate, mountain climate. Summers are generally sunny with moderate, warm days and cool nights. High altitude, light winds, clear skies, and dry atmosphere allow summer temperatures to range from 50°F to 80°F at TA-33. During the

winter, temperatures typically range from 14°F to 54°F. The average annual rainfall in the area of TA-33 is estimated to range from 8 to 19 in. Of this total, approximately 40% occurs as brief, intense thunderstorms during July and August. Intermittent streamflow in adjacent canyons can occur as a result of these storms. Spring snowmelt runoff may also induce intermittent streamflow in local canyons.

2.2 Geology

2.2.1 Geologic Setting

A detailed discussion of the geology of the entire Los Alamos area can be found in Subsection 2.5.1 of the IWP (LANL 1995, 1164). The geology of TA-33 is described in Subsection 2.5 of the Work Plan for OU 1122. White Rock Canyon of the Rio Grande, 1 000 ft deep, is the southeastern boundary of TA-33. Two tributaries, Ancho and Chaquehui Canyons, join White Rock Canyon at TA-33. The firing sites and NRAO site are located on level mesas between the two tributary canyons. East Site and NRAO site are located near the south rim of Ancho Canyon. South Site lies on the north rim of Chaquehui Canyon. Runoff from East Site drains primarily to White Rock Canyon. Runoff from NRAO site and South Site drains into Chaquehui Canyon.

LANL activities were confined to the mesa top, composed of the Tshirege Member of Bandelier Tuff. Deposits of Unit 3 of the Tshirege Member are intermittent at the eastern end of TA-33. Unit 2 constitutes bedrock at East Site and NRAO, underlain by approximately 125 ft of Units 2, 1v, and 1g. At South Site, remnants of Unit 3 of the Tshirege Member are exposed at high points north and west of the site. Bedrock at South Site consists of Unit 2, approximately 50 ft in depth, underlain by approximately 150 ft of Units 1v and 1g. The tuffs at TA-33 are underlain by 650 ft of basalts, including tholeiitic, andesitic, and phreatomagmatic basalt deposits. Beneath the basalts layers are sedimentary deposits of the Puye Formation and the Santa Fe Group (Reneau et al. 1994, 02-092). Data on the subsurface geology at TA-33 were obtained from deep boreholes located at MDA K. A full description of core logging of these boreholes is provided in the RFI report for MDA K submitted to EPA in September 1995 (Environmental Restoration Project 1995, 1263)

All sampling at TA-33 discussed in this RFI report was in surface or shallow (less than 6 ft) subsurface soils of Unit 2 of Bandelier Tuff. No operational or sampling activities affected the subsurface units described above.

2.2.2 Soils

A discussion of the soils in the Los Alamos area can be found in Subsection 2.5.1.3 of the IWP (LANL 1995, 1164). Soil at South Site is classified as Hackroy Rock. Hackroy soils are shallow, well-drained soils that form on mesa tops from weathered tuff. The surface layer of Hackroy is a brown sandy loam about 4 in. thick. Hackroy subsoil is a reddish brown clay mixed with gravel or loam about 8 in. deep. The Hackroy Rock complex contains intermingled 20% Hackroy soils, 10% Nyjack soils, and 70% rock outcrop. Nyjack soil is similar to Hackroy but deeper and more loamy. Soil at East Site and NRAO is classified as Mesic Rock outcrop land type, containing 65% rock outcrop, 5% undeveloped soil, 5% Hackroy soil, and 25% narrow escarpments (Nyhan et al. 1978, 0161). Much of the soil at South Site was scraped to bedrock to build the berms. Most of East Site has been scraped to bedrock to supply material for the berms. Soils at NRAO range from 0 to 1 ft deep.

2.3 Hydrology

The hydrology of the Pajarito Plateau is summarized in Subsection 2.5.2 of the IWP (LANL 1995, 1164). Depth to groundwater at the TA-33 sites discussed in this RFI report is estimated to be a minimum of 700 ft. No activities performed during the TA-33 1994 sampling campaign affected or were influenced by hydrological considerations

2.3.1 Surface Water

TA-33 is bounded by canyons. At TA-33 ephemeral surface-water flow to local canyons may be expected during the spring snowmelt and summer thunderstorm seasons. Surface water does not collect on the mesas at the three sites discussed in this report.

2.3.2 Groundwater

At East Site and NRAO (elevation 6 400 ft) the depth of groundwater is assumed to be 700 ft, based on the elevation (5 700 ft) of a spring in Ancho Canyon. At South Site (elevation 6 400 ft) the depth of groundwater is assumed to be 800 ft, based on the elevation (5 600 ft) of Doe Spring in White Rock Canyon. No ground water wells are located in or near TA-33. Deep drilling at MDA K at Main Site did not encounter perched water. In a geomorphological study of TA-33, no evidence was found of springs nearer the firing sites (Reneau et al. 1995, 02-092). Figure 2.3.2-1 shows the topography of TA-33 and the relationship of the firing sites to known springs.

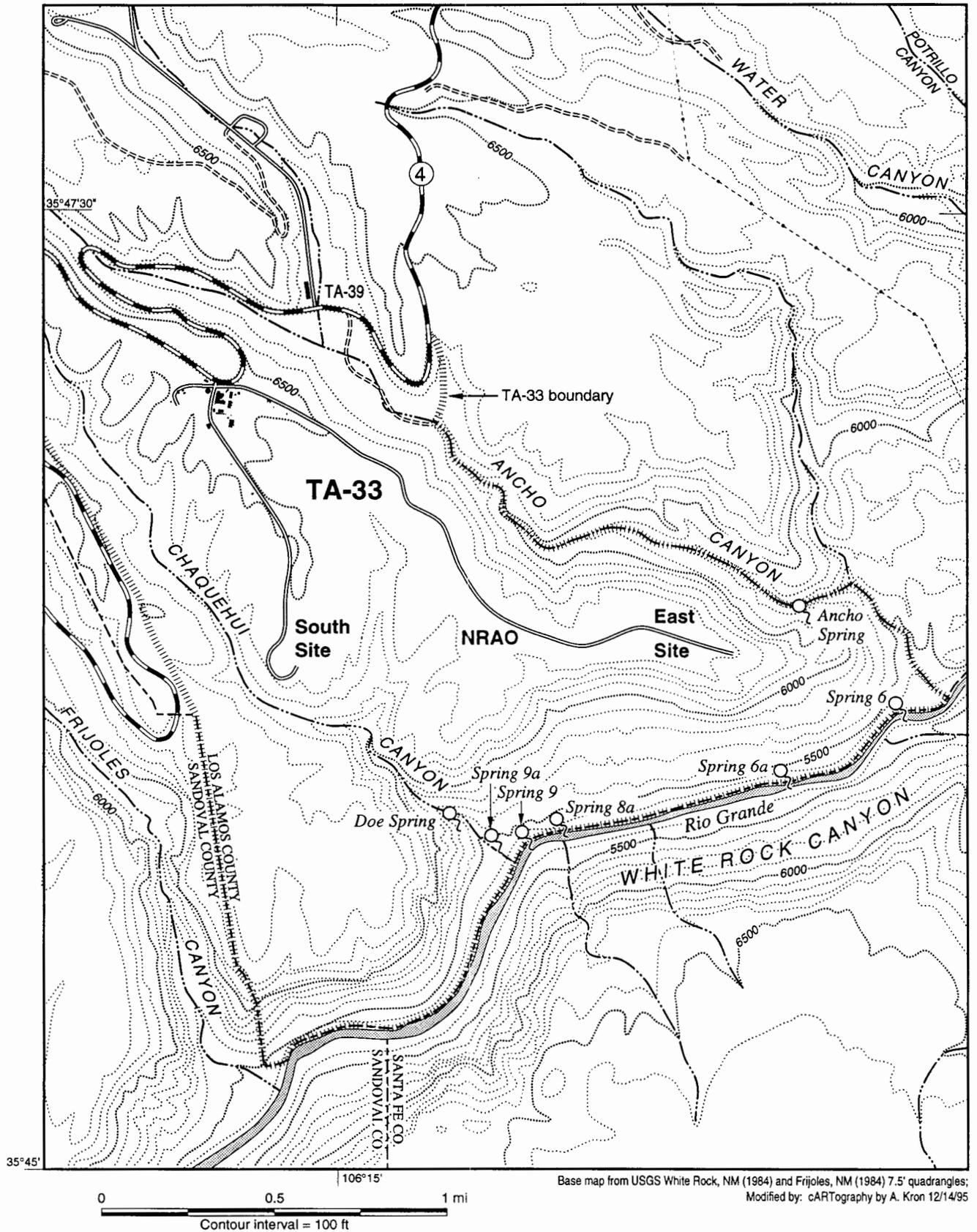


Fig. 2.3.2-1. Topography of TA-33 showing locations of area springs.

2.4 Biological Surveys

Biological resource field surveys were conducted at TA-33 for compliance with the Federal Endangered Species Act of 1973; the New Mexico Wildlife Conservation Act; the New Mexico Endangered Species Act; Executive Order 11990, Protection of Wetlands, Executive Order 11988, Floodplain Management; 10 CFR 1022; Department of Energy (DOE) Compliance With Floodplain/Wetlands Environmental Review Requirements (DOE 1979, 0633) and DOE Order 5400.1, General Environmental Protection Program (DOE 1988, 0075). The biological summary is included as Appendix B in the RFI Work Plan for OU 1122 (LANL 1992, 0784).

Environmental conditions at three areas discussed in this RFI report were highly disturbed during construction in 1947 and the early 1950s. The firing sites currently are either scraped to bedrock or overgrown with chamisa. No habitats for threatened or endangered species were identified on the mesas. Bald eagles, golden eagles, and peregrine falcons forage and possibly nest in White Rock Canyon near TA-33. Restriction on LANL activities are in place at TA-33 between November 1 and July 1 when a field survey for these birds must be conducted at East Site before noisy equipment can be used. NRAO and South Site are not affected by this restriction. Habitats for additional threatened and endangered species were mapped in the canyons below TA-33, but no species were found during the surveys.

2.5 Cultural Surveys

A cultural resource survey was conducted at TA-33 as required by the National Historic Preservation Act (National Park Service 1983, 0632). Sixty-four archaeological sites were identified at TA-33. No archaeological sites were found at South, East, or NRAO sites, which consist largely of disturbed areas. Seven archaeological sites are located near the areas discussed in this report.

South Site: One archaeological site is located approximately 100 ft north of the PRS 33-007(b) tower area. The site is undisturbed and surrounded by junipers; it was not impacted by operational activities or by ER sampling activities. No other archaeological sites were found on the mesa at South Site.

East Site: One archaeological site is located on the mesa at the west end of East Site. The site is undisturbed and surrounded by junipers. It lies near an area that was cleared in 1948 during the construction of East Site. No PRSs are nearby. No operational or ER activities have been conducted near the archaeological site.

NRAO: Five archaeological sites lie near the NRAO complex. All are located near the East Site Road. The site nearest NRAO has been fenced for protection. PRS 33-011(b) surface storage area is approximately 100 ft south of that site. The remaining sites are in undisturbed areas approximately 600 ft northwest of the radiotelescope. None of these sites were impacted by operational activities or by ER sampling activities.

3.0 APPROACH TO DATA ASSESSMENT AND ANALYSIS

The decision approach used for the PRSs described in this report involved a series of steps that include field investigation, chemical analysis, data validation, and result reporting. Further steps included comparing site data to LANL and TA-33 background concentration data, verifying the identities of detected organic chemicals, comparing site data to screening action levels (SALs) for human health impacts, and performing human health risk assessments when necessary. The following sections provide overviews of the methods used to complete these steps.

3.1 Sample Analysis

At the time of sampling, field data (date, time, surveyed location, soil type, sampling anomalies, etc.) were collected for each sample and each sample was assigned a unique identification. For samples collected at PRSs in this RFI report, all samples requiring chemical or radiological analysis and chain-of-custody documentation were submitted to the LANL mobile radiological analysis laboratory for screening and to the Sample Management Office (SMO) for fixed-laboratory analysis. All data validation was performed under the auspices of the SMO.

3.1.1 Analytical Methods

All samples were analyzed under SMO contracts using EPA SW-846 methods or equivalent methods and/or LANL ER-approved radiological methods.

3.1.2 Data Verification and Validation

Data verification and validation procedures are intended to determine whether data packages have been generated according to specifications, are of known quality, and contain the information necessary to determine data sufficiency for decision making. Data verification is a check of data deliverables against contract requirements to ensure that what has been ordered has been delivered, thus indicating that the analytical laboratories can be paid. All analytical data generated by external laboratories in support of the ER Project is verified.

Routine data validation is the comparison of quality indicators (holding times, surrogate recovery, analyses of method blanks, and differences between replicate measurements) with clearly defined limits to determine whether limitations may need to be placed on use of the data. Validators may apply qualifier flags on individual analytical results to indicate that those data should be used with caution. Routine validation is most suitable for routine analyses and for those nonroutine analyses for which clearly defined control standards have been established.

Focused data validation may be performed when routine validation cannot adequately determine if analytical procedures were in control. For the analyses performed for this RFI report, focused validation for inorganic analyses was requested for one sample delivery group. Focused validation was requested for all HE analyses performed during the TA-33 1994 field season. Because of the problems with the HE data discussed in Section 4.2 (missed holding times and low surrogate recoveries), the high pressure liquid chromatography (HPLC) scans were reviewed to identify additional peaks that could be associated with HE at levels below the contract-required quantitation limit (CRQL). These results are discussed in Section 4.2.

A statistical assessment of data validation qualifiers for individual results and of patterns observed in the QA data (such as results for blank samples inserted into the sample train by the SMO and reported surrogate and matrix spike recoveries) complements routine data validation as described above. Field QA samples, including PE samples submitted with routine samples, pairs of collocated samples, and equipment rinsates, are also evaluated during this process.

3.2 Background Comparisons

Once the data validation process is complete and the site data are finalized, the next step in the process is to compare site data to available background data. The results of a focused data validation should exclude from consideration for background comparison any contaminant that is identified as an artifact of analytical laboratory or field contamination, analytical interference, or improper analyte identification or quantitation. The purpose of this decision step is to determine if chemicals that have natural or anthropogenic background distributions should be retained or eliminated from further consideration. Background data are available from two sources: 1) soil samples collected throughout Los Alamos County for which chemical analyses were performed for certain inorganic chemicals and naturally occurring radioactive chemicals (Longmire et al. 1995, 1142); and, 2) background concentrations of radioactive chemicals associated with global fallout from atmospheric nuclear testing (e.g., plutonium, cesium,

strontium, and tritium) reported in LANL Environmental Surveillance reports (Purtymun et al. 1987, 0211; ESG 1988, 0408; ESG 1989, 0308; Environmental Protection Group 1990, 0497; Environmental Protection Group 1992, 0740).

Comparisons between site data and background data are initially performed by comparing each observed concentration datum to an upper tolerance limit (UTL) estimated from background data. Details of statistical methods used to generate UTLs from the background data sets and suggestions for statistical methods for comparing site and background concentration distributions are presented in the guidance document, *Statistical Comparisons to Background, Part I* (Environmental Restoration Project Assessments Council 1995, 1218).

If a chemical has a reported concentration that exceeds its UTL, or fails other statistical background comparison tests (i.e., the site data are statistically greater than background data), then that chemical is carried forward in the screening assessment process. If a chemical does not have a reported concentration that exceeds the UTL, then that chemical is removed from further consideration.

The ER Project has developed UTLs for the most commonly sampled chemicals and the most commonly analyzed media. For chemicals and/or media not included in the Longmire data, or in the Facility for Information Management and Display (FIMAD) database, UTLs are developed by the Decision Support Council as needed.

A set of UTLs was developed for TA-33. A detailed assessment of the Main Site grid samples analyzed for TA-33 inorganic and radionuclide background concentrations is provided in the RFI report for OU 1122, LA-UR-95-882, submitted to EPA in January 1995 (LANL 1995, 1212). A summary of these data, incorporating revised UTLs calculated at the (95%,0.95) level, is given for analytes discussed in this report (Table 3.2-1). Main Site tritium levels are not applicable to South Site where a few samples were collected for tritium analysis and, therefore, are not included in Table 3.2-1. Sample sizes, column N in Table 3.2-1, vary because high outliers are removed before summary statistics (mean, standard deviation, maximum, UTL, and number of observations above the UTL) are calculated. As the last column of Table 3.2-1 indicates, there are frequently one or two observations above the (0.95,0.95) UTL even in the background population. This reflects the fact that this UTL is an approximation of the true 95th percentile of the background distribution, a level which, by definition, will be exceeded by 5% of all background samples.

TABLE 3.2-1

SUMMARY OF TA-33 BACKGROUND DATA BASED ON MAIN SITE GRID DATA

ANALYTE	N ^a	N>DL ^b	MINIMUM	MEAN	STANDARD DEVIATION	MAXIMUM	0.95,0.95 UTL ^c	N>UTL
Antimony	48	15	<0.02	0.053	0.062	0.27	0.25	1
Arsenic	50	50	1.000	2.354	0.687	3.6	3.773	0
Barium	48	48	31.000	83.58	26.88	150	139.4	3
Beryllium	51	51	0.31	0.706	0.251	1.3	1.22	1
Cadmium	51	10	<0.4	0.38	1.23	5.2	3.19	1
Cesium-137	51	24	<0.37	0.868	0.582	2.61	2.07	2
Chromium	50	50	3.4	7.57	3.40	19	14.6	2
Lead	46	46	7.0	15.07	4.82	28	25.12	1
Mercury	11	0	<0.1	N/A ^d	N/A	N/A	N/A	N/A
Nickel	48	35	<2.0	4.72	3.05	13.5	11.04	2
Selenium	51	34	<0.20	0.376	0.264	1.39	0.92	2
Silver	50	2	<1.000	N/A	N/A	2.3	N/A	N/A
Uranium	49	49	1.800	2.661	0.705	41.6	4.120	2
Zinc	48	48	16.0	36.92	9.85	57	57.35	0

^a N = Number of samples.

^b DL = Analytical detection limit.

^c UTL = Upper tolerance limit.

^d N/A = Not applicable due to insufficient detections.

3.3 Evaluation of Organic Constituents

Background data are not available for organic constituents. This preliminary evaluation of organics considers detected analytes and analytes that were analyzed for but not detected in any sample. The purpose of this decision step is to determine if organics should be retained or eliminated from further consideration based on detection status. Detection status is determined by the analytical laboratory on a sample-by-sample, analyte-by-analyte basis. Estimated quantitation limits (EQLs) have been established for each analyte as reporting limits when the analyte is not detected. It should be noted that the EQLs reported for individual samples are dependent on a number of factors and may vary from sample to sample and from analysis to analysis. Therefore, the sample-specific EQL for a analyte must be used in this comparison.

If an analyte is reported as detected, then that analyte is generally carried forward through the screening assessment process. If an analyte is not reported as detected in any sample analyses, then that analyte is generally not carried forward in the screening assessment. Exceptions to these general rules may be made if site-specific process knowledge so indicates. An analyte that is detected may be removed from further consideration if it can be determined that its presence is not due to LANL operations, and an analyte that is not detected in any sample may be carried through the decision process if the analyte can be expected to be present at the site based on historical operations.

3.4 Human Health Assessment

3.4.1 Screening Assessment

The screening assessment consists of sequential decisions that are used to determine if chemicals have been released to the environment as a result of historical LANL operations at levels that may be hazardous to human health or the environment. The decisions include:

- Can reported concentrations be attributed solely to positive analytical laboratory or field bias?
- Are field results greater than background UTLs?
- Is the maximum site concentration greater than the SAL?

The purpose of this decision step is to determine if chemicals should be retained or eliminated from further consideration based on comparisons with SALs. This is the last step in the screening assessment process for human health concerns. If chemicals remain after this step, then further action may be proposed. If no chemicals remain after this step, then NFA may be proposed based on human health concerns. SALs are medium-specific concentrations that are calculated using chemical-specific toxicity information and conservative, default exposure assumptions. A complete description of the methods used to generate SALs is provided in Screening Assessment Methodology (ER Project Assessments Council In preparation, 02-111). For those chemicals for which SALs are available, each observed concentration datum is compared to the chemical's SAL. If a chemical has a reported concentration greater than its SAL, then that chemical is retained pending further analysis. If a chemical does not have a reported concentration greater than its SAL, then that chemical is generally removed from further consideration. If more than one chemical is present at the site, this decision is

deferred pending the results of the multiple constituent evaluation (MCE). The decision to identify a chemical as a concern when a SAL is not available is made on a case-by-case basis, taking into account the availability of process knowledge and toxicological information.

It is possible that chemicals should be retained because of the combined adverse health effects of several chemicals. This possibility is evaluated in the MCE, in which the reported concentration for each chemical is divided by its respective SAL, and the resulting normalized values are incorporated into a simple additive model. If the sum of the normalized values (i.e., the total normalized value) is less than 1, then the chemicals are removed from further consideration. If the total normalized value is greater than 1, then chemicals having an individual normalized value greater than or equal to 0.1 are retained pending further evaluation.

Only those chemicals that exceed background concentration thresholds (certain inorganics and radionuclides) or are detected (organics) in at least one sample are included in the MCE. These chemicals are divided into three classes: noncarcinogens, chemical carcinogens, and radionuclides. Additive effects are assumed within each class, but each class is evaluated separately. For further information on the calculation of MCEs see Screening Assessment Methodology (Environmental Restoration Assessments Council In preparation, 02-111).

The screening assessment process described above was followed in this RFI report.

3.4.2 Risk Assessment

The human health risk assessment(s) presented in Chapter 5 follow the guidance document Risk-Based Corrective Action Process (Environmental Restoration Project Decision Support Council In preparation, 02-112). The human health risk assessment process consists of the following four steps:

- identification of chemicals of potential concern,
- exposure assessment,
- toxicity assessment, and
- risk characterization.

Risk assessments were performed for uranium and copper for PRS 33-010(c) in Section 5.11 of this RFI report. Risk assessment calculations are given in Appendix C.

3.5 Ecological Assessment

In accordance with LANL ER policy, ecological screening assessments will be conducted at TA-33 in order to evaluate the exposure of relevant endpoints or receptors to contamination. Ecological exposure units (EEUs) will be defined for both ecological screening and ecological risk assessments. An EEU is defined by two criteria. First, the endpoint is considered. Endpoints of interest at TA-33 include plants and animals of the soil ecosystem, elk and deer population, small game population, and threatened and endangered (T&E) species such as peregrine falcon, Mexican spotted owl, and spotted bat. The second criterion that defines an EEU is the habitat or range required by a particular endpoint. For example, elk and deer occupy a range that could include the entire LANL reservation, whereas small game such as rabbits or ground squirrels may occupy several acres within TA-33 or other suitable areas. Thus, for each endpoint there will be an EEU that is defined on these criteria and serves as the ecological unit for screening assessment and risk assessment.

Because EEUs generally are larger than a single PRS, several PRSs could be contained within a single EEU. The EEU approach will provide assessments of potential exposures to contamination that incorporate the natural processes to which endpoints would be subjected. In addition, the assessments will be based on the ranges of the endpoints of interest instead of on a PRS-by-PRS scale. This approach provides assessment of all contaminants within the EEU simultaneously, and potential effects of several PRSs can be evaluated as well as potential effects of exposure to multiple contaminants. EEUs will integrate the potential exposure to single or multiple contaminants over the range within which the animals of interest normally function.

Remediation activities at selected PRSs will remove sources of contamination from some EEUs. The screening and risk assessments will take the reduction of the source term into account as well as the potential effects of the residual contamination within the EEU. In addition, the possible effects on the ecosystem of removing a source term, that is, the effects of the remediation itself, can be estimated using the EEU approach.

Evaluations will be conducted of each PRS for T&E species and for habitat in or near each PRS that is critical for T&E species. Biological survey information and site reconnaissance will provide the information for the T&E evaluation. Site access by receptors and site landscape condition will be scored in order to evaluate the PRSs for their potential as critical habitat for

T&E species. The results of the screening and risk assessments from each EEU will be reported in a separate document.

According to the biological survey for OU 1122 as presented in Appendix B of the RFI work plan, there are several possible T&E species at TA-33. Peregrine falcon, golden eagle, Mexican spotted owl, and spotted bat have either been observed within TA-33 or are expected to forage there (LANL 1992, 0784). Anecdotal information from Bandelier National Monument in September 1995 confirmed that a pair of golden eagles may be nesting in White Rock Canyon within Bandelier National Monument.

Surveys for critical habitat were conducted in December 1994 and in October 1995. The TA-33 sites in this report were assessed as moderately disturbed and moderately accessible for resource use by receptors (Myers and Ferenbaugh 1995, 1250). ER activities at the PRSs would not disturb critical habitat. If active nearby nests are reported, activities will be curtailed. Ingestion of shrapnel or debris from testing is a potential ecological exposure pathway at PRS 33-006(a) that will be evaluated in the ecological screening and risk assessments.

3.6 Development of Conclusions and Recommendations

The RFI Work Plan for OU 1122 was based on a phased effort using reconnaissance sampling to detect contamination, if present (LANL 1992, 0784). Conclusions and recommendations in this RFI report are based on the results of sampling and analysis as specified in the work plan. Each sampling point was examined as to appropriateness for the decisions being made. Analytical results were compared to background and to SALs. Results from all samples within the entire geographical area of the PRS were then evaluated for trends to determine if contaminants below SAL may be moving through the PRS. If necessary, a preliminary risk assessment was performed. Based on the overall evaluation, a PRS is recommended for NFA if no contamination was detected at hazardous levels. Some form of accelerated cleanup is recommended for PRSs with an obvious, straightforward remedy. Phase II sampling and analysis is proposed when further sampling is needed to provide additional data for the risk assessment process.

The LANL ER Project and EPA have agreed upon four criteria under which a PRS may be proposed for NFA (Environmental Restoration Project 1995, 1173). The appropriate criterion for the PRSs proposed for NFA in this report is Criterion 4: the PRS has been characterized or remediated in accordance with current applicable state or federal regulations, and the available data indicate that contaminants of concern are either not present or are present in concentrations that would pose an acceptable level of risk under the projected future land use.

4.0 RESULTS OF QUALITY ASSURANCE/QUALITY CONTROL ACTIVITIES

This section reviews the impact on data useability of QC results reported in Appendix B of this report, as well as QA results associated with collocated sample pairs and PE samples submitted by the field unit as additional QA samples.

4.1 Inorganic Analysis

A total of 211 samples from 14 PRSs, plus 8 PE samples, were submitted for inorganic analyses. The bulk of these samples were submitted to a single laboratory, but a total of five different laboratories were used. No significant differences among laboratories were noted.

Anomalous results associated with matrix spikes, QC blinds, and duplicate analyses are summarized in Appendix B, Table B-1 of this report. Of these results, only the failure of duplicate analysis to reproduce the original lead result of 326 mg/kg for AAA9646 from canyonside disposal PRS 33-010(a) at East Site deserves special mention (request no. 19257). The duplicate result (16 mg/kg) was within background. Both results were accepted during validation. The discrepancy is taken as evidence of the particulate nature of lead contamination at this and similar PRSs.

Eight pairs of collocated surface soil samples were collected and analyzed for inorganics. Pairs with large relative differences included copper in AAA9789/AAA9790 (1320 and 25.6 mg/kg, respectively) from PRS 33-006(a) and lead AAA9649/AAA9650 (989 and 83.7 mg/kg, respectively) from PRS 33-010(a), illustrating again the particulate nature of lead contamination at PRS 33-010(a) and copper at the shot pad, PRS 33-006(a).

The eight PE samples included three types of material, two certified reference materials prepared by Resource Technology Corporation (two samples each), and a laboratory control soil sample material prepared by INEL (four samples). Four of these were sent to the primary laboratory, whose results were generally within the suggested 95% control limits. (Exceptions were above the upper control limit, suggesting that bias may be upward.) Somewhat larger "out of control" rates with biases in both direction were observed in samples sent to other laboratories. In particular, results from request/report 17843/26560 showed three out of eight analytes (barium, lead, and zinc) below the lower control limits. Other samples in this report came from East Site PRSs 33-007(a) and 33-010(d).

Request 19113 included eleven surface samples from PRS 33-007(b) and one field PE sample composed of material prepared by INEL. Ten of these 11 surface samples (and only these 10 samples, among all the surface samples from South Site) were reported to contain arsenic at levels above background, from 8.3 to 18.3 mg/kg. Relatively high levels of several other analytes (notably chromium, iron, nickel, and vanadium) were also reported in these samples.

Results for the blind (to the analytical laboratory) PE sample included with this request were very poor. Seven out of twenty analytes were reported above their upper prediction limits. Arsenic was not one of these seven, but it was near the upper prediction limit for arsenic. Chromium was very near its upper prediction limit, and iron and vanadium were above their limits. Nickel, although reported slightly above the upper prediction limit, was below the EQL.

A detailed review of this data package showed that all samples were analyzed at least twice although they were extracted only once, except for a second extraction used for mercury analysis only. The arsenic results that were reported for the PE sample (AAA9874) and for the one surface sample that had background levels of arsenic (AAA9705) came from a different run, on a different instrument, than the results for the remaining surface samples. If the results of the other run had been reported for the PE sample, arsenic would have been above its upper prediction limit, and arsenic for AAA9705 would have been reported at 11.6 mg/kg instead of undetected (<2.5 mg/kg). Conversely, if the arsenic results of the run that produced the PE data had been reported, they would have been uniformly below the instrument detection limit rather than greater than 8 mg/kg. Examination of the laboratory QC results in this data package revealed no significant problems and produced no explanation of why the samples were run twice or why one run was reported rather than the other.

Because of these problems and because no other surface samples from South Site, including several in the same area as those included in Request 19113, indicated a release of arsenic, the reported elevated arsenic results appear to be unreliable. Three of the PRS 33-007(b) locations were resampled. The original arsenic results at these locations were all above 13 mg/kg; the resampled results were all below 2 mg/kg.

Based on these results, the arsenic data from request 19113 are considered unusable, and results for the other analytes that were above prediction limits in the PE sample in the run that produced the PRS 33-007(b) data (calcium, copper, iron, manganese, lead, vanadium, and zinc) are considered to be estimated, possibly biased upward. PRS 33-007(b) is discussed in Section 5.9 of this RFI report.

Overall, the remaining inorganic analysis results are judged to be usable.

4.2 Organic Analysis

4.2.1 Volatile Organic, Semivolatile Organic, Pesticide, and Herbicide Analyses

Fifteen samples from 3 PRSs were submitted for volatile organic analysis (VOA), 94 samples from 7 PRSs for semivolatile organic analysis (SVOA), 4 samples from 3 PRSs for polychlorinated biphenyl (PCB)/pesticide analysis, and 17 samples from 5 PRSs for herbicide analysis. The remaining analyses were distributed among five laboratories. While there are significant differences in reported surrogate recoveries among laboratories for SVOA, these differences do not consistently place any laboratory outside accepted EPA criteria and do not affect the data discussed in this report.

Anomalous results associated with matrix spikes, QC blinds, and duplicate analyses are summarized in Appendix B of this RFI report in Tables B-2 (volatile organics), B-3 (semivolatile organics), and B-4 (PCBs, pesticides, and herbicides).

All but one of the positive VOA results were associated with PRS 33-004(m). They included one measurement of acetone at 23 mg/kg, but acetone was also reported in two associated blanks at 22 to 23 ug/L (request/report 17774/27772). Acetone results are considered questionable, but high toluene results in these two samples are accepted.

Most of the detected semivolatile organic compounds (SVOCs) are low level polycyclic aromatic hydrocarbons (PAHs) from East Site firing areas. No reported QC results appear to significantly affect the reliability of these results.

The only reported pesticide detected in the 1994 campaign was p,p'-DDT (0.0055 mg/kg) in sample AAA9656 at PRS 33-007(a). This compound was reported out of control in the associated QA blind (request/report 17674/27622); only 46% of the spiked compound was recovered. Even adjustment for possible analytical error leaves the concentration 100 times below SAL of 1.3 mg/kg. There are also problems associated with general rinsate sample AAB1205 (report/request 18353/28639), no PCBs or pesticides were detected but surrogate recovery was only 7%; all results are qualified as estimated-undetected.

VOC, SVOC, pesticide, and herbicide organic results are judged usable for the purposes of the decisions addressed in this report.

4.2.2 HE Analyses

A total of 163 samples from 8 PRSs were collected for HE analysis. All HE samples were sent to one laboratory. Many HE results are compromised by missed holding times and/or other problems identified in Appendix B, Table B-4. Most samples were kept frozen until extracted, and therefore the data validator did not consider that missed extraction times invalidated the results. However, when extracts were kept up to four times longer than the holding time for analysis, results for undetected compounds were rejected, while positive results were either rejected or qualified as estimated values (J flag). The majority of the rejected results were associated with samples from South Site.

Positive results were identified in 9 of the 163 samples submitted for HE analysis. Two of these 9 came from East Site and the remainder from South Site. The positive results from East Site were unqualified observations of less than 1 mg/kg nitrotoluenes (NT), dinitrotoluenes (DNT), and tetryl. Positive results from South Site were qualified or rejected observations of less than 1 mg/kg research department explosive (RDX), amino-DNTs (A-DNT), nitrobenzene (NB), trinitrobenzenes (TNB), NT, trinitrotoluene (TNT), and tetryl. The TNT degradation product 2-amino-4,6-DNT was also reported at 5.35 mg/kg (J-qualified) in one sample.

Because of the adverse impact of rejected HE results on decisions for several PRSs in this report, all qualified HE results were subjected to a focused evaluation of laboratory control data generated during analysis. Review of the HPLC scans, on which peaks are automatically identified even when they are below the quantitation level, detected HE peaks in an additional 24 samples, plus unidentified peaks collected at HE elution times in 5 more samples (Campbell 1995, 02-107). Most of these were the explosives high melting explosive (HMX) and RDX peaks. These additional samples included 7 from East Site (plus 3 with unidentified peaks) with HMX, RDX, NT, and tetryl at levels below 1 mg/kg. The remaining 17 samples (plus 2 with unidentified peaks) came from South Site and included HMX, RDX, DNT, TNT, tetryl, and amino-DNT. Observations above 1 mg/kg were associated with one sample where they were quantified from the confirmation, rather than the primary, HPLC column. These additional results, together with the originally reported analytes detected, are summarized in Attachment B.

All QC blind data from this laboratory were also reviewed for the period in question, when instrumental difficulties resulted in the reported delays. This review showed that the laboratory rarely missed a spiked analyte. Some of the spiked analytes were below the CRQL, but when the HPLC scans for these samples were reviewed, only one case was found where the peak was not large enough to be detected by the HPLC. Spiking concentrations in these QC blinds are within the range of interest, most often 1–4 mg/kg. The fact that these compounds can be detected, although possibly underquantified, even when holding times are missed, suggests that the PRS 33-006(a) data are at least qualitatively usable. Among four QC HE blinds submitted with our requests, only one result out of 54 was an incorrect “undetected” result.

These data reviews were supplemented by an experiment that was run using some of the QC blinds submitted to the laboratory (Campbell 1995, 02-107). Originally, the sample extracts were held for 146 to 212 days, after being extracted about 60 days after receipt. (This case is similar to the data for this report.) Even with these long delays, all but one spiked compound was identified, although recovery rates averaged less than 40% (8.5% to 89.2%, with a median of 37.4%). Later (240 to 280 days after receipt), the samples were re-extracted and analyzed within three days. Recovery rates averaged about 20% higher than in the original case (24.9% to over 100%, with a median of 61.6%), supporting the data validator’s decision not to reject data when only the extraction holding time was missed.

Based on these reviews and studies, the TA-33 HE data qualified as quantitatively rejected are judged to be qualitatively usable. Specifically, compounds not detected after review of the HPLC scans are unlikely to have been present in these samples. Those that were identified in samples with missed holding times were probably present in larger amounts than reported, but probably not at levels greater than 5 to 10 times what is estimated. To confirm this assessment, a limited resampling program will be conducted, as described in Section 5.5 of this report PRS 33-006(a) at South Site.

4.3 Radiochemistry Analysis

Two hundred one samples from 14 PRSs, plus 7 PE samples, were submitted for radiochemistry analysis. All samples were analyzed for cesium-137, 85% for total uranium, and 35% for cobalt-60. One isotopic uranium and six tritium analyses were performed.

Only two QC blinds are associated with radiochemical analyses: one for cesium-137 (report/request 19636/30109) and one for total uranium (report/request 19636/30113). Results are reported under control in both cases. Duplicate analyses for these constituents also indicated uniformly adequate replicability.

Data validators qualified a handful of results as estimated (J-qualified) as noted in Appendix B, Table B-6. Several of these results are associated with above-background results for total uranium, which are expected at some of the PRSs examined in this report.

Among the six collocated pairs of surface soil samples for which total uranium was measured, there were two pairs in which an elevated level of total uranium in one sample was not reproduced in the other: samples AAA9628/AAA9629 from PRS 33-007(a) (5.63 and 40.67 mg/kg, respectively) and samples AAA9649/AAA9650 from PRS 33-010(a) (8.34 and 2.80 mg/kg, respectively).

Overall, the radiochemical analysis results are judged to be usable.

4.4 Results for Performance Evaluation Samples of INEL Material

Six samples of INEL soil laboratory control sample material, used as TA-33 performance evaluation QA samples, were prepared in the same manner as field samples, submitted as part of a sample request group, and analyzed by six different laboratories during the 1994 field season (Table 4.4-1).

TABLE 4.4-1
SAMPLES OF INEL PE MATERIAL

SAMPLE ID	DATE	REQUEST	LAB	ANALYSIS	TECHNIQUE
AAA9436	8-18-94	19598	203	Isotopics	Gamma spectroscopy (cesium-137) Alpha spectroscopy (uranium and thorium isotopes)
AAA9450	9-13-94	19997	216	Isotopics	Gamma spectroscopy (cesium-137, americium-241) Alpha spectroscopy (uranium and thorium isotopes)
AAA9851	7-14-94	19636	203	Isotopics	Gamma spectroscopy (cesium-137)
		19636	203	Uranium	Kinetic phosphorescence analysis
		19640	203	Inorganics	Inductively-coupled plasma emission spectroscopy Cold vapor atomic absorption (mercury)
AAA9862	7-13-94	19076	212	Isotopics	Gamma spectroscopy (cesium-137, cobalt-60)
		19095	200	Inorganics	Inductively-coupled plasma emission spectroscopy Inductively-coupled plasma mass spectrometry (antimony) Electrothermal vaporization atomic absorption (arsenic, selenium)
AAA9874	6-15-94	19113	206	Inorganics	Inductively-coupled plasma emission spectroscopy Cold vapor atomic absorption (mercury)
		19472	211	Uranium	Kinetic phosphorescence analysis
AAA9890	6-9-94	19405	211	Inorganics	Inductively-coupled plasma emission spectroscopy Graphite furnace atomic absorption (arsenic, lead, selenium, thallium) Cold vapor atomic absorption (mercury)
		19414	211	Uranium	Kinetic phosphorescence analysis

The INEL material contained cobalt-60, cesium-137, and strontium-90 well above LANL background UTLs; plutonium-238, plutonium-239/-240, and americium-241 somewhat above LANL background UTLs; and uranium isotopes at LANL background UTL. Activities of thorium isotopes were not known, but they appear to be within LANL background UTLs. Several inorganic constituents were spiked into this material at levels ranging from 2 to 200 times background.

Results for the four samples receiving at least one isotopic analysis are shown in Table 4.4-2. The TA-33 sampling plan included no analyses for isotopic plutonium, americium, or strontium, although one americium-241 result was reported with other gamma spectroscopy results.

- All results by gamma spectroscopy were within the supplied prediction intervals.
- Results for sample AAA9436 were low for uranium-234 and uranium-238 (as indicated by minus signs in Table 4.4-2), and high for uranium-235 (indicated by plus signs). All results for sample AAA9436 were qualified as estimates. All results for the associated QA blind sample were out of control; uranium isotopes were reported as zero and thorium isotopes were low by a factor of three to five.
- The result for uranium-235 was slightly high for sample AAA9862, but the other two uranium isotopes were within their prediction intervals, although near the upper end.

**TABLE 4.4-2
ISOTOPIC RESULTS**

ANALYTE	SAMPLE AAA9436	SAMPLE AAA9450	SAMPLE AAA9851	SAMPLE AAA9862
Americium-241 ^a	NA ^b	0.104	NA	NA
Cesium-137 ^a	122.9	120	121	136
Cobalt-60 ^a	NA	NA	NA	12.9
Thorium-228	0.0456 J	1.01 J	NA	NA
Thorium-230	0.0627 J	1.05 J	NA	NA
Thorium-232	0.0709 J	1.03 J	NA	NA
Uranium-234 ^a	1.04 J (-)	1.17	NA	1.44
Uranium-235 ^a	0.4634 J (+)	0.0655	NA	0.1 (+)
Uranium-238 ^a	0.7414 J (-)	1.21	NA	1.49

^a Prediction intervals provided for these isotopes. In this case, (-) after the results indicates that the result is below the lower prediction limit, (+) indicates that it is above the upper prediction limit. Other results are within the prediction interval.

^b NA = Not analyzed.

Leaving aside the qualified results for sample AAA9436, 1 of 15 isotopic measurements lies outside the prediction intervals, which is reasonable if these are (as is traditional) 95% prediction intervals.

Prediction limits were also provided for twenty inorganic constituents of the INEL material. (Wide "advisory" control limits, of which the lower limit was always zero, were also supplied for antimony, selenium, and thallium.) Four samples were analyzed for inorganics, as shown in Table 4.4-3.

- Two of the 20 constituents were above the upper prediction limit in sample AAA9851. A significant number of qualifiers were assigned by the data validator to all chromium, copper, mercury, nickel, lead, antimony, and selenium results in this request. Mercury was high for sample AAA9851 but out of control low in an associated QC blind. It is not clear why the other results were qualified. Except for copper they were within the prediction limits.
- One of 12 reported analytes (among 20) for sample AAA9862 was above its upper control limit.
- Seven out of 20 analytes were above their upper control limits for sample AAA9874. No QC samples were submitted with this request, and routine data validation recorded no problems. However, there are other reasons to question this data package, for which in-depth validation focused particularly on arsenic (which was not one of the problems with sample AAA9874) was requested. All samples in request number 19113 were eventually rejected and three of the sample locations resampled as described in Section 4.1 of this RFI report.
- Two of the 20 analytes were above their upper control limits for sample AAA9890, and one was below its lower control limit.

Leaving aside sample AAA9864, 6 of 52 reported observations were outside the recommended control limits, which statistically would occur about one time in 100 if the observations were independent. However, independence is probably not a reasonable assumption; these results suggest that these limits should be accepted as reasonable 95% prediction limits. Two misses in 20, and 1 in 12 are both quite likely occurrences for 95% prediction limits. Even 3 out of 20 happens more than one time in 100. Seven misses out of 20, (sample AAA9874) however, and all in the same direction, indicate a serious analytical problem.

TABLE 4.4-3
PE INORGANIC RESULTS

ANALYTE	SAMPLE AAA9851	SAMPLE AAA9862	SAMPLE AAA9874	SAMPLE AAA9890
Aluminum ^a	10 700	NA ^b	15 600	10 600
Antimony	<10 UJ	0.5	<8	<8.5
Arsenic ^a	226	323 (+)	246	385 (+)
Barium ^a	230	260	309	223
Beryllium ^a	<0.9	0.17	<0.65	<0.66
Cadmium ^a	7.7	9	9.1	7.7
Calcium ^a	26 200	NA	29 800 (+)	25 900
Chromium ^a	48 J	51	62.9	42
Cobalt ^a	<7	NA	<8.7	<6.2
Copper ^a	75.1 J (+)	NA	86.1 (+)	66.2
Iron ^a	18 700	NA	21 600 (+)	16 500
Lead ^a	167 J	160	206	236 (+)
Magnesium ^a	5 990	NA	7 700 (+)	5 280
Manganese ^a	276	NA	326 (+)	252
Mercury ^a	0.15 J (+)	NA	<0.12	<0.07 UJ
Nickel ^a	27.9 J	23	<30.6	21.2
Potassium ^a	2 280	NA	4 780	2 430
Selenium	1.3 R	1	<19.6	<0.5
Silver ^a	<0.84	2	<2.3	<1.9
Sodium	<554	NA	<926	<652
Thallium	<0.62	NA	<4.2	<0.26
Uranium	2.99 J	4.4	1.5	1.88
Vanadium ^a	50.6	NA	66.9 (+)	39.2 (-)
Zinc ^a	1 230	1 200	1 440 (+)	1 140

^a Prediction intervals provided for these elements. In this case, (-) after the results indicates that the result is below the lower prediction limit; (+) indicates that it is above the upper prediction limit. Other results are within the prediction interval.

^b NA = Not analyzed.

Two of the arsenic results exceeded the upper control limit for arsenic, and the other two were in the upper half of the prediction interval. The high arsenic results are associated with atomic absorption measurements, while observations within the prediction interval were made by

inductively-coupled plasma emission spectroscopy (ICPES) analyses; however, INEL also used graphite furnace atomic absorption (GFAA) for its analysis. The high lead measurement and the INEL lead measurement are also GFAA analyses, while the others were made by ICPES. Overall, therefore, these data suggest that results are not biased by the use of different instrumental methods.

5.0 SITE-SPECIFIC RESULTS, CONCLUSIONS, AND RECOMMENDATIONS

This RFI report discusses the 1994 Phase I sampling and analysis for 17 PRSs located at East Site, South Site, and NRAO. Site information, results of analyses, evaluation of contamination, and recommendations for these PRSs are presented in this section. Table 5.0-1 summarizes the PRSs and the recommendation for each PRS. Figures 5.0-1, 5.0-2, and 5.0-3 show PRS locations at South Site, East Site, and NRAO, respectively. Plates 5.0-1 and 5.0-2 show photographic overviews of South Site and East Site, respectively.

TABLE 5.0-1
PRSs IN THIS TA-33 RFI REPORT

SECTION	PRS ID	LOCATION	PRS TYPE	RECOMMENDATION
5.1	33-004(b)	South Site	Septic system TA-33-33	NFA ^a
5.2	33-004(c)	East Site	Septic system TA-33-96	NFA
5.3	33-004(j)	South Site	TA-33-26 outfall	NFA
5.4	33-004(m)	NRAO	Septic system TA-33-179	NFA
5.5	33-006(a) ^b	South Site	South Site shot pads	Phase II/VCA ^c
5.6	33-006(b)	East Site	East Site shot pads	NFA
5.7	33-007(a)	East Site	East Site firing area	NFA
5.8	33-007(b) ^b	South Site	South Site firing area	NFA/VCA
5.9	33-010(a)	East Site	Canyonside disposal	VCA
5.10	33-010(b)	East Site	Canyonside disposal	VCA
5.11	33-010(c) ^b	South Site	Drainageside disposal	NFA/VCA
5.12	33-010(d)	East Site	Canyonside disposal	VCA
5.13	33-010(g)	South Site	Canyonside disposal	VCA
5.14	33-010(h)	South Site	Surface disposal	NFA
5.15	33-011(b)	NRAO	Surface disposal	VCA
5.16	33-011(c)	South Site	Blivit storage	NFA
5.17	33-014	South Site	Burn pit	NFA

^a NFA = No further action.

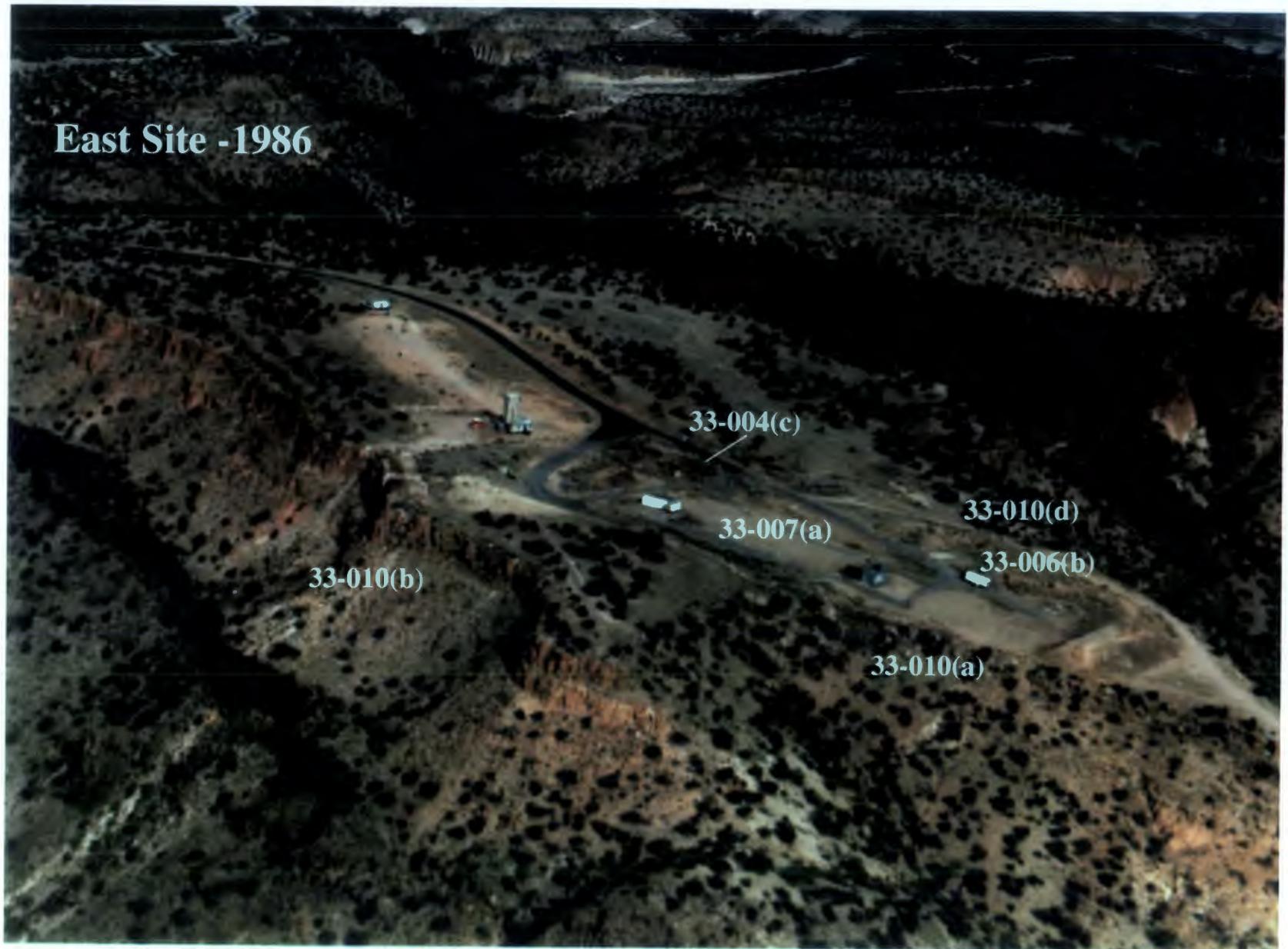
^b Possible VCA.

^c VCA = Voluntary corrective action.

South Site - 1986



East Site -1986



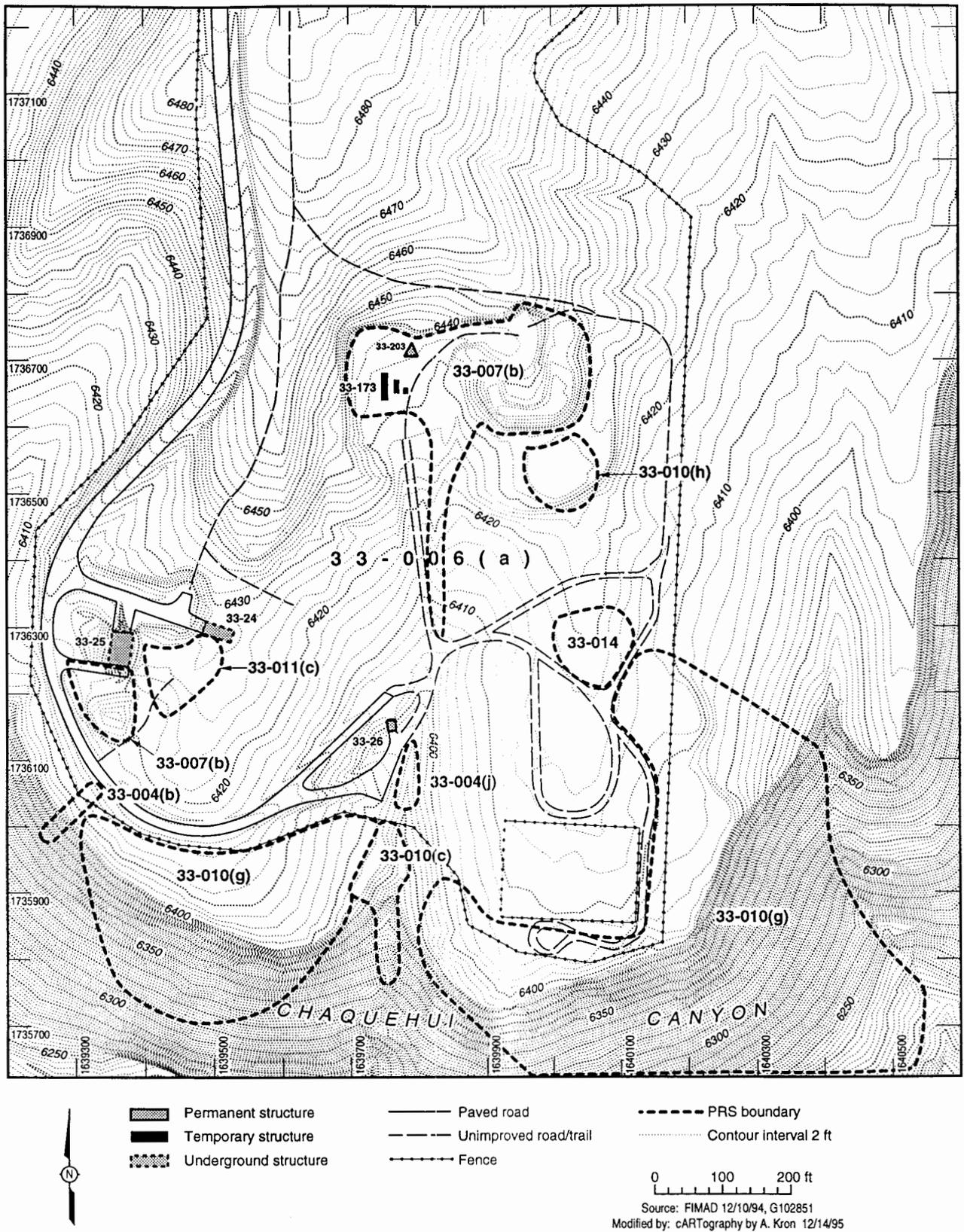


Fig. 5.0-1. South Site PRSs in this RFI report.

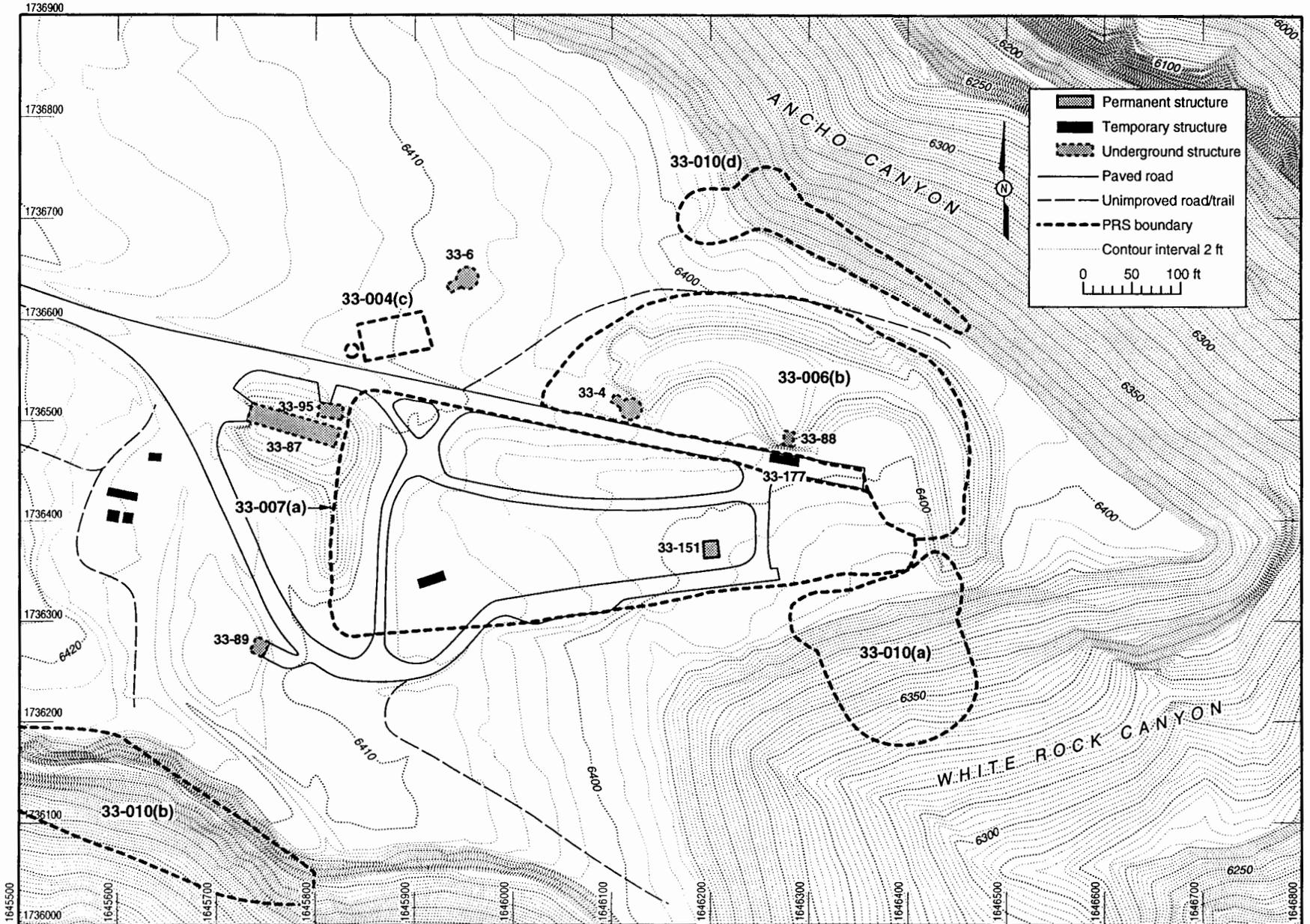
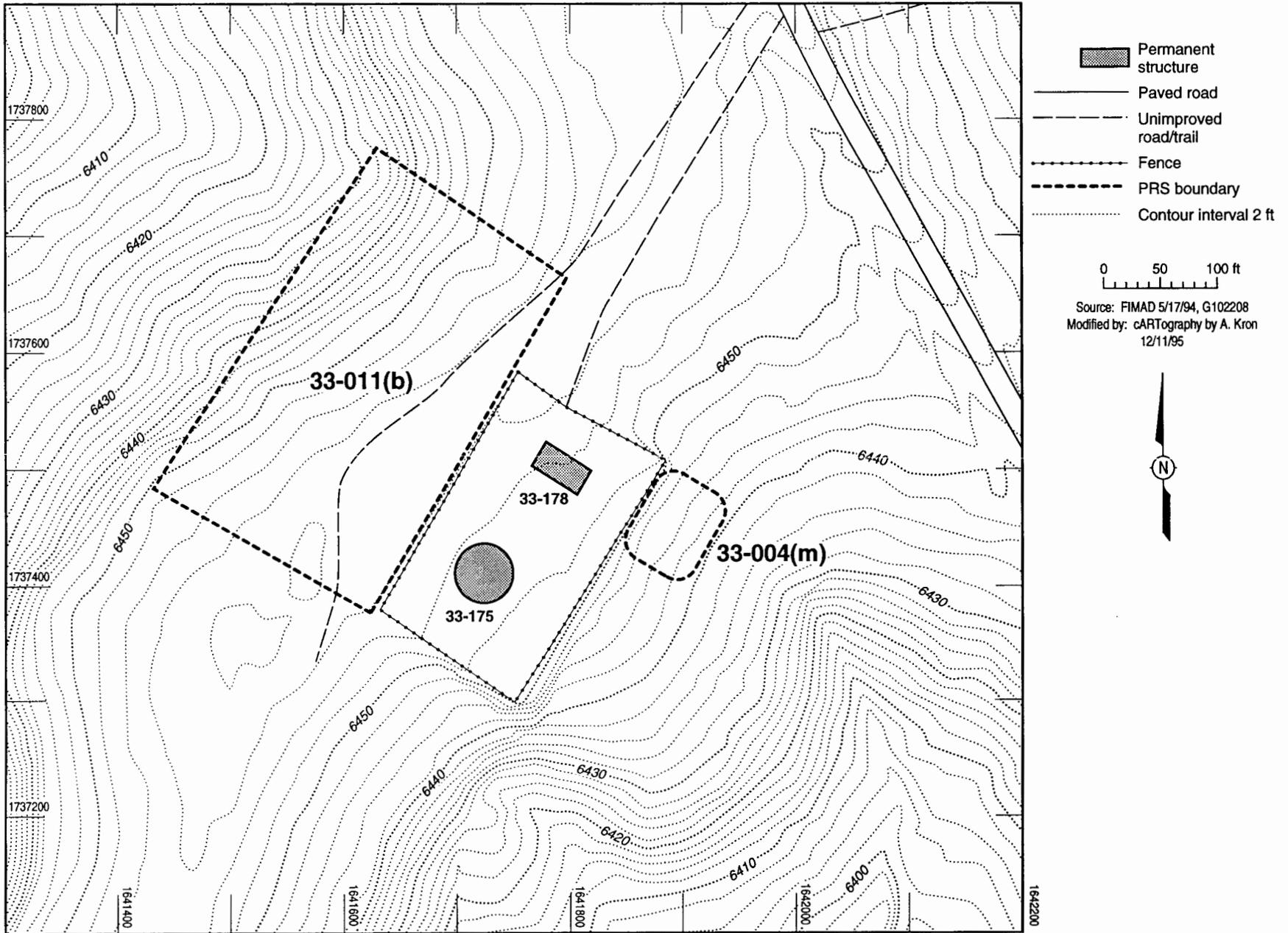


Fig. 5.0-2. East Site PRSs in this RFI report.

Source: FIMAD 5/17/94, G102209
Modified by: cARTography by A. Kron 12/11/95



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Fig. 5.0-3. NRAO Site PRSs in this RFI report.

As specified in the RFI work plan, all PRSs in this section were subject to the initial radiation survey prior to sampling. In addition, each sample was individually screened at the time of collection as required by the OU 1122 site-specific health and safety plan. Radiation above background was detected at PRSs 33-006(a), 33-007(b), and 33-010(c) as described in Sections 5.6, 5.7, and 5.12 of this RFI report. Elevated uranium concentrations were detected in all samples collected from these locations. No radiation was detected at any other site; therefore the radiation survey is not mentioned in other PRS assessments.

Many samples had more than one chemical above background (95%, 0.95) UTLs. In such cases, an MCE is required and was performed. (An MCE is the sum of the ratios of each chemical result to its SAL.) For the sake of brevity in this RFI report, calculations are not shown unless the MCE yields a result of at least 75% of the target value of 1.

5.1 PRS 33-004(b) South Site Septic System TA-33-33

PRS 33-004(b) is septic system TA-33-33 at South Site. Arsenic and PAHs were detected above background in the dry tank, but because these are not migrating and contamination outside the tank was detected only at low levels, the system is recommended for NFA.

5.1.1 History

PRS 33-004(b) is discussed in the RFI Work Plan for OU 1122, Subsections 3.4.2.2, 4.4.3.1, and 4.4.5. Septic system TA-33-33 supported control bunker TA-33-24, which was completed in June 1950. The septic system was permitted as NMED LA-33. TA-33-24 housed personnel in support of firing pad and X-unit vault, TA-33-26, located 250 ft southeast of TA-33-24. No record has been found of any incident involving hazardous or radioactive material in TA-33-24. Photo developing may have taken place. Water was shut off to TA-33-24 in 1994 and the septic system is inactive.

Potential contaminants were listed as photoprocessing chemicals.

5.1.2 Description

Septic system TA-33-33 consists of a 6-in. steel pipe from TA-33-24 extending through a trench 300 ft south to a 730-gal septic tank. A second pipe, 35 ft long, extends from the septic tank to an outfall on the rim of Chaquehui Canyon. Two additional drain lines run within the same trench from TA-33-24 to the canyon, bypassing the septic tank. The tank lies on level ground south of the access road within 35 ft of the rim of Chaquehui Canyon. The three outfall pipes

daylight on the rim. There is no indication that the pipes ever discharged enough effluent to cause erosion gullies to form down the cliff into the canyon. The soil ranges in composition from loamy to mostly organic material with small pebbles and occasional pieces of gravel. Soil is dry. Weeds and chamisa grow near the tank and pipes.

5.1.3 Previous Investigations

No previous investigations were conducted at this PRS.

5.1.4 Field Investigation

Sampling at PRS 33-004(b) was designed to determine if leakage occurred from the tank and if contaminants were released at the outfalls. The work plan specified that fluid and sludge samples be collected; neither fluid nor sludge was present in the tank. Instead, a single sediment sample was collected from the bottom of the tank. As specified in the work plan, one surface and two subsurface samples were collected from a borehole location 5 ft downslope from the tank. Three surface locations were sampled at the outfall (Figure 5.1.4-1). Table 5.1.4-1 lists sample parameters and the request numbers under which the samples were analyzed.

**TABLE 5.1.4-1
SUMMARY OF SAMPLES TAKEN FOR PRS 33-004(b)**

LOCATION ID	SAMPLE ID	DEPTH (ft)	MATRIX	INORGANICS	RADIO-NUCLIDES	VOCs ^a	SVOCs ^b	HERBICIDE	CYANIDE
33-1305	AAA9735	0-0.5	Soil	19283	19471	NA ^c	17798	17798	NA
33-1305	AAA9736	6	Soil	19283	19471	17798	17798	NA	NA
33-1305	AAA9737	4	Soil	19283	19471	17798	17798	NA	NA
33-1306	AAA9738	0-0.5	Soil	19393	19421	NA	17764	NA	19393
33-1307	AAA9739	0-0.5	Soil	19393	19421	NA	17764	NA	19393
33-1308	AAA9740	0-0.5	Soil	19393	19421	NA	17764	NA	19393
33-1530	95-002	In tank	Sediment	14384	NA	14383	14383	NA	14384

^a VOCs = Volatile organic compounds.

^b SVOCs = Semivolatile organic compounds.

^c NA = Not analyzed.

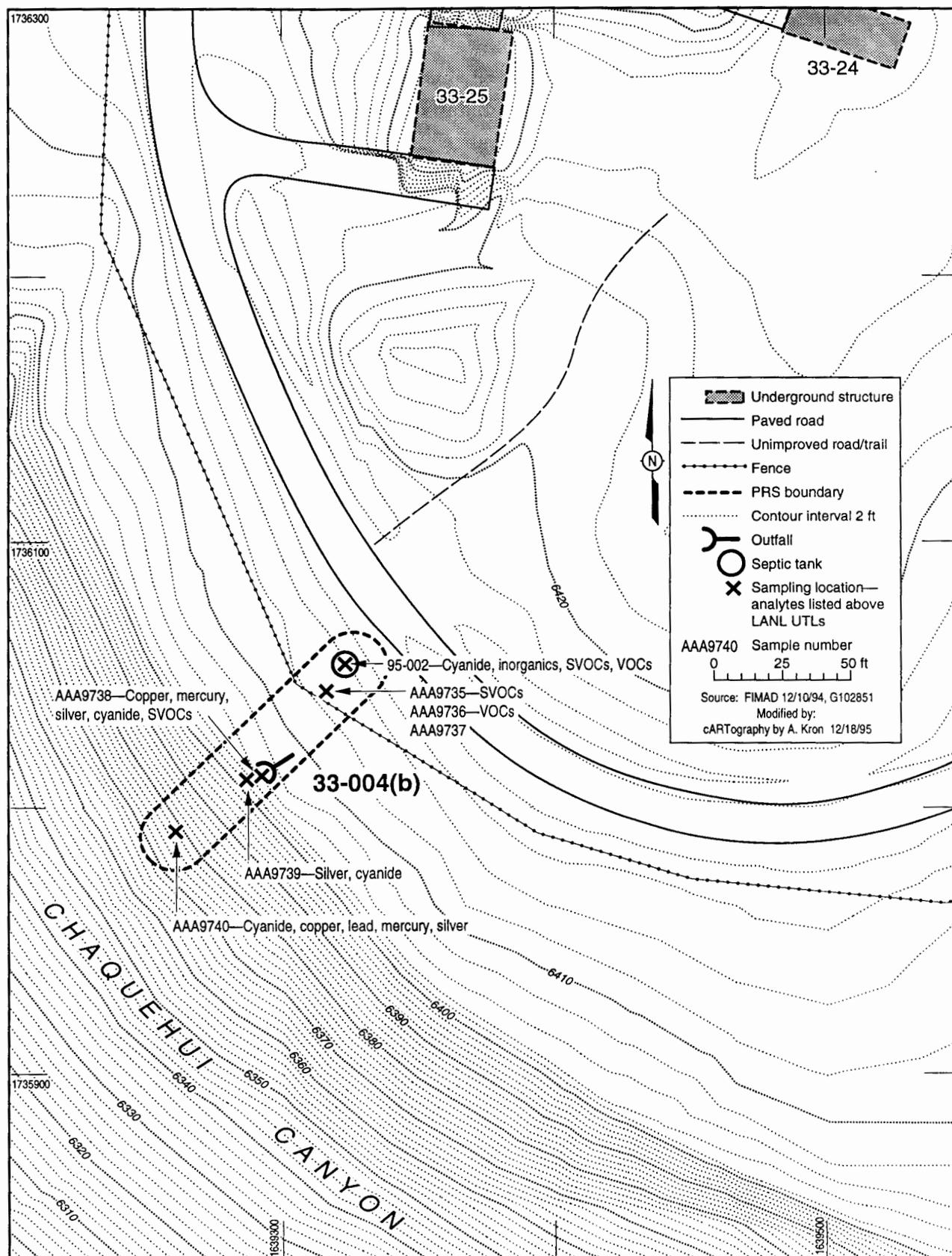


Fig. 5.1.4-1. South Site: PRS 33-004(b) septic system TA-33-33.

5.1.5 Background Comparison

Traces of cyanide were detected in the outfall samples and in the tank. Low levels of copper, lead, and silver, and a trace of mercury were detected above LANL background soil UTLs in the downgradient sample, AAA9740, 25 ft below the outfall pipes (Table 5.1.5-1). Extremely low levels of above-background metals were found in the upgradient samples.

The septic tank contained copper, cyanide, mercury, and silver, also found in surface samples outside the tank. Arsenic, chromium, nickel, lead, and zinc concentrations are elevated in the tank, but did not migrate from the septic system to the environment. These are listed in Table 5.1.5-1 for comparison purposes only. Soil background UTLs are not relevant to the sediment in the tank, which contained 27.3% iron.

TABLE 5.1.5-1

INORGANICS WITH CONCENTRATIONS GREATER THAN BACKGROUND UPPER TOLERANCE LIMITS FOR PRS 33-004(b)

SAMPLE ID	DEPTH (ft)	ARSENIC (mg/kg)	CHROMIUM (mg/kg)	COPPER (mg/kg)	CYANIDE (mg/kg)	LEAD (mg/kg)	NICKEL (mg/kg)	MERCURY (mg/kg)	SILVER (mg/kg)	ZINC (mg/kg)
LANL UTL ^a	N/A ^b	7.82	19.3	30.7	NA ^c	23.3	15.2	0.1	NA	50.8
TA-33 UTL	N/A	3.77	14.6	NA	NA	25.2	11.1	ND ^d	ND	57.3
SAL ^e	N/A	Background	30	2 800	2 600	400	1 500	23	380	23 000
AAA9738	0-0.5	3.7	5.2	30.8	1.7 (J) ^f	11.2	<7.9	<0.03	<0.77	43.7
AAA9738D9	0-0.5	4.4	5	39.6	0.51	11.5	9.2	0.03	0.79	46.6
AAA9739	0-0.5	<1.2	3.1	10.2	0.81 (J)	9.3	<2.3	<0.06	0.86	40.2
AAA9740	0-0.5	5.1	5.5	70	1 (J)	24.6	<6.1	0.17	28.4	40.5
95-002 ^h	In tank	41.8	43	192	1.3	71.6	59	1.8	6.3	584

^a UTL = Upper tolerance limit.

^b N/A = Not applicable.

^c NA = Not analyzed.

^d ND = Not detected.

^e SAL = Screening action level.

^f J = Estimated concentrations.

^g D = Analyzed in duplicate.

^h Soil background UTLs are not relevant to septic tank sample.

5.1.6 Evaluation of Organics

Organics were detected in few samples (Table 5.1.6-1). Low levels of the plasticizer di-n-butylphthalate were detected in sample AAA9738 at the outfalls. Trace levels of PAHs were detected in surface sample AAA9735 near the tank. These compounds are long-lived components of asphalt and are attributed to runoff deposits from the adjacent paved road. A trace amount of the solvent methylene chloride (0.036 mg/kg) was detected at a depth of 6 ft, but not at 4 ft. (The soil/tuff interface was encountered at 5 ft during hand-augering.) A trace amount of methylene chloride (0.002 mg/kg) was detected in the laboratory blank for request 17798.

A number of volatile and semi-volatile organics were detected in the tank, including poly-aromatic hydrocarbons (PAHs) at levels above soil SALs. Soil SALs are not directly relevant to sediment intanks.

TABLE 5.1.6-1

PRS 33-004(b) SOIL CONCENTRATIONS FOR ORGANIC ANALYTES WITH VALUES GREATER THAN THE ESTIMATED QUANTITATION LIMIT.

ANALYTE	SAMPLE ID	DEPTH (ft)	MATRIX	RESULT (mg/kg)	SAL ^a (mg/kg)	EQL ^b (mg/kg)
Benzo[b]fluoranthene	AAA9735	0-0.5	Soil	0.38	0.61	0.33
Fluoranthene		0-0.5	Soil	0.59	2 600	0.33
Phenanthrene		0-0.5	Soil	0.56	ND ^c	0.33
Pyrene		0-0.5	Soil	0.58	2 000	0.33
Methylene chloride	AAA9736	6	Soil	0.036	11	0.01
Di-n-butylphthalate	AAA9738	0-0.5	Soil	1.1	ND	0.33
Acetone	95-0002	In tank	Sediment	87	2 029	0.01
Anthracene		In tank	Sediment	3.9(J) ^d	19	0.33
Benzo(a)anthracene		In tank	Sediment	12	0.61	0.33
Benzo(b)fluoranthene		In tank	Sediment	17	0.61	0.33
Benzo(a)pyrene		In tank	Sediment	9.8(J)	0.06	0.33
Chrysene		In tank	Sediment	13	24	0.33
Di-n-butylphthalate		In tank	Sediment	2.3(J)	ND	0.33
Fluoranthene		In tank	Sediment	29	2 600	0.33
Isopropyl alcohol		In tank	Sediment	20(NJ) ^e	ND	ND
Phenanthrene		In tank	Sediment	15	ND	0.33
1,1,2-Trichloroethane		In tank	Sediment	0.13	1.41	0.005

^a SAL = Screening action level.

^b EQL = Estimated quantitation limit.

^c ND = Not determined.

^d J = Estimated quantity.

^e NJ = Presumed present, estimated quantity reported.

5.1.7 Human Health Assessment

5.1.7.1 Screening Assessment

Only low-level PAHs contained within the septic tank were found above SALs, and soil SALs are not directly applicable to material in a closed tank. Several samples have multiple constituents with results above background UTLs but below SALs. In all cases, MCE screening yields a value less than the target limit of 1.

5.1.7.2 Risk Assessment

No risk assessment was performed for this PRS.

5.1.8 Ecological Assessment

5.1.8.1 Ecotoxicological Screening Assessment

This PRS will be included in EEU's defined for both ecological screening and ecological risk assessments. A site inspection of this PRS indicates that it will be adequately addressed in the EEU's.

5.1.8.2 Ecological Risk Assessment

No ecological risk assessment has been performed for this PRS. An ecological risk assessment will be evaluated when an approach is approved by regulators. See Section 3.5 of this report for the approach to ecological risk to be implemented at TA-33.

5.1.9 Extent of Contamination

Biased sampling was performed at the outfalls to support a screening decision.

5.1.10 Conclusion and Recommendation

Based on NFA Criterion 4, a Class III permit modification is requested to remove PRS 33-004(b) from the HSWA Module of LANL's RCRA operating permit.

- No chemicals were detected at hazardous levels. Contamination was low level and spotty. PAHs at levels above SAL are confined to the tank.
- Sampling was performed at locations most likely to be contaminated.

5.2 PRS 33-004(c) East Site Septic Tank TA-33-96

PRS 33-004(c) is septic tank TA-33-96 that served control bunker TA-33-87 at East Site. Because no contamination was detected above SALs and only a few chemicals were detected above LANL UTLs, the PRS is recommended for NFA.

5.2.1 History

PRS 33-004(c) is discussed in the RFI Work Plan for OU 1122, Subsections 3.5.2.2 and 4.5.3.1. Control bunker TA-33-87 was completed in June 1955. It served as support for group W-3 tests at East Site until 1972. The septic system is operational under New Mexico Environmental Department (NMED) Permit LA-34; the septic system has been active since 1955 and appears to be operating properly. Since 1972, bunker TA-33-87 has been used for storage and for occasional short-term experiments

There is no record of radioactive or hazardous materials other than photoprocessing chemicals and possibly solvents being used or stored in the building (Hoard 1990, 02-022). Potential contaminants were listed in the work plan as photoprocessing chemicals and VOCs.

5.2.2 Description

The septic tank is located beside East Site road north of TA-33-87. A 4-in. diameter vitrified-clay pipe carried waste from TA-33-87 for 100 ft northeast to the 768-gal. tank. A similar pipe, 30 ft long, carried effluent from the tank to a small drain field. The area is level, with no drainage pattern discernible. The septic system does not have an outfall to the surface. Soils are dry and powdered. Interspersed tuff fragments are due to excavation for the septic tank and drain field. Prior to sampling, a thick stand of chamisa grew on the site.

5.2.3 Previous Investigations

No previous investigations were conducted at this PRS.

5.2.4 Field Investigation

Sampling at PRS 33-004(c) was designed to determine if leakage from the tank occurred or if contaminants were released in the drain field. A total of 14 samples were taken. As specified in the work plan, two fluid samples were taken from the tank. No sludge was present in the tank; material scraped from the bottom was primarily gravel and was judged to be unsuitable as a

sample. As part of the investigation, a trench was dug into the drain field to locate the position of the tiles and any buried outfall pipes. One surface and two subsurface samples (Location 33-1450) were collected from a borehole located 5 ft from the tank. One surface sample and two subsurface samples were collected from each of three boreholes in the drain field (Figure 5.2.4-1). Table 5.2.4-1 lists sample parameters and the request numbers under which the samples were analyzed.

TABLE 5.2.4-1
SUMMARY OF SAMPLES TAKEN FOR PRS 33-004(c)

LOCATION ID	SAMPLE ID	DEPTH (ft)	MATRIX	INORGANICS	RADIO-NUCLIDES	VOCs ^a	SVOCs ^b
33-1451	AAA9597	Tank	Liquid	18837	18756	17992	17992
33-1451	AAA9850	Tank	Liquid	19569	20173	NA ^c	NA
33-1450	AAA9599	0-0.5	Soil	18837	18756	NA	18085
33-1450	AAA9600	2.5	Soil	18837	18756	18085	18085
33-1450	AAA9601	4.33	Soil	18837	18756	18085	18085
33-1309	AAA9602	0-0.5	Soil	18837	18756	NA	18085
33-1309	AAA9603	2.5	Soil	18837	18756	18085	18085
33-1309	AAA9604	5	Soil	18837	18756	18085	18085
33-1310	AAA9605	0-0.5	Soil	18837	18756	NA	18085
33-1310	AAA9606	2.5	Soil	18837	18756	18085	18085
33-1310	AAA9607	4	Soil	18837	18756	18085	18085
33-1450	AAA9709	0-0.5	Soil	18616	19026	NA	18115
33-1450	AAA9710	3	Soil	18616	19026	18115	18115
33-1450	AAA9711	6	Soil	18616	19026	18115	18115

^a VOCs = Volatile organic compounds.

^b SVOCs = Semivolatile organic compounds.

^c NA = Not analyzed.

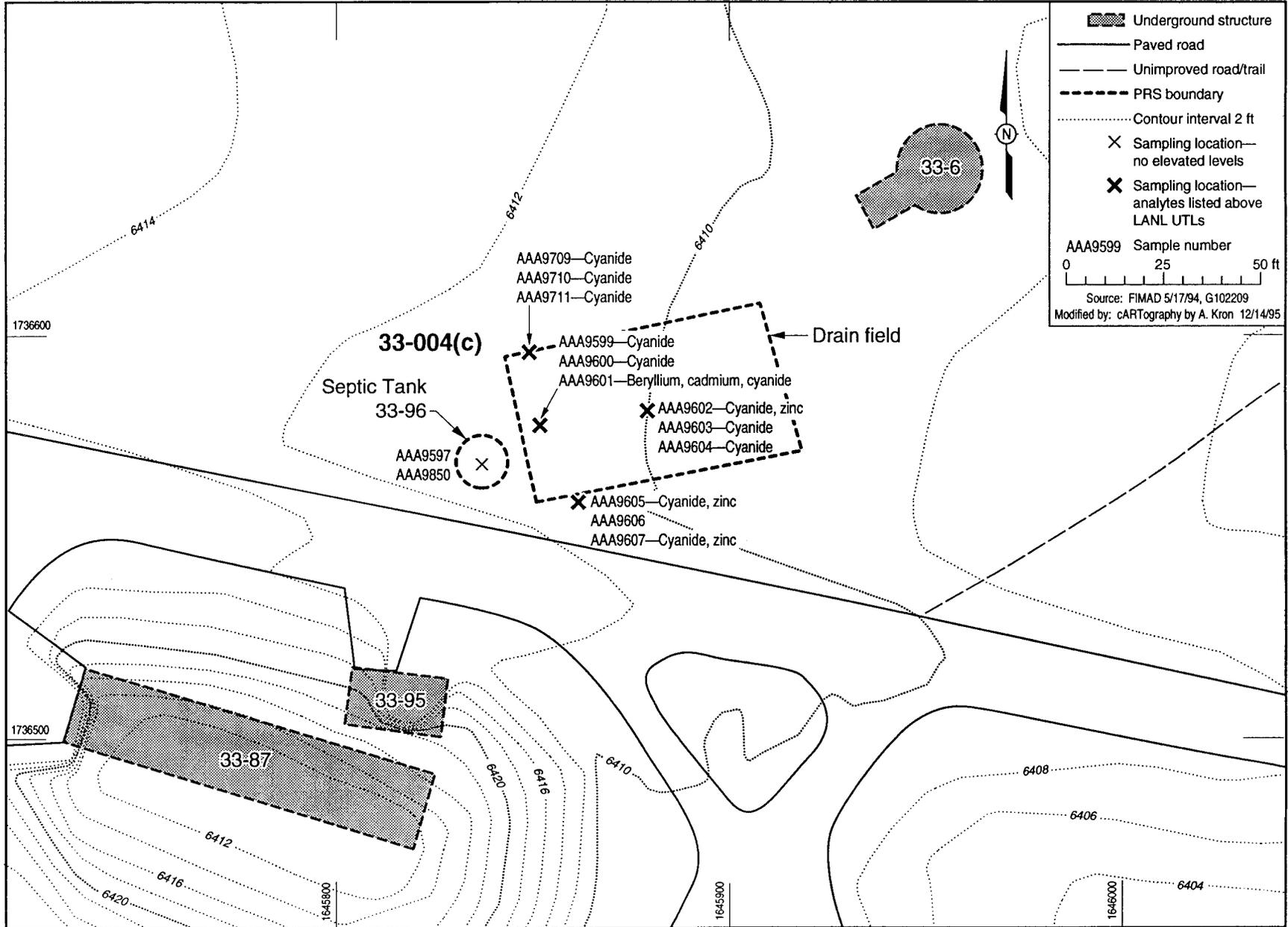


Fig. 5.2.4-1. East Site: PRS 33-004(c), septic system TA-33-96.

5.2.5 Background Comparison

Low levels of cyanide were detected in most samples. Cadmium and beryllium were detected slightly above background UTLs in a laboratory duplicate analysis of sample AAA9601, but not in the original run. No other inorganics or radionuclides were detected above LANL UTLs (Table 5.2.5-1) except very low levels of zinc.

TABLE 5.2.5-1

INORGANICS AND CYANIDE WITH CONCENTRATIONS GREATER THAN BACKGROUND UPPER TOLERANCE LIMITS FOR PRS 33-004(c)

SAMPLE ID	DEPTH (ft)	BERYLLIUM (mg/kg)	CADMIUM (mg/kg)	CYANIDE (mg/kg)	ZINC (mg/kg)
LANL UTL ^a	N/A ^b	1.95	1.4	NA ^c	50.8
TA-33 UTL	N/A	1.22	ND ^d	NA	57.3
SAL ^e	N/A	Background	38	2 607	23 000
AAA9599	0-0.5	0.94	<1	1.10	43
AAA9600	2.5	1.4	1.1	0.91	40
AAA9601	4.33	1.1	<1	0.29	40
AAA9601D ^f	4.33	4.8	3.9	NA	44
AAA9602	0-0.5	1.1	<1	2.30	66
AAA9604	5	1.1	<1	1.30	39
AAA9605	0-0.5	1.2	<1	2.10	52
AAA9607	4	1.1	<1	0.70	54
AAA9709	0-0.5	1	<0.4	7.70	43
AAA9710	3	<1	<0.4	0.42	28
AAA9711	6	<1	<0.4	0.41	32

^a UTL = Upper tolerance limit.

^b N/A = Not applicable.

^c NA = Not analyzed.

^d ND = Not detected.

^e SAL = Screening action level.

^f D = Analyzed in duplicate.

5.2.6 Evaluation of Organics

VOCs and SVOCs were analyzed for but not detected at PRS 33-004(c).

5.2.7 Human Health Assessment

5.2.7.1 Screening Assessment

No chemical was detected above SAL at this PRS. Beryllium was detected above background (95%,0.95) UTL in one sample but not in a duplicate analysis of the same sample. Other sample results indicate that beryllium is not of concern at this PRS. Several samples have multiple constituents with results above background UTLs but below SALs. In all cases, MCE screening yields a value far less than the target limit of 1.

5.2.7.2 Risk Assessment

No risk assessment was performed for this PRS.

5.2.8 Ecological Assessment

5.2.8.1 Ecotoxicological Screening Assessment

This PRS will be included in EEU's defined for both ecological screening and ecological risk assessments. A site inspection of this PRS indicates that it will be adequately addressed in the EEU's.

5.2.8.2 Ecological Risk Assessment

No ecological risk assessment has been performed for this PRS. An ecological risk assessment will be evaluated when an approach is approved by regulators.

5.2.9 Extent of Contamination

Biased sampling was performed in the drain field to support a screening decision. No attempt was made to determine the extent of contamination at this PRS.

5.2.10 Conclusion and Recommendation

Based on NFA Criterion 4, a Class III permit modification is requested to remove PRS 33-004(c) from the HSWA Module of LANL's RCRA operating permit.

- No chemicals were detected at hazardous levels. Cyanide concentrations were far below the SAL of 2 607 mg/kg. Only one zinc result exceeded the TA-33 background (95%, 0.95) UTL of 57.3 mg/kg. Low levels of cadmium and beryllium concentrations are suspect because neither was detected in both laboratory replicates of the same sample.
- Sampling was performed at locations most likely to be contaminated.
- The septic system is active.

5.3 PRS 33-004(j) Outfall from TA-33-26, South Site

PRS 33-004(j) is the outfall of a pipe draining the entrance to the South Site X-unit vault TA-33-26. The unit is recommended for NFA because no contamination except low-level uranium was detected above LANL UTLs. This uranium is considered to result from activities associated with overlapping PRSs 33-006(a), 33-007(b), and 33-010(c).

5.3.1 History

The outfall is discussed in the RFI Work Plan for OU 1122, Subsections 3.4.2.3 and 4.4.3.2. The X-unit vault, TA-33-26, held electronic apparatus to control experiments on the shot pad directly above it. Atmospheric implosion tests were conducted on the shot pad at South Site in the mid-1950s. The vault is empty.

Potential contaminants listed in the work plan were beryllium and uranium.

5.3.2 Description

The X-unit vault is cut into a tuff bank. A 4-in. steel pipe drains the below-grade entrance pad to the vault. The pipe extends 75 ft southeast to an outfall in an arroyo leading to Chaquehui Canyon. The end of the pipe is wrapped in wire mesh. The arroyo has eroded to bedrock tuff and is filled with sand and some sediments.

A paved road ends at the entrance pad with an unimproved road extending beyond the pavement. A culvert under the unimproved road empties into the same arroyo upstream from the outfall pipe. Because this culvert may have delivered runoff from the entrance pad of the vault, samples collected at the east end of the culvert are included in the evaluation of this PRS.

5.3.3 Previous Investigations

No previous investigations were conducted at this PRS.

5.3.4 Field Investigation

Sampling at PRS 33-004(j) was designed to determine if chemicals were released at the outfall. As specified in the work plan, two samples were collected in the arroyo below the outfall. In addition, two samples collected below the culvert may be relevant for this PRS (Figure 5.3.4-1). Table 5.3.4-1 lists sample parameters and the request numbers under which the samples were analyzed.

TABLE 5.3.4-1
SUMMARY OF SAMPLES TAKEN FOR PRS 33-004(j)

LOCATION ID	SAMPLE ID	DEPTH (ft)	MATRIX	INORGANICS	RADIO-NUCLIDES	HE ^a
33-1368	AAA9749	0-0.5	Sediment	19264	19357	17733
33-1369	AAA9750	0-0.5	Sediment	19264	19357	17733
33-1311	AAA9752	0-0.5	Sediment	20384	19433	NA ^b
33-1312	AAA9753	0-0.5	Sediment	20384	19433	NA

^a HE = High explosives.

^b NA = Not analyzed.

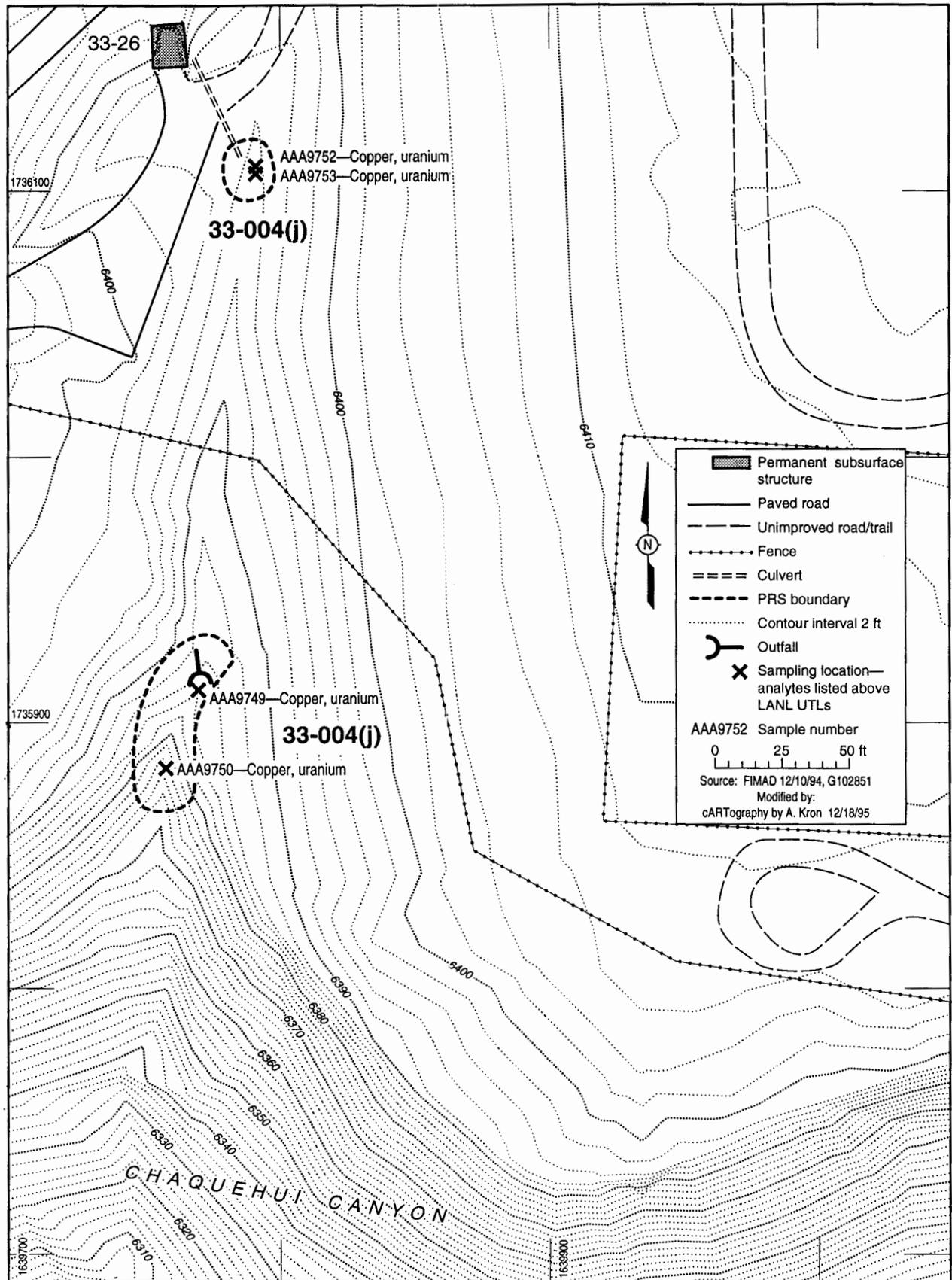


Fig. 5.3.4-1. South Site: PRS 33-004(j), outfall from TA-33-26

5.3.5 Background Comparison

Copper was detected above background UTL in samples associated with septic tank 33-004(j), far below the SAL of 2 800 mg/kg. Copper in the South Site valley is discussed in detail in Section 5.5 of this RFI report. No other inorganics were detected above background UTLs in any sample at PRS 33-004(j).

Uranium was detected above LANL and TA-33 background UTLs but below SAL in all samples (Table 5.3.5-1). Uranium in this drainage is attributed to and discussed in overlapping PRSs 33-006(a) (Section 5.5), 33-007(b) (Section 5.9), and 33-010(c) (Section 5.12) of this RFI report. No other radionuclides were detected above LANL UTLs.

TABLE 5.3.5-1

URANIUM WITH CONCENTRATIONS GREATER THAN BACKGROUND UPPER TOLERANCE LIMITS FOR PRS 33-004(j)

SAMPLE ID	DEPTH (ft)	URANIUM (mg/kg)
LANL UTL ^a	N/A ^b	5.45
TA-33 UTL	N/A	4.12
SAL ^c	N/A	29
AAA9749	0-0.5	20.93 (J) ^d
AAA9750	0-0.5	6.24 (J)
AAA9752	0-0.5	16.77
AAA9753	0.0.5	18.49

^a UTL = Upper tolerance limit.

^b N/A = Not applicable.

^c SAL = Screening action level.

^d J = Estimated quantity.

5.3.6 Evaluation of Organics

No HE was detected at this PRS. HE analyses have been reassigned to PRS 33-006(a) in Section 5.5 of this RFI report. The question of missed HE holding times is addressed there. No other organics were analyzed for.

5.3.7 Human Health Assessment

5.3.7.1 Screening Assessment

No chemical was detected above SAL at this PRS. Several samples have multiple constituents (uranium and copper) with results above background UTLs but below SALs. Uranium and copper are discussed further in Section 5.5. No MCE was performed because these two chemicals have different biological effects.

5.3.7.2 Risk Assessment

No risk assessment was performed for this PRS

5.3.8 Ecological Assessment

5.3.8.1 Ecotoxicological Screening Assessment

This PRS will be included in EEU's defined for both ecological screening and ecological risk assessments. A site inspection of this PRS indicates that it will be adequately addressed in the EEU's.

5.3.8.2 Ecological Risk Assessment

No ecological risk assessment has been performed for this PRS. An ecological risk assessment will be evaluated when an approach is approved by regulators.

5.3.9 Extent of Contamination

Low concentrations of uranium and copper detected in the arroyo can be attributed to overlapping PRS 33-006(a). Biased sampling was performed at PRS 33-004(j) to support a screening decision. No attempt was made to determine the extent of contamination.

5.3.10 Conclusion and Recommendation

Based on NFA Criterion 4, a Class III permit modification is requested to remove PRS 33-004(j) from the HSWA Module of LANL's RCRA operating permit.

- Sampling was performed at locations most likely to be contaminated.
- No chemicals were detected at hazardous levels. Uranium and copper below SAL were the only chemicals detected in the arroyo receiving effluent from the entrance pad of TA-33-26. Elevated uranium and copper are assigned to overlapping PRS 33-006(a) as discussed in Section 5.5 of this RFI report.

5.4 PRS 33-004(m) NRAO Septic Tank TA-33-179

PRS 33-004(m) is the septic system of the service building for the radiotelescope at NRAO. Only low levels of solvents were detected. The system is recommended for NFA because no contamination was detected at hazardous levels.

5.4.1 History

PRS 33-004(m) is discussed in the RFI Work Plan for OU 1122, Subsections 3.6.2.1 and 4.6.4. Septic tank TA-33-179 was installed when the NRAO complex was built in 1987. The system is operated under registration number Santa Fe- (SF) 89032 and serves TA-33-178, support building for the radiotelescope. There is no record of radioactive materials being used or stored in TA-33-178. Technicians assigned to the facility indicated that solvents have been used to clean equipment and some of these solvents may have been discharged to the septic system.

5.4.2 Description

The NRAO site is built on near-bedrock, forcing the septic system to be excavated into tuff. The system lies outside the northeast corner of the fenced telescope compound. The tank has a capacity of 1 000 gal. and discharges to a leach field. No engineering drawings of the unit are available. The soil at sampling points is described as loamy and very fine with sand and tuff inclusions. The tuff pieces range in size from less than 1 in. to greater than 5 in. The organic matter consists mostly of roots. The site slopes to the south and bedrock is exposed beyond the drain field area.

5.4.3 Previous Investigations

No previous investigations were conducted at this PRS.

5.4.4 Field Investigation

Sampling at PRS 33-004(m) was designed to determine the level of organic solvent contamination in the tank and whether solvents escaped from the tank. Thirteen samples were collected, including a collocated sample and one extra surface sample. One fluid and one sludge sample were collected from the septic tank. Four borehole locations were sampled; one borehole (samples AAA9824 and AAA9906) was located at the drain pipe from the drain field (Figure 5.4.4-1). Field screening for organics did not detect organic vapors in the tank. All samples were analyzed for SVOCs, four samples were analyzed for VOCs, and one sample was analyzed for pesticides (Table 5.4.4-1).

TABLE 5.4.4-1
SUMMARY OF SAMPLES TAKEN FOR PRS 33-004(m)

LOCATION ID	SAMPLE ID	DEPTH (ft)	MATRIX	VOCs ^a	SVOCs ^b	PESTICIDES
33-1469	AAA9818	Tank	Liquid	17774	17774	NA ^c
33-1469	AAA9819	Tank	Sludge	17774	17774	NA
33-1318	AAA9820	0.5	Soil	NA	17970	NA
33-1318	AAA9821	2	Soil	17970	17970	NA
33-1318	AAA9822	4	Soil	17970	17970	NA
33-1319	AAA9823	0.5	Soil	NA	17774	17774
33-1503	AAA9824	3.5	Soil	NA	17970	NA
33-1319	AAA9825	4	Soil	NA	17970	NA
33-1320	AAA9826	0.5	Soil	NA	18061	NA
33-1470	AAA9827	0.5	Soil	NA	18061	NA
33-1320	AAA9828	3	Soil	NA	18061	NA
33-1320	AAA9829	4	Soil	NA	18061	NA
33-1503	AAA9906	0.5	Soil	NA	18061	NA

^a VOCs = Volatile organic compounds.

^b SVOCs = Semivolatile organic compounds.

^c NA = Not analyzed.

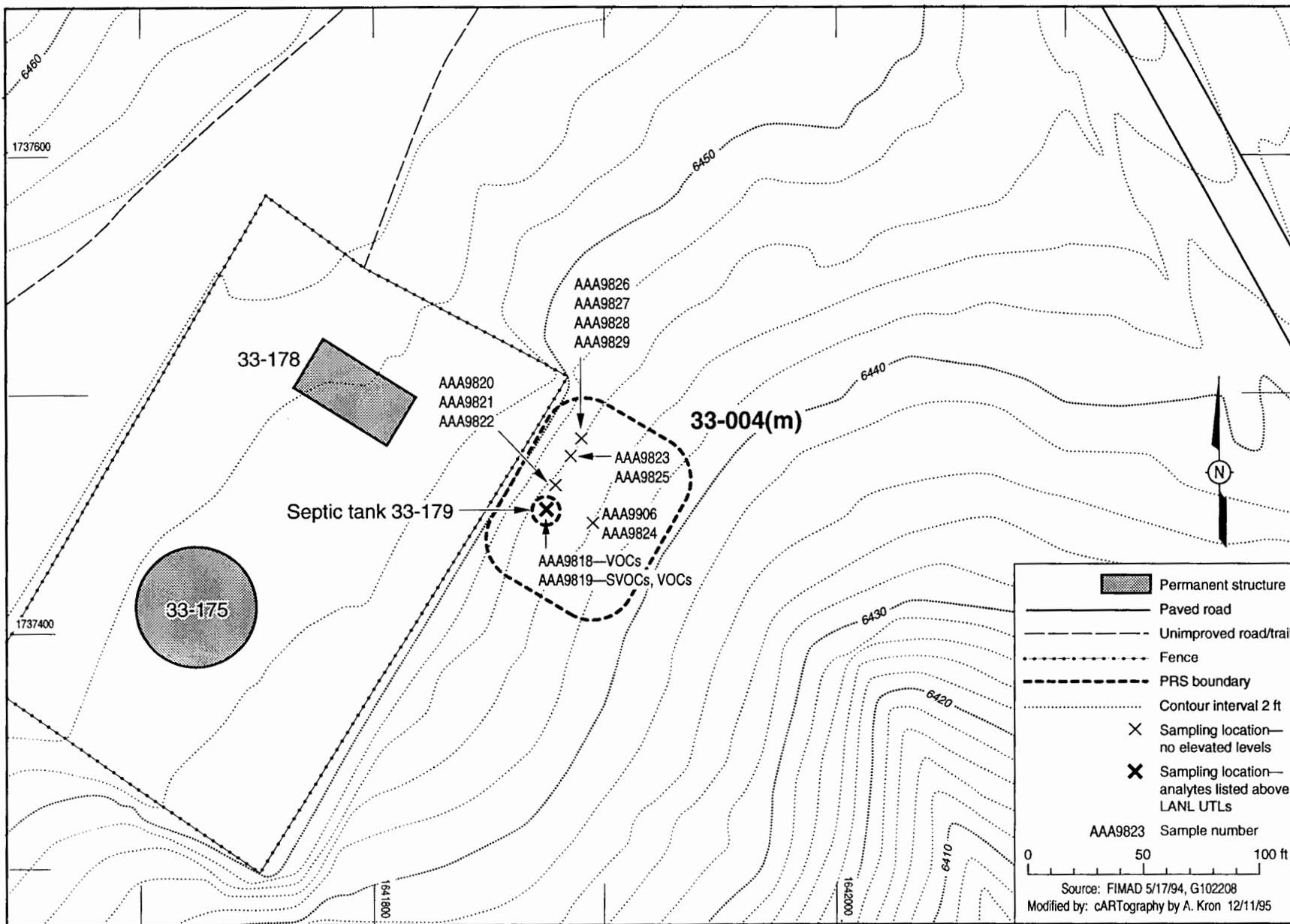


Fig. 5.4.4-1. NRAO Site: PRS 33-004(m), septic system TA-33-179.

5.4.5 Background Comparison

No inorganics or radionuclides were analyzed at PRS 33-004(m), therefore no background comparisons can be made.

5.4.6 Evaluation of Organics

No organics were detected in the drain field. Acetone and toluene were detected in both the liquid and sludge sample. The acetone result is suspect because acetone was detected in laboratory QC blanks. The sludge sample also contained ethylbenzene, 1,3,5-trimethylbenzene, and mixed xylenes (Table 5.4.6-1). Although drinking water and soil SALs are not strictly appropriate for septic tank fluid and sludge, they are provided in Table 5.4.6-1 for comparison purposes only.

TABLE 5.4.6-1

PRS 33-004(m) SOIL CONCENTRATIONS FOR ORGANIC ANALYTES WITH VALUES GREATER THAN THE ESTIMATED QUANTITATION LIMIT

SAMPLE ID	VOCs ^a	RESULT	SAL ^b	EQL ^c	UNITS
AAA9818	Acetone ^d	23	2 000	20	µg/L
AAA9818	Toluene	82	1 900	5	µg/L
AAA9819	Acetone	2	2 000	0.020	mg/kg
AAA9819	Ethylbenzene	0.23	700	0.005	mg/kg
AAA9819	Toluene	4.1	1 900	0.005	mg/kg
AAA9819	1,3,5-Trimethylbenzene	0.48	6.4	0.005	mg/kg
AAA9819	Mixed xylenes	0.34	990	0.005	mg/kg

^a VOCs = Volatile organic compounds.

^b SAL = Screening action level.

^c EQL = Estimated quantitation limit.

^d Acetone was detected in analytical laboratory blanks.

5.4.7 Human Health Assessment

5.4.7.1 Screening Assessment

No chemical was detected above SAL at this PRS. Two samples have multiple constituents with results above background UTLs but below SALs. In all cases, MCE screening yields a value far less than the target limit of 1.

5.4.7.2 Risk Assessment

No risk assessment was performed for this PRS.

5.4.8 Ecological Assessment

5.4.8.1 Ecotoxicological Screening Assessment

This PRS will be included in EEUs defined for both ecological screening and ecological risk assessments. A site inspection of this PRS indicates that it will be adequately addressed in the EEUs.

5.4.8.2 Ecological Risk Assessment

No ecological risk assessment has been performed for this PRS. An ecological risk assessment will be evaluated when an approach is approved by regulators.

5.4.9 Extent of Contamination

Contamination was confined to the septic tank at this PRS. Biased sampling was performed in the drain field to support a screening decision. No attempt was made to determine the extent of contamination at this PRS.

5.4.10 Conclusion and Recommendation

Based on NFA Criterion 4, a Class III permit modification is requested to remove PRS 33-004(m) from the HSWA Module of LANL's RCRA operating permit.

- Sampling was performed at locations most likely to be contaminated.
- No chemicals were detected at hazardous levels. The expected solvent contamination at PRS 33-004(m) was detected at low levels only in the septic tank. No chemicals were detected in the drain field.
- The system is active.

5.5 PRS 33-006(a) South Site Shot Pad

PRS 33-006(a) is the shot pad at South Site where implosion studies were conducted. Uranium and copper are widespread in soils, but a risk assessment indicates that no unacceptable risk is present (Section 5.5.7.2 of this RFI report). All surface uranium analyses at South Site were included in the risk assessment regardless of the PRS to which it was originally assigned.

Because of widespread shrapnel distribution and documented evidence that approximately 30% of shrapnel may be contaminated with radioactive material, the PRS may be considered for VCA. HE analyses at South Site were compromised by missed holding times. Because PRS 33-006(a) covers all of South Site, all surface HE analyses collected under Phase I sampling plans for other PRSs at South Site have been reassigned to PRS 33-006(a). Limited resampling for HE is proposed in a Phase II sampling plan.

5.5.1 History

The South Site shot pad is discussed in the RFI Work Plan for OU 1122, Subsections 3.4.2.4 and 4.4.3.3. PRS 33-006(a) was initially described as a shot pad at South Site. Because shrapnel from detonations is widespread, the extent of the PRS has been redefined to cover an area with radius of approximately 1.1 mile.

The buildings at South Site were completed and testing began in June 1950. The X-unit vault contained electronic control equipment used to detonate implosion test apparatus. Uranium shells holding the initiators were used in implosion tests involving from 275 to 5 000 lb of HE. The apparatus and neutron detectors were put into large copper shells for electrical shielding, then the entire assemblage was covered by a wooden shack prior to detonation (Hoard 1990, 02-022). The detonations spread debris, shrapnel, and wood fragments over the entire South Site valley and beyond. After the implosion test program was transferred to other LANL groups in 1955 or 1956, implosion tests were discontinued at TA-33. The shot pad has been inactive since that time.

Potential contaminants were listed as uranium and inorganics.

5.5.2 Description

South Site lies in a small valley about 600 ft in diameter. The entire area drains to Chaquehui Canyon through a short arroyo. The shot pad atop TA-33-26 is located in the middle of this valley. Much of the valley was scraped to bedrock during site construction. The pad itself is located directly above X-unit vault TA-33-26 and is approximately 40 ft in diameter. The pad is covered with sand a foot or more deep. Runoff from the pad enters the main drainage arroyo serving the whole of South Site. Soils are thin and bedrock outcrops prevalent in undisturbed areas. Chamisa covers large areas of the site.

Implosion shots spread shrapnel over a wide area at TA-33 and into Bandelier National Monument. For that reason, the boundaries of PRS 33-006(a) have been expanded to cover a radius 1.1 miles, centered at the shot pad.

5.5.3 Previous Investigations

No previous investigations were conducted at this PRS.

5.5.4 Field Investigation

Sampling at PRS 33-006(a) was designed to determine mean contamination and contaminant distribution by employing random sampling over a wide area. The work plan specified 38 surface samples collected at random locations around the shot pad and 11 samples from the drainage. Forty-six samples were taken over a wide area at South Site (Table 5.5.4-1) (Figure 5.5.4-1). Eleven samples were taken in the main drainage (Table 5.5.4-2) (Figure 5.4.4-2). All samples were analyzed for inorganics, uranium, gamma emitters, and HE.

Because PRS 33-006(a) covers the entire developed area at South Site, results of sampling and analysis attributed to other PRSs are used in subsequent assessment of contaminant distribution. In addition to the samples listed in Tables 5.5.4-1 and 5.5.4-2, surface samples from nearby PRSs were evaluated for possible contamination from the PRS 33-006(a) implosion tests. These included eight surface samples from the tower area of PRS 33-007(b), four samples from the burn area PRS 33-014, and four samples from disposal area PRS 33-010(c).

TABLE 5.5.4-1

SUMMARY OF SURFACE SAMPLES TAKEN FOR PRS 33-006(a)

LOCATION ID	SAMPLE ID	DEPTH (ft)	MATRIX	INORGANICS	RADIO-NUCLIDES	HE ^a
33-1321	AAA9769	0-0.5	Soil	19405	19414	17786
33-1332	AAA9770	0-0.5	Soil	19405	19414	17786
33-1343	AAA9771	0-0.5	Soil	19405	19414	17786
33-1354	AAA9772	0-0.5	Soil	19405	19414	17786
33-1460	AAA9773	0-0.5	Soil	19405	19414	17786
33-1355	AAA9774	0-0.5	Soil	19405	19414	17786
33-1356	AAA9775	0-0.5	Soil	19405	19414	17786
33-1357	AAA9776	0-0.5	Soil	19405	19414	17786
33-1358	AAA9777	0-0.5	Soil	19405	19414	17786
33-1464	AAA9778	0-0.5	Soil	19405	19414	17786
33-1359	AAA9779	0-0.5	Soil	19405	19414	17786
33-1322	AAA9780	0-0.5	Soil	19405	19414	17786
33-1323	AAA9781	0-0.5	Soil	19405	19414	17786
33-1324	AAA9782	0-0.5	Soil	19405	19414	17786
33-1325	AAA9783	0-0.5	Soil	19405	19414	17786
33-1326	AAA9784	0-0.5	Soil	19405	19414	17786

TABLE 5.5.4-1 (CONTINUED)
SUMMARY OF SURFACE SAMPLES TAKEN FOR PRS 33-006(a)

LOCATION ID	SAMPLE ID	DEPTH (ft)	MATRIX	INORGANICS	RADIO-NUCLIDES	HE ^a
33-1327	AAA9785	0-0.5	Soil	19403	19360	17791
33-1328	AAA9786	0-0.5	Soil	19403	19360	17791
33-1329	AAA9787	0-0.5	Soil	19403	19360	17791
33-1465	AAA9788	0-0.5	Soil	19403	19360	17791
33-1330	AAA9789	0-0.5	Soil	19403	19360	17791
33-1466	AAA9790	0-0.5	Soil	19403	19360	17791
33-1331	AAA9791	0-0.5	Soil	19403	19360	17791
33-1333	AAA9792	0-0.5	Soil	19403	19360	17791
33-1334	AAA9793	0-0.5	Soil	19403	19360	17791
33-1335	AAA9794	0-0.5	Soil	19396	19462	17732
33-1336	AAA9795	0-0.5	Soil	19403	19360	17791
33-1337	AAA9796	0-0.5	Soil	19396	19462	17732
33-1338	AAA9797	0-0.5	Soil	19396	19462	17732
33-1339	AAA9798	0-0.5	Soil	19396	19462	17732
33-1340	AAA9799	0-0.5	Soil	19396	19462	17732
33-1341	AAA9800	0-0.5	Soil	19396	19462	17732
33-1342	AAA9801	0-0.5	Soil	19396	19462	17732
33-1467	AAA9802	0-0.5	Soil	19396	19462	17732
33-1344	AAA9803	0-0.5	Soil	19396	19462	17732
33-1345	AAA9804	0-0.5	Soil	19396	19462	17732
33-1346	AAA9805	0-0.5	Soil	19396	19462	17732
33-1347	AAA9806	0-0.5	Soil	19396	19462	17732
33-1348	AAA9807	0-0.5	Soil	19396	19462	17732
33-1349	AAA9808	0-0.5	Soil	19396	19462	17732
33-1475	AAA9809	0-0.5	Soil	19396	19462	17732
33-1350	AAA9810	0-0.5	Soil	19283	19471	17831
33-1351	AAA9811	0-0.5	Soil	19283	19471	17831
33-1352	AAA9812	0-0.5	Soil	19283	19471	17831
33-1353	AAA9813	0-0.5	Soil	19283	19471	17831
33-1473	AAA9891	0-0.5	Soil	19403	19360	17791

^a HE = High explosives.

TABLE 5.5.4-2
SUMMARY OF DRAINAGE SAMPLES TAKEN FOR PRS 33-006(a)

LOCATION ID	SAMPLE ID	DEPTH (ft)	MATRIX	INORGANICS	RADIO-NUCLIDES	HE ^a	PESTI-CIDES	HERBI-CIDES
33-1363	AAA9743	0-0.5	Sediment	20384	19433	17789	NA ^b	NA
33-1364	AAA9744	0-0.5	Sediment	19264	19357	17733	NA	NA
33-1463	AAA9745	0-0.5	Sediment	19264	19357	17733	NA	NA
33-1365	AAA9746	0-0.5	Sediment	19264	19357	17733	NA	NA
33-1366	AAA9747	0-0.5	Sediment	19264	19357	17733	NA	NA
33-1367	AAA9748	0-0.5	Sediment	19264	19357	17733	17728	17728
33-1368	AAA9749	0-0.5	Sediment	19264	19357	17733	NA	NA
33-1369	AAA9750	0-0.5	Sediment	19264	19357	17733	NA	NA
33-1361	AAA9751	0-0.5	Sediment	19264	19357	17733	17728	17728
33-1311	AAA9752	0-0.5	Sediment	20384	19433	NA	NA	NA
33-1312	AAA9753	0-0.5	Sediment	20384	19433	NA	NA	NA

^a HE = High explosives.

^b NA = Not analyzed.

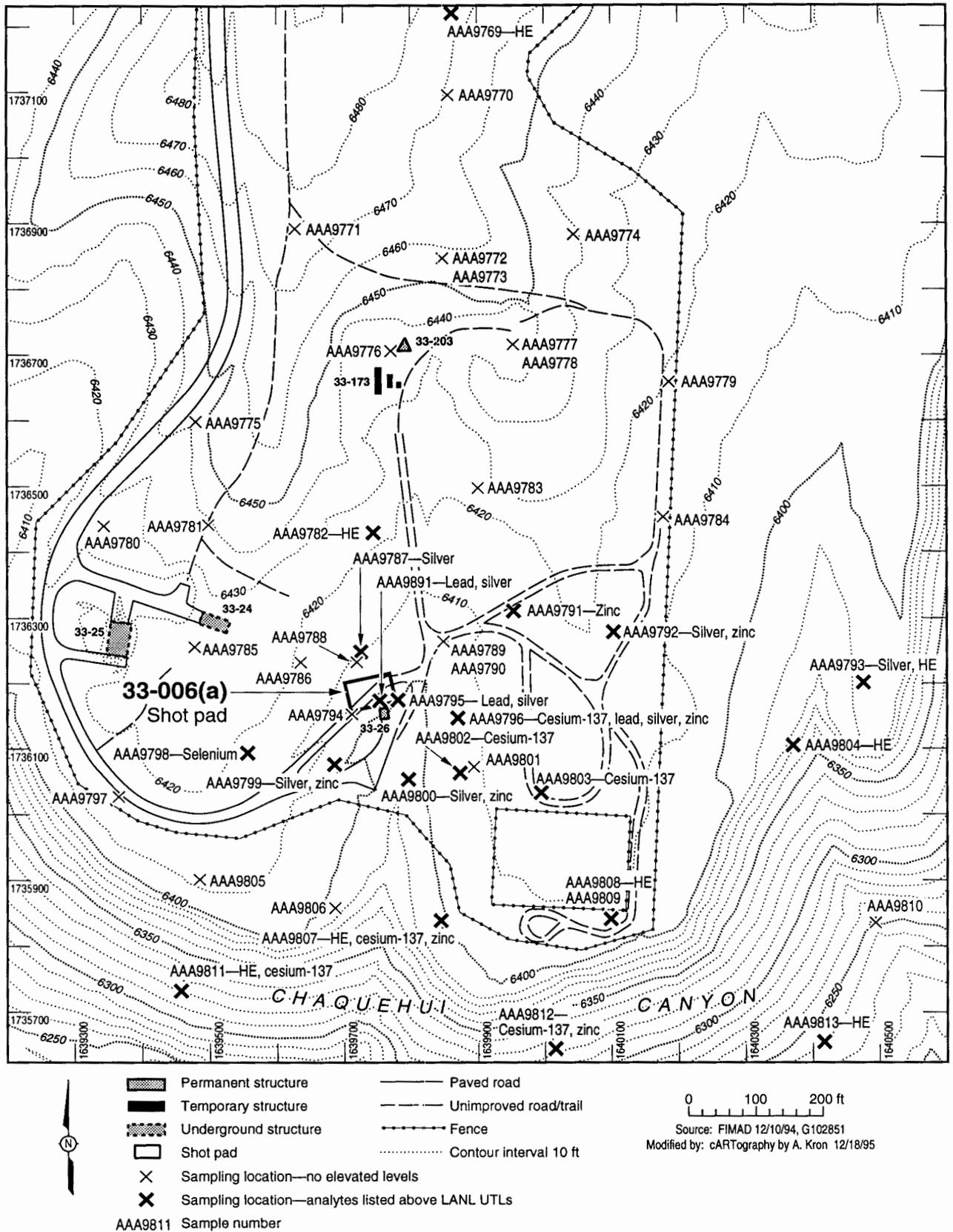


Fig. 5.5-4-1. South Site: PRS 33-006(a), shot pad. Uranium and copper locations not indicated.

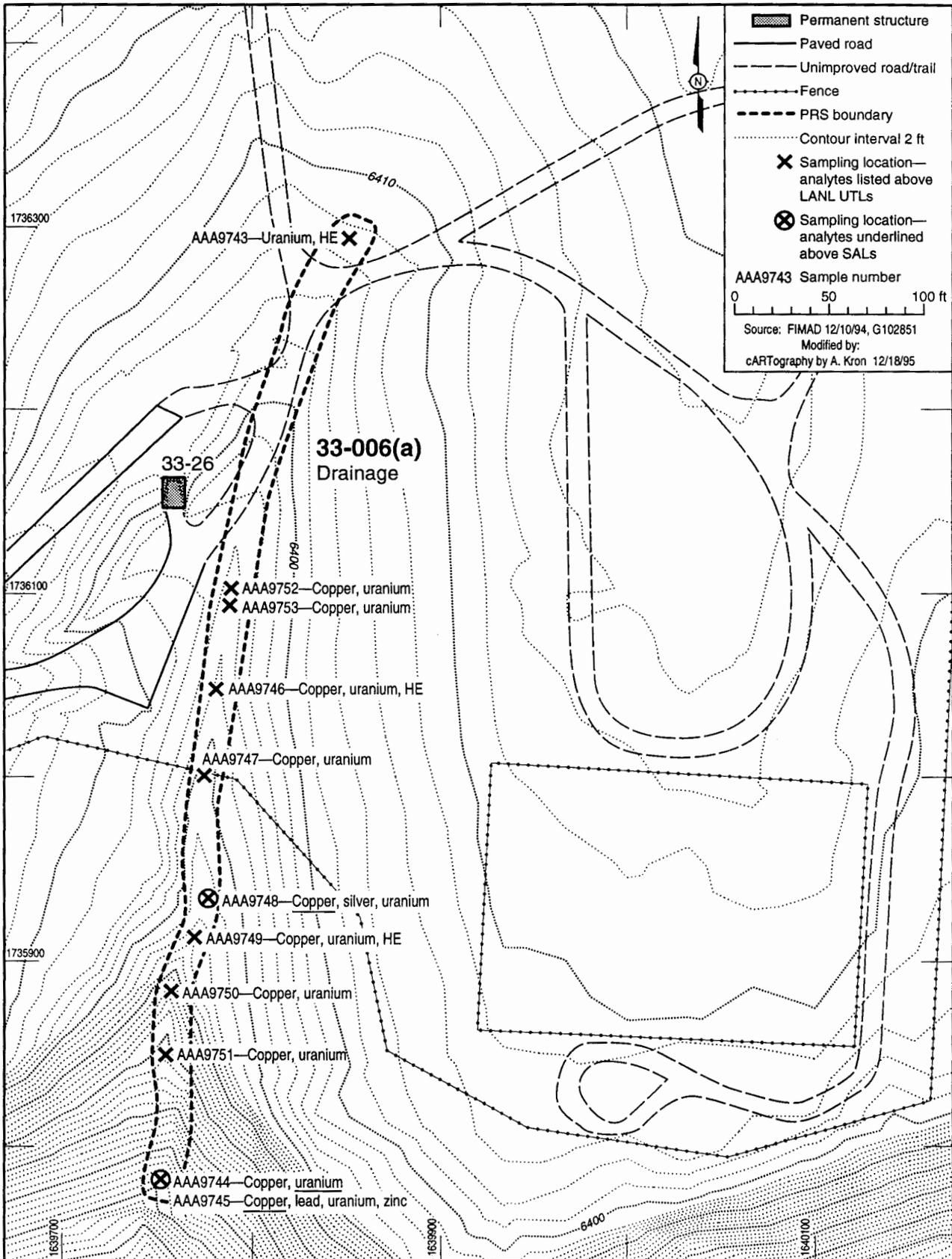


Fig. 5.5.4-2. South Site: PRS 33-006(a), drainage.

5.5.5 Background Comparison

Uranium and copper were detected in most PRS 33-006(a) samples. Results for both these chemicals are included in the discussion of sitewide distribution of uranium and copper presented in Section 5.5.9 of this RFI report. All other inorganic concentrations were below SALs in both random surface samples and drainage samples. Table 5.5.5-1 lists inorganics, except copper, detected above LANL UTLs in the random surface samples. Table 5.5.5-2 lists inorganics, except copper, detected above LANL UTLs in the drainage samples.

TABLE 5.5.5-1
INORGANICS^a WITH CONCENTRATIONS GREATER THAN BACKGROUND UPPER TOLERANCE LIMIT FOR PRS 33-006(a) SURFACE SAMPLES

SAMPLE ID	DEPTH (ft)	LEAD (mg/kg)	SELENIUM (mg/kg)	SILVER (mg/kg)	ZINC (mg/kg)
LANL UTL ^b	N/A ^c	23.3	1.7	NA ^d	50.8
TA-33 UTL	N/A	25.2	0.921	ND ^e	57.3
SAL ^f	N/A	400	380	380	23 000
AAA9787	0-0.5	11.2	<0.56	2.3	39.1
AAA9791	0-0.5	8.5	<0.54	<2.2	54.2
AAA9792	0-0.5	17.5	<0.54	2.3	113
AAA9793	0-0.5	12.1	<0.54	0.81	45.8
AAA9795	0-0.5	41.4	<0.52	1.2	40.8
AAA9796	0-0.5	32.3	<0.53	4	66.1
AAA9798	0-0.5	8.8	4.4	<0.78	30.2
AAA9799	0-0.5	12.5	<0.54	2.2	87.8
AAA9800	0-0.5	14.5	<0.52	9.7	86.8
AAA9807	0-0.5	18.8	<0.54	<0.8	54.2
AAA9807R ^g	0-0.5	17.7	<0.54	<0.98	51.3
AAA9812	0-0.5	21.0	<.52	<.77	54
AAA9891	0-0.5	51.6	<0.55	0.81	51.8

^a Copper results are listed in Section 5.5.9.

^b UTL = Upper tolerance limit.

^c N/A = Not applicable.

^d NA = Not analyzed.

^e ND = Not detected.

^f SAL = Screening action level.

^g R = Reanalyzed.

Cesium-137 was detected above LANL UTL in seven samples; levels are above TA-33 background UTL only in two of these samples. Table 5.5.5-3 lists cesium-137 detected above LANL UTLs in the random surface samples.

TABLE 5.5.5-2

**INORGANICS^a WITH CONCENTRATIONS GREATER THAN BACKGROUND UTLs FOR
PRS 33-006(a)**

SAMPLE ID	DEPTH (ft)	LEAD (mg/kg)	SILVER (mg/kg)	ZINC (mg/kg)
LANL UTL ^b	N/A ^c	23.3	NA ^d	50.8
TA-33 UTL	N/A	25.2	NA	57.3
SAL ^e	N/A	400	380	23 000
AAA9745	0-0.5	31.5	<0.75	1 160
AAA9748	0-0.5	5.7	0.8	43.1

^a Copper results are listed in section 5.5.9

^b UTL = Upper tolerance limit.

^c N/A = Not applicable.

^d NA = Not analyzed.

^e SAL = Screening action level.

TABLE 5.5.5-3

**RADIONUCLIDES^a WITH CONCENTRATIONS GREATER THAN BACKGROUND
CONCENTRATIONS FOR PRS 33-006(a) DRAINAGE SAMPLES**

SAMPLE ID	DEPTH (ft)	CESIUM-137 (pCi/g)
LANL UTL ^b	N/A ^c	1.4
TA-33 UTL	N/A	2.068
SAL ^d	N/A	5.1
AAA9796	0-0.5	1.612
AAA9802	0-0.5	2.979
AAA9803	0-0.5	2.678
AAA9807	0-0.5	1.505
AAA9811	0-0.5	1.506
AAA9811R ^e	0-0.5	1.416
AAA9812	0-0.5	2.085

^a Uranium results are listed in section 5.5.9.

^b UTL = Upper tolerance limit.

^c N/A = Not applicable.

^d SAL = Screening action level.

^e R = Reanalyzed.

5.5.6 Evaluation of Organics

About 80% of the data used to assess the level and extent of HE contamination in areas affected by the South Site shot pad, PRS 33-006(a), were rejected during data validation. These data include samples listed in Tables 5.5.4-1 and 5.5.4-2, and data from surface samples taken for PRSs 33-007(b), 33-010(g), and 33-014, all of which are within boundary of PRS 33-006(a) (Fig. 5.0-1). Low levels of HE for half a dozen samples were reported with qualifiers due to missed holding times. The detailed review of the HPLC scans described in Section 4.2.2 increased the number of samples in this group in which low levels of HE could be identified. Original estimated results are listed in Table 5.5.6-1.

Data are sufficiently complete to determine that while there are trace amounts of explosives in surface samples at South Site, they are not at levels of concern. Table 5.5.6-1 lists all surface HE results (as reported) detected at South Site, including both results that were originally reported and those that were added as a result of reevaluation of the raw data, described in Section 4.2. The first qualifier is that provided during the reevaluation; the second is that applied by the data validators to the original result, which in many cases was reported as below the CRQL.

In general, HE results in these samples are below levels of concern, even if the estimated results are multiplied by a factor of 5 to 10 to compensate for missed holding times. A few RDX data points would be above the SAL of 4 if the results were multiplied by 5 to 10. One questionable RDX result is above SAL. However, a limited resampling campaign is proposed in Section 5.5.11 to confirm this assessment.

**TABLE 5.5.6-1
HIGH EXPLOSIVES DETECTED IN SOUTH SITE SURFACE SAMPLES**

PRS	DESCRIPTION	DEPTH (ft)	SAMPLE	HE ^a	RESULT (mg/kg)	SAL ^b (mg/kg)	EQL ^c (mg/kg)	QUALIFIERS	
33-006(a)	Drainage	0-0.5	AAA9743	HMX	0.15	3 259	1.1	N/A ^d	R ^e
33-006(a)	Drainage	0-0.5	AAA9746	RDX	0.59	4.0	0.5	J ^f	R
				TNT	0.07	48.4	0.13	J ^f	R
33-006(a)	Drainage	0-0.5	AAA9749	RDX	0.56	4.0	0.5	J ^f	R
33-006(a)	Operational release	0-0.5	AAA9769	HMX	0.30	3 259	1.1	J ^f	R
33-006(a)	Operational release	0-0.5	AAA9782	HMX	0.30	3 259	1.1	J ^f	R
				RDX	0.20	4.0	0.5	J ^f	R
				TNT	0.27	48.4	0.13	R	R
33-006(a)	Operational release	0-0.5	AAA9793	TIC ^h	N/A	N/A	N/A	N/A	N/A
33-006(a)	Operational release	0-0.5	AAA9804	Tetryl	0.69	650	0.33	J ⁱ	J
33-006(a)	Operational release	0-0.5	AAA9807	A-DNT	0.50	NC ^j	0.13	J ^f	R
33-006(a)	Operational release	0-0.5	AAA9808	A-DNT	0.66	NC	0.13	J ^f	J

TABLE 5.5.6-1 (CONTINUED)

HIGH EXPLOSIVES DETECTED IN SOUTH SITE SURFACE SAMPLES

PRS	DESCRIPTION	DEPTH (ft)	SAMPLE	HE	RESULT (mg/kg)	SAL (mg/kg)	EQL (mg/kg)	QUALIFIERS	
33-006(a)	Operational release	0-0.5	AAA9811	A-DNT	5.35	NC	0.13	J+	J
				NB	0.51	33	0.13	J+	J
				2-NT	0.16	NC	0.13	J+	J
				3-NT	0.51	650	0.13	J+	J
				4-NT	0.51	650	0.13	J+	J
				RDX	0.54	4.0	0.5	J+	J
	TIC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
33-006(a)	Operational release	0-0.5	AAA9813	A-DNT	0.36	NC	0.13		J
				TIC	N/A	N/A	N/A	N/A	N/A
33-007(b)	Drainage	0-0.5	AAA9741	HMX	0.30	3 259	1.1	J+	R
				RDX	0.50	4.0	0.5	N/A	J
				TNB	0.17	3.3	0.13	N/A	J
33-007(b)	Drainage	0-0.5	AAA9742	HMX	0.20	3 259	1.1	J+	R
33-007(b)	Gun mount	0-0.5	AAA9761	HMX	0.83	3 259	1.1	N/A	R
33-010(h)	Surface disposal	0-0.5	AAA9724	HMX	0.20	3 259	1.1	J+	UJ ^k
33-014	Burn area	0-0.5	AAA9758	HMX	0.53	3 259	1.1	J-	R
33-014	Burn area	0-0.5	AAA9759	A-DNT	1.20	NC	0.13	J2 ^l	R
				HMX	0.36	3 259	1.1	J2	R
				RDX	8.20	4.0	0.5	J2	R
				TNT	0.81	48.4	0.13	J2	R
				Tetryl	1.85	650	0.33	J2	R

^a HE = High explosives.

^b J+ = Estimated quantity, biased high based on surrogate recovery.

^c R = Rejected.

^d J = Estimated quantity.

^e J- = Estimated quantity, biased low based on surrogate recovery.

^f UJ = Not detected, quantitative limit reported is estimated.

^g J2 = Estimated from confirmation column data.

5.5.7 Human Health Assessment

5.5.7.1 Screening Assessment

Uranium and copper were detected above SAL in the soil samples collected for this PRS, and will therefore be carried forward through the screening assessment. Based on Phase I random sampling, copper and uranium distributions were determined for the area surrounding the pad, discussed in Section 5.5.9 of this RFI report.

Other chemicals identified to be greater than LANL background UTLs were submitted for an MCE for noncarcinogenic effects. HE data are used as reported in Table 5.5.6-1, recognizing that much of this data is of uncertain quality. The sum of the maxima for the noncarcinogenic group is 0.40. The sum of the maxima for the carcinogenic group is 0.13. These results are well

below the target value of 1, which indicates a low potential for adverse effects due to exposure to these multiple groupings. Therefore, these chemicals are not identified as potentially hazardous. The data from Phase II resampling for HE may require us to revisit this MCE in a Phase II report. Only one radionuclide (cesium-137) was detected above UTL, but below SAL; therefore, no MCE was performed for this grouping. The results of the MCE for this PRS are summarized in Table 5.5.7-1.

TABLE 5.5.7.1-1

MULTIPLE CONSTITUENT EVALUATION FOR PRS 33-006(a)

ANALYTE	MAXIMUM SOIL CONCENTRATION (mg/kg)	SOIL SAL ^a (mg/kg)	CONCENTRATION NORMALIZED TO SAL
NONCARCINOGENIC EFFECTS			
Lead	51.6	400	0.129
Selenium	4.4	380	0.012
Silver	9.7	380	0.026
Zinc	1160	23 000	0.050
1,3,5-Trinitrobenzene	0.17	3.3	0.052
m-Nitrotoluene	0.51	650	0.001
Nitrobenzene	0.51	33	0.002
p-Nitrotoluene	0.51	650	0.001
RDX	0.5	4	0.12
HMX	0.30	3 259	0.001
Tetryl	0.69	650	0.001
Total			0.400
CARCINOGENIC EFFECTS			
RDX	0.5	4	0.125
2,4,6-TNT	0.27	48	0.006
Total			0.131

^a SAL = Screening action level.

5.5.7.2 Risk Assessment

No risk assessment was performed for this PRS because the risk assessment for PRS 33-010(c) indicated elevated uranium and copper posed no unacceptable risk. These two contaminants are evaluated in detail in Section 5.11.8 of this RFI report for PRS 33-010(c), which is in close proximity to this PRS. Because the upper confidence level (UCL) calculated for uranium (68.4 mg/kg) is lower than that evaluated as the source term in the 33-010(c)

analysis (81.5 mg/kg), it is concluded that potential exposure to uranium and copper in soil at this site should not result in adverse noncarcinogenic health effects or an unacceptable radiation dose to trail users. See Appendix C of this RFI report for risk calculations for PRS 33-010(c).

5.5.8 Ecological Assessment

5.5.8.1 Ecotoxicological Screening Assessment

This PRS will be included in EEUs defined for both ecological screening and ecological risk assessments. A site inspection of this PRS indicates that it will be adequately addressed in the EEUs.

5.5.8.2 Ecological Risk Assessment

No ecological risk assessment has been performed for this PRS. An ecological risk assessment will be evaluated when an approach is approved by regulators.

5.5.9 Extent of Contamination

As expected, uranium and copper are widespread around the shot pad. A total of 46 surface soil samples and 11 drainage samples were collected in PRS 33-006(a) to assess the spatial distribution of contaminants around the shot pad. Sampling at South Site also included eight surface soil samples from the tower area [PRS 33-007(b)], four surface samples from the burn pit (PRS 33-014), and four surface samples from a canyonside disposal area [PRS 33-010(g)]. Because PRS 33-006(a) overlaps these PRSs, the 16 additional samples from these PRSs can be used to extend the area included in this assessment to the north, east, and south, for a total of 73 samples. Data for these samples are listed in Table 5.5.9-1, including collocated (CO) samples and duplicate laboratory analyses of single samples.

Total uranium results are available for all 73 samples. Thirty-one, or 42%, of these results exceed the LANL background UTL. These are concentrated in the central valley, as shown in Figure 5.5.9-1. The shaded area in Figure 5.5.9-1 estimates the boundary of above-background uranium contamination. Occasional above-background observations are found outside this contour. Within-background observations are found inside this contour. Collocated pairs can differ significantly (compare AAA9772 and AAA9773 at the south end of the drainage, for example). The overall trend, however, is well defined by the existing samples, except that the extent of contamination in the central drainage has not been bounded at the southern end. All samples but the northernmost drainage sample are above background. Ten observations exceed the uranium SAL of 29 mg/kg.

Copper analyses are available for 65 of the samples. Thirty-three, or 46%, of these results exceed the background UTL, and six (including the duplicate but not the original analysis of AAA9748) exceed the SAL of 3 000 mg/kg. There is a high degree of overlap between the sets of samples that exceed background for uranium and for copper, and on a logarithmic scale, the correlation between the two measurements is 0.67.

TABLE 5.5.9-1
URANIUM AND COPPER IN SOUTH SITE SURFACE SOIL SAMPLES

SAMPLE ID	TYPE	PRS	LOCATION	COPPER (mg/kg)	URANIUM (mg/kg)
LANL UTL ^a	N/A ^b	N/A	N/A	30.7	5.1
TA-33 UTL	N/A	N/A	N/A	NC ^c	4.1
SAL ^d	N/A	N/A	N/A	2 800	29
AAA9741	Field	33-006(a)	Drainage	13.2 (J) ^e	4.23 (J) ^f
AAA9741	Duplicate	33-006(a)	Drainage	13.9	NA ^g
AAA9742	Field	33-006(a)	Drainage	27.5 (J)	407.12 ^h
AAA9743	Field	33-006(a)	Drainage	22.1 (J)	7.01 (J) ^f
AAA9744	Field	33-006(a)	Drainage	847.0 ^f	21.48 (J) ^f
AAA9744	Duplicate	33-006(a)	Drainage	NA	31.78 (J) ^h
AAA9745	CO(AAA9744)	33-006(a)	Drainage	5 760.0 ^h	16.68 (J) ^f
AAA9746	Field	33-006(a)	Drainage	817.0 ^f	13.51 (J) ^f
AAA9747	Field	33-006(a)	Drainage	291.0 ^f	6.63 (J) ^f
AAA9748	Field	33-006(a)	Drainage	1 380.0 ^f	22.74 (J) ^f
AAA9748	Duplicate	33-006(a)	Drainage	4 010.0 ^h	NA
AAA9749	Field	33-006(a)	Drainage	494.0 ^f	20.93 (J) ^f
AAA9750	Field	33-006(a)	Drainage	60.1 ^f	7.55 (J) ^f
AAA9750	Duplicate	33-006(a)	Drainage	NA	6.24 (J) ^f
AAA9751	Field	33-006(a)	Drainage	1 270.0 ^f	21.43 (J) ^f
AAA9763	Field	33-007(b)	Operational release	13.2	0.74
AAA9764	CO(AAA9763)	33-007(b)	Operational release	13.6	0.91
AAA9765	Field	33-007(b)	Gun mount	23.1	1.96
AAA9766	Field	33-007(b)	Operational release	10.6	0.94
AAA9767	Field	33-007(b)	Operational release	31.8 ^f	19.27 ^f
AAA9768	Field	33-007(b)	Operational release	10.2	2.45
AAA9769	Field	33-006(a)	Operational release	6	0.54
AAA9770	Field	33-006(a)	Operational release	5.7	0.71
AAA9771	Field	33-006(a)	Operational release	27.6	1.61
AAA9772	Field	33-006(a)	Operational release	183 ^f	11.54 ^f

TABLE 5.5.9-1 (CONTINUED)

URANIUM AND COPPER IN SOUTH SITE SURFACE SOIL SAMPLES

SAMPLE ID	TYPE	PRS	LOCATION	COPPER (mg/kg)	URANIUM (mg/kg)
AAA9773	CO(AAA9772)	33-006(a)	Operational release	11.1	3.76
AAA9774	Field	33-006(a)	Operational release	<5.7	0.47
AAA9775	Field	33-006(a)	Operational release	5.7	1.02
AAA9776	Field	33-006(a)	Operational release	8.8	2.74
AAA9777	Field	33-006(a)	Operational release	5.4	1.58
AAA9778	Field	33-006(a)	Operational release	<5.2	0.66
AAA9779	Field	33-006(a)	Operational release	10.5	3.35
AAA9780	Field	33-006(a)	Operational release	7.3	1.48
AAA9780	Duplicate	33-006(a)	Operational release	6.1	1.17
AAA9781	Field	33-006(a)	Operational release	<10.5	4.15 ^f
AAA9782	Field	33-006(a)	Operational release	39.2 ^f	14.14 ^f
AAA9783	Field	33-006(a)	Operational release	10	1.18
AAA9783	Duplicate	33-006(a)	Operational release	NA	1.75
AAA9784	Field	33-006(a)	Operational release	12.7	2.34
AAA9785	Field	33-006(a)	Operational release	16.4	0.85
AAA9785	Duplicate	33-006(a)	Operational release	18.5	0.90
AAA9786	Field	33-006(a)	Operational release	539 ^f	8.25 ^f
AAA9787	Field	33-006(a)	Operational release	2 500 ^f	52.41 ^h
AAA9788	Field	33-006(a)	Operational release	300 ^f	30.44 ^h
AAA9789	Field	33-006(a)	Operational release	1320 ^f	4.20 ^f
AAA9790	CO(AAA9789)	33-006(a)	Operational release	25.6	3.12
AAA9791	Field	33-006(a)	Operational release	23 300 ^h	23.34 ^f
AAA9792	Field	33-006(a)	Operational release	18 100 ^h	7.88 ^f
AAA9793	Field	33-006(a)	Operational release	22.3	1.10
AAA9794	Field	33-006(a)	Operational release	409 ^f	35.24 ^h
AAA9795	Field	33-006(a)	Operational release	1 140 ^f	90.94 ^h
AAA9796	Field	33-006(a)	Operational release	3 180 ^h	208.85 ^h
AAA9797	Field	33-006(a)	Operational release	8.7	0.45
AAA9798	Field	33-006(a)	Operational release	58.7 ^f	6.05 ^f
AAA9799	Field	33-006(a)	Operational release	3 340 ^h	58.50 ^h
AAA9800	Field	33-006(a)	Operational release	1210 ^f	84.33 ^h
AAA9801	Field	33-006(a)	Operational release	41 ^f	26.66 ^f
AAA9802	Field	33-006(a)	Operational release	40.2 ^f	9.69 ^f
AAA9803	Field	33-006(a)	Operational release	33 ^f	1.20
AAA9804	Field	33-006(a)	Operational release	9	2.12
AAA9804	Duplicate	33-006(a)	Operational release	NA	2.33

TABLE 5.5.9-1 (CONTINUED)
URANIUM AND COPPER IN SOUTH SITE SURFACE SOIL SAMPLES

SAMPLE ID	TYPE	PRS	LOCATION	COPPER (mg/kg)	URANIUM (mg/kg)
AAA9805	Field	33-006(a)	Operational release	23.9	3.40
AAA9806	Field	33-006(a)	Operational release	91.5 ^f	6.05 ^f
AAA9807	Field	33-006(a)	Operational release	69.8 ^f	3.93
AAA9807	Duplicate	33-006(a)	Operational release	76.3 ^f	NA
AAA9808	Field	33-006(a)	Operational release	11.5	1.27
AAA9809	Field	33-006(a)	Operational release	5.5	15.05 ^f
AAA9810	Field	33-006(a)	Operational release	NA	0.62
AAA9811	Field	33-006(a)	Operational release	NA	0.87
AAA9812	Field	33-006(a)	Operational release	NA	1.35
AAA9813	Field	33-006(a)	Operational release	NA	0.62
AAA9891	Field	33-006(a)	Operational release	1 330 ^f	678.30 ^h
AAA9761	Field	33-007(b)	Gun mount	27.1	12.19 ^f
AAA9761	Duplicate	33-007(b)	Gun mount	25.2	NA
AAA9762	Field	33-007(b)	Gun mount	23.6	3.80
AAA9762	Duplicate	33-007(b)	Gun mount	NA	3.77
AAA9814	Field	33-010(g)	Canyonside disposal	NA	0.55
AAA9815	Field	33-010(g)	Canyonside disposal	NA	0.18
AAA9816	Field	33-010(g)	Canyonside disposal	NA	1.57
AAA9817	Field	33-010(g)	Canyonside disposal	NA	1.16
AAA9817	Duplicate	33-010(g)	Canyonside disposal	NA	1.27
AAA9757	Field	33-014	Burn area	147 ^f	2.32
AAA9758	Field	33-014	Burn area	31.6 ^f	1.14
AAA9759	Field	33-014	Burn area	302 ^f	72.39 ^h
AAA9760	Field	33-014	Burn area	1450 ^f	3.86

^a UTL = Upper tolerance limit.

^b N/A = Not applicable.

^c NC = Not calculated.

^d SAL = Screening action level.

^e J = Estimate quantity.

^f Above background UTL.

^g NA = Not analyzed.

^h Above SAL.

Low levels of silver were detected near the shot pad and at least 700 ft to the east (Figure 5.5.4-1). This distribution implies that silver was a component of the implosion experiments. Because of its high SAL (383 mg/kg) and spotty distribution, silver is not considered a potential concern (Section 5.5.7.1 of this RFI report).

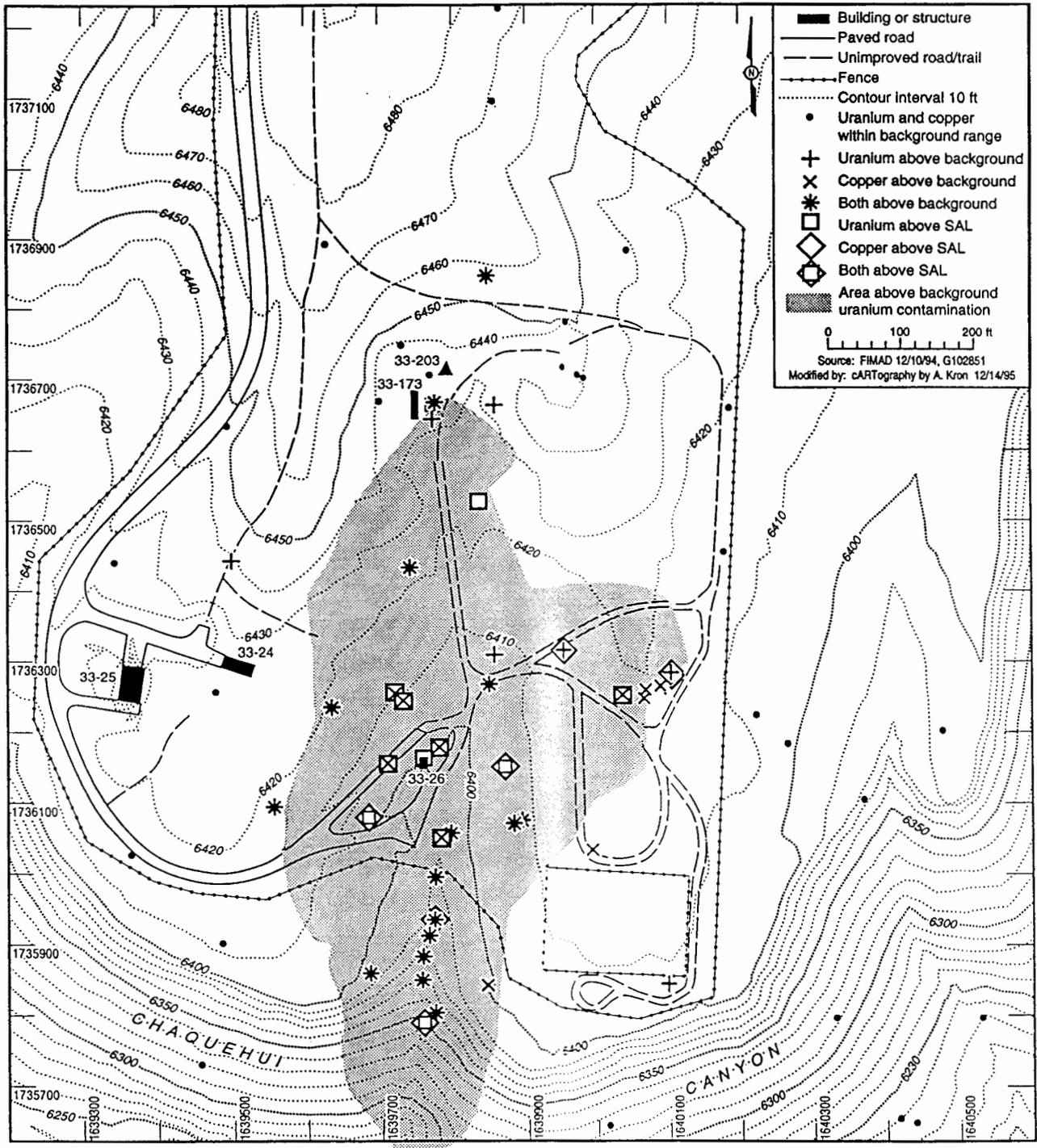


Fig. 5.5.9-1. South Site: distribution of uranium and copper.

Lead was detected at locations near the shot pad, but not at levels of concern (Section 5.5.7.1 of this RFI report). Lead bricks and plates were commonly used for shielding against radioactivity and anchoring experimental apparatus. Because pieces of lead have been found on the surface at South Site, identification of lead is specified in the shrapnel sampling plan in Section 5.5.11 of this RFI report.

5.5.10 Conclusion and Recommendation

PRS 33-006(a) is recommended for limited HE Phase II resampling because HE results at South Site were compromised by missed holding times. While focused validation indicates that contamination may be low, a limited resampling effort is recommended to verify the assessment that HE is not a concern at South Site. The resampling plan is presented in Section 5.5.11.1 of this RFI report.

Shrapnel is widespread at South Site, in Chaquehui Canyon, and on adjacent mesa tops. During an investigation in 1989, approximately 20% of the shrapnel was found to be radioactively contaminated (Buckland 1989, 02-059). A shrapnel pickup VCA will be evaluated and performed if appropriate.

5.5.11 Resampling and Analysis Plan for PRS 33-006(a)

Approximately 80% of the data to assess the distribution of HE in areas affected by the shot pad [surface samples from PRS 33-006(a), PRS 33-007(b), PRS 33-010(g), and PRS 33-014] were rejected by data validation. Review of the HPLC scans for these samples, as described in Section 4.2, almost tripled the number of samples in which low levels of HE could be identified. In general, HE results in these samples are below levels of concern, even when adjusted to compensate for missed holding times. However, a limited resampling campaign is proposed to confirm this assessment. Eight South Site surface sampling locations, listed in Table 5.5.11-1, will be resampled for HE analysis only. At six locations, the original sampling suggests the presence of HE. Two locations are selected to confirm negative results. These locations are shown on Figure 5.5.11-1.

TABLE 5.5.11-1
SOUTH SITE HIGH EXPLOSIVES RESAMPLING LOCATIONS

PRS	DESCRIPTION	LOCATION ID	SAMPLE	CRITERIA
33-006(a)	Drainage	33-1360	AAA9741	Drainage w/ most hits
33-006(a)	Drainage	33-1365	AAA9746	High RDX
33-006(a)	Drainage	33-1366	AAA9747	Drainage w/ no hits
33-006(a)	Operational release	33-1351	AAA9811	High A-DNT, other hits, high surrogate recovery
33-006(a)	Operational release	33-1353	AAA9813	High A-DNT, unknowns
33-006(a)	Operational release	33-1324	AAA9782	Dirty sample, analytical problems
33-007(b)	Gun mount	33-1402	AAA9761	High HMX
33-014	Burn area	33-1446	AAA9759	RDX>8, several hits >1, analytical problems

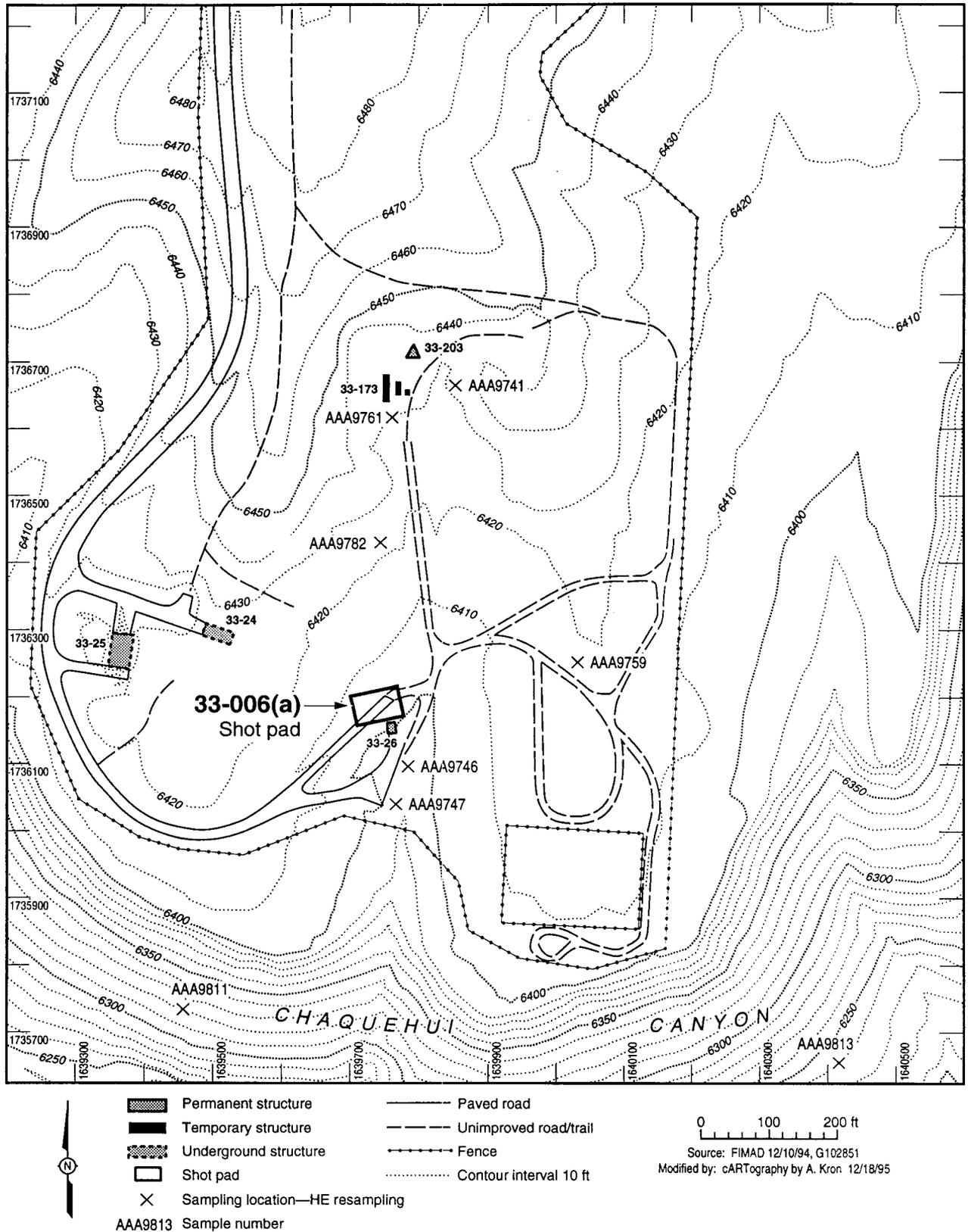


Fig. 5.5.11-1. South Site: PRS 33-006(a), shot pad. Resampling locations for high explosives.

5.6 PRS 33-006(b) East Site Shot Pads

PRS 33-006(b) consists of two shot pads in the large, double berm at East Site. The PRS is proposed for NFA based on sampling and analysis. Except for one elevated lead result below SAL and one suspect arsenic result, contamination is low-level and spotty.

5.6.1 History

PRS 33-006(b) is discussed in the RFI Work Plan for OU 1122, Subsections 3.5.2.4 and 4.5.3.1. The facilities at East Site were completed in June 1955. Gun-type, rather than implosion-type, tests were performed on initiators. Uranium projectiles containing beryllium and polonium-210 (half-life 138 days) were used in the gun tests. Some projectiles contained cobalt-60 (half-life 5.26 years) used as a tracer. The projectiles were not detonated but were shot intact into berms for recovery and later investigation. Some neutron detectors at East Site contained scintillation fluids.

Potential contaminants were listed as uranium, inorganics, HE, and cobalt-60. Scintillation fluids may have contained SVOCs. Low levels of tritium were used at East Site. Tritium was not analyzed in East Site samples because much lower than expected levels of tritium were detected elsewhere at TA-33 where contamination was expected to be much higher (e.g. the tritium facility at Main Site) (Environmental Restoration Project 1995, 1263).

5.6.2 Description

The shot pad area PRS 33-006(b) consists of two adjacent crescent-shaped berms, each 10 ft high and 200 ft across the face. In the center of each crescent is a concrete gun mount, TA-33-97 and TA-33-98, respectively from west to east. The double berm is a prominent feature located on the northern edge of East Site near the rim of Ancho Canyon. The 15 ft X 15 ft concrete shot pads lie in the U-shaped portion of each berm. The berms were built of soil and tuff fragments scraped from the mesa at East Site. Soil is classified as Mesic Rock, described in Section 2.2.2 of this RFI report.

5.6.3 Previous Investigations

No previous investigations were conducted at this PRS.

5.6.4 Field Investigation

A geophysical survey was conducted over the berms at PRS 33-006(b) in an attempt to locate buried metallic objects. A grid system was established at East Site. Data were obtained from a 5-ft x 5-ft uniform spacing within the grid. The investigation area for PRS 33-006(b),

approximately 240 ft x 240 ft, encompassed the entire double berm. Numerous anomalies not associated with known surface structures or objects were detected in the berm. The anomalies occurred in two general zones. The first zone was at the west berm. These small-magnitude magnetic anomalies generally occurred on the northern slope. Subsequent trenching determined that the anomalies were caused by large pieces of buried tuff. No metallic objects were located and no samples were taken. The second zone was located at the northern perimeter of the grid area. A rusty metallic object that resembled a piece of an artillery gun breech was observed on the sloping surface of the berm.

Reconnaissance sampling at PRS 33-006(b) was designed to detect maximum contamination. In addition, geophysical surveys and trenching were intended to find experimental objects remaining in the berms. The work plan specified four surface soil samples from the shot pads and six subsurface samples from the berms. Four surface samples were taken, two near each pad. Nine subsurface samples were collected from trenching—six samples from the west berm and three samples from the east berm. Trenching was performed directly in front of each gun mount to a depth of 5 ft from the face of the berm (Figure 5.6.4-1). Soil collected for samples AAA9910, AAA9911, and AAA9912 was dug from around metal projectiles found in the west berm. All samples were analyzed for inorganics, uranium, gamma emitters, SVOCs, and HE (Table 5.6.4-1).

TABLE 5.6.4-1
SUMMARY OF SAMPLES TAKEN FOR PRS 33-006(b)

LOCATION ID	SAMPLE ID	DEPTH (ft)	MATRIX	INORGA-NICS	RADIO-NUCLIDES	SVOCs ^a	HE ^b
33-1370	AAA9614	0-0.5	Soil	19257	19354	17669	17668
33-1372	AAA9615	0-0.5	Soil	19257	19354	17669	17668
33-1373	AAA9616	0-0.5	Soil	19257	19354	17669	17668
33-1374	AAA9617	0-0.5	Soil	19257	19354	17669	17668
33-1375	AAA9672	West trench	Soil	19095	19076	18109	18112
33-1375	AAA9673	West trench	Soil	19095	19076	18109	18112
33-1375	AAA9674	West trench	Soil	19095	19076	18109	18112
33-1371	AAA9706	East trench	Soil	18590	18758	18104	18103
33-1371	AAA9707	East trench	Soil	18590	18758	18104	18103
33-1371	AAA9708	East trench	Soil	18590	18758	18104	18103
33-1375	AAA9910	West trench	Soil	18590	18758	18104	18103
33-1375	AAA9911	West trench	Soil	18590	18758	18104	18103
33-1375	AAA9912	West trench	Soil	18590	18758	18104	18103

^a SVOCs = Semivolatile organic compounds.

^b HE = High explosives.

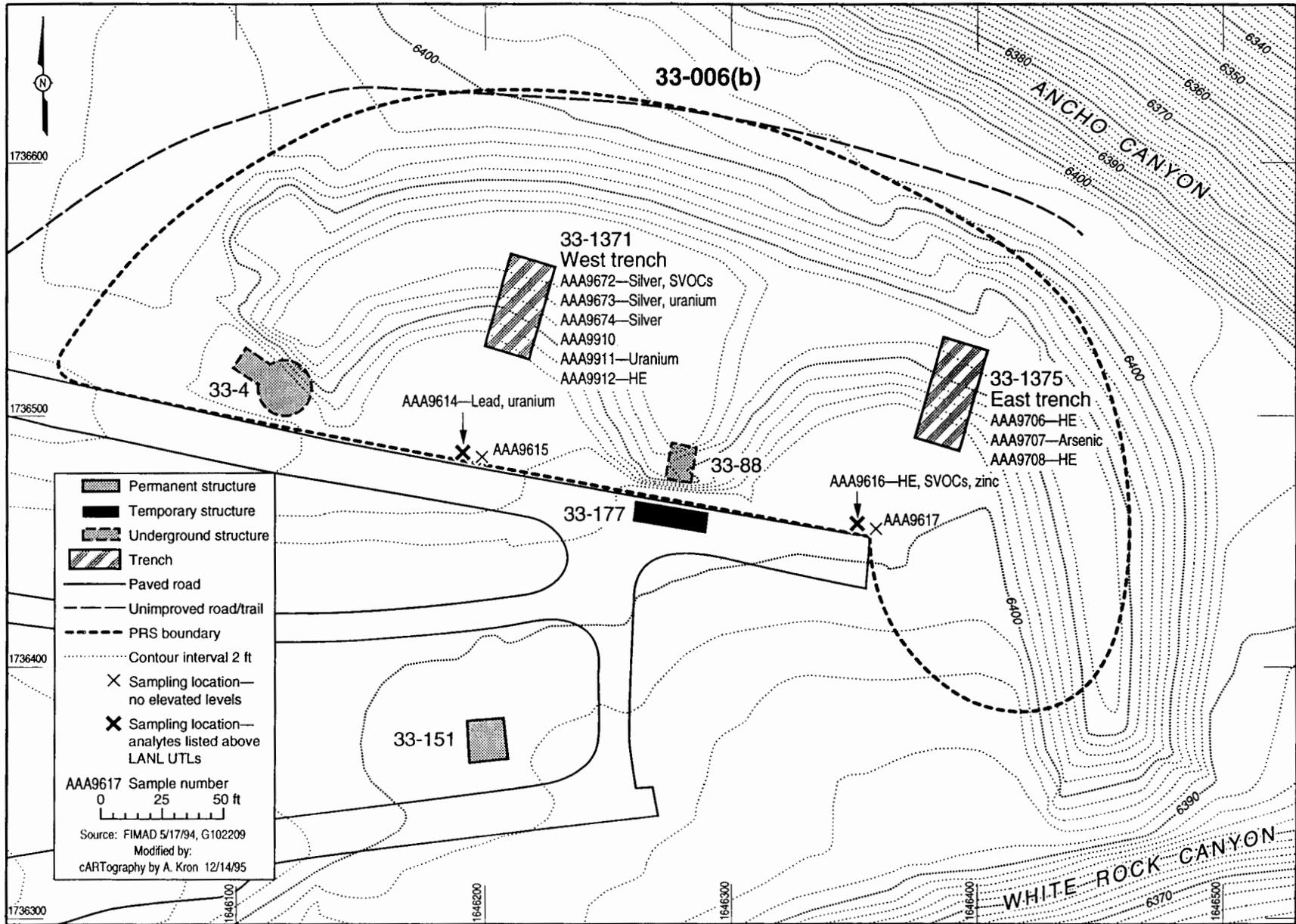


Fig. 5.6.4-1. East Site: PRS 33-006(b), shot pads.

5.6.5 Background Comparison

Sample AAA9614 near the road at the west berm contained elevated lead (326 mg/kg). Other inorganics were detected above LANL background UTL but far below SAL. (Table 5.6.5-1). Uranium slightly above background UTL was detected in isolated samples (Table 5.6.5-2), include sample AAA9911 taken adjacent to a metal projectile discovered in the west berm. No other radionuclides were detected.

TABLE 5.6.5-1

INORGANICS WITH CONCENTRATIONS GREATER THAN BACKGROUND UPPER TOLERANCE LIMITS FOR PRS 33-006(b)

SAMPLE ID	DEPTH (ft)	ARSENIC (mg/kg)	LEAD (mg/kg)	SILVER (mg/kg)	ZINC (mg/kg)
LANL UTL ^a	N/A ^b	6.82	23.3	N/A	50.8
TA-33 UTL	N/A	3.77	25.2	N/A	57.3
SAL ^c	N/A	Background	400	380	23 000
AAA9614	0-0.5	0.92	326	<0.77	29
AAA9616	0-0.5	<1.2	20	<0.78	67
AAA9672	West trench	3	4	2	41
AAA9673	West trench	1	<4	2	16
AAA9674	West trench	4	<4	2	38
AAA9707	East trench	12	14	<13	30

^a UTL = Upper tolerance limit.

^b N/A = Not applicable.

^c SAL = Screening action level.

TABLE 5.6.5-2

**URANIUM WITH CONCENTRATIONS GREATER THAN BACKGROUND UPPER TOLERANCE
LIMITS FOR PRS 33-006(b)**

SAMPLE ID	DEPTH (ft)	URANIUM (mg/kg)
LANL UTL ^a	N/A ^b	5.45
TA-33 UTL	N/A	4.12
SAL ^c	N/A	29
AAA9614	0-0.5	6.85
AAA9673	West trench	6.10
AAA9911	West trench	6.7
AAA9911R ^d	West trench	6.9

^a UTL = Upper tolerance limit.

^b N/A = Not applicable.

^c SAL = Screening action level.

^d R = Reanalyzed.

5.6.6 Evaluation of Organics

Review of HE data validation indicates that 70% of the results for PRS 33-006(b) were analyzed according to EPA-approved procedures. For the 30% of results rejected because of missed holding times, focused validation by investigation of analytical scans detected trace HE levels (mostly HMX) in four samples in the double-berm area. These trace results were in samples that missed the holding time between sample collection and extraction, not in samples that missed holding time between extraction and analysis, and were, therefore, rejected by routine validation. After a complete review of all HE results for TA-33 1994 samples, data for PRS 33-006(b) are deemed sufficiently complete for decision making (specifically, NFA with respect to HE). See Section 4.2.2 of this RFI report for a discussion of HE-focused validation.

All HE surface sample results, including those from PRS 33-006(b), are assessed in the East Site site-wide evaluation of HE in Section 5.7.6 [PRS 33-007(a)] of this RFI report.

Trace levels of PAHs and a common plasticizer, bis(2-ethylhexyl)phthalate, were detected (Table 5.6.6-1).

TABLE 5.6.6-1

PRS 33-006(b) SOIL CONCENTRATIONS FOR ORGANIC ANALYTES WITH VALUES GREATER THAN THE ESTIMATED QUANTITATION LIMITS

SAMPLE ID	SVOCs ^a	RESULT (mg/kg)	SAL ^b (mg/kg)	EQL ^c (mg/kg)
AAA9616	Bis(2-ethylhexyl)phthalate	0.108	50	0.33
AAA9672	Fluoranthene	0.114	2 600	0.33
	Phenanthrene	0.132	ND ^d	0.33

^a SVOCs = Semivolatile organic compounds.

^b SAL = Screening action level.

^c EQL = Estimated quantitation limit.

^d ND = Not determined.

5.6.7 Human Health Assessment

5.6.7.1 Screening Assessment

No chemical was detected above SAL at the shot pads. Arsenic (12 mg/kg) was detected above background UTL in one sample from within the berm. Arsenic is not considered a potential contaminant; no processes involving arsenic are known to have occurred at East Site, with the possible exception of pesticide spraying. Of 75 samples collected at East Site during the 1994 ER sampling campaign, no other arsenic concentration exceeded the (95%, .95) UTL.

Elevated lead (326 mg/kg) was detected in one sample, but below SAL of 400 mg/kg. Chemicals identified to be greater than LANL background were submitted for an MCE for noncarcinogenic effects. The sum of the maxima for the noncarcinogenic group of chemicals is 0.82. This result is less than the threshold value of 1, which indicates a low potential for adverse effects due to exposure to this multiple grouping. The results of the MCE are summarized in Table 5.6.7-1. Only one constituent was detected in each of the carcinogenic effects [bis(2-ethylhexyl)phthalate] and radionuclide effects (uranium) groups; therefore, no MCE has been performed for these groupings.

TABLE 5.6.7-1

MULTIPLE CONSTITUENT EVALUATION FOR NONCARCINOGENIC EFFECTS PRS 33-006(b)

ANALYTE	MAXIMUM SOIL CONCENTRATION (mg/kg)	SOIL SAL ^a (mg/kg)	CONCENTRATION NORMALIZED TO SAL
Fluoranthene	0.114	2 600	0.00004
Lead	326	400	0.815
Silver	2	380	0.005
Zinc	67	23 000	0.003
Sum of normalized concentrations			0.82

^a SAL = Screening action level.

5.6.7.2 Risk Assessment

Based on the results of the screening assessment, no risk assessment was performed for this PRS.

5.6.8 Ecological Assessment**5.6.8.1 Ecotoxicological Screening Assessment**

This PRS will be included in EEU's defined for both ecological screening and ecological risk assessments. A site inspection of this PRS indicates that it will be adequately addressed in the EEU's.

5.6.8.2 Ecological Risk Assessment

No ecological risk assessment has been performed for this PRS. An ecological risk assessment will be evaluated when an approach is approved by regulators.

5.6.9 Extent of Contamination

Biased sampling was performed at this PRS to support screening decisions. Results indicate that chemicals were detected infrequently and at low levels. No assessment of extent was performed.

5.6.10 Conclusion and Recommendation

Based on NFA Criterion 4, a Class III permit modification is requested to remove PRS 33-006(b) from the HSWA Module of LANL's RCRA operating permit.

- No experimental material was found in berms during trenching.
- Sampling was performed at locations most likely to be contaminated.
- No chemicals were detected at hazardous levels based on screening assessments. Result of an MCE (0.82) for chemicals above LANL background UTLs was below the threshold value of 1. Analytical data indicate that neither arsenic nor lead are widespread at this PRS.

5.7 PRS 33-007(a) East Site Firing Area

PRS 33-007(a), the firing area at East Site, covers a large percentage of the developed area. The PRS is recommended for NFA because no chemicals were detected above SAL.

5.7.1 History

East Site firing activities are discussed in the RFI Work Plan for OU 1122, Subsections 3.5.2.4 and 4.5.3.1. East Site was developed as a firing area in the mid-1950s and was in use for a variety of experimental activities until group W-2 left TA-33 in 1972. Prominent among the shots were projectiles shot from large cannons into catcher boxes, 10 ft x 10 ft on the face and 100 ft long, filled with vermiculite and sand. A small container of cobalt-60 was put in projectiles to aid in recovery of the projectile from the catcher box. During one test in 1962, a uranium projectile apparently disintegrated in the gun barrel at the time of ignition. Only a few fragments were recovered; the cobalt-60 vial was never found (Russ 1962, 02-037). Other activities included experiments using scintillation fluids and x-rays. In 1984 East Site was subject to a major cleanup (Buhl 1988, 02-038). All catcher box material was put into a landfill created at East Site, PRS 33-008(b), discussed in the RFI report for OU 1122, (Environmental Restoration Project 1995, 1265). The East Site firing range has been inactive since 1972 except for occasional, short-term experiments.

Potential contaminants are uranium, inorganics, SVOCs, and HE residues.

5.7.2 Description

The main firing area at East Site lies south of the PRS 33-006(b) double berm. PRS 33-007(a) is a large area, approximately 550 ft x 150-ft. Gun mounts TA-33-116 and TA-33-135 are located at the west end of the area. The mounts are concrete pads. TA-33-151, the X-ray flash building, is 330 ft east of the mounts; a 25- x 35- x 8-ft metal box filled with sand is adjacent to TA-33-151 on the west. A narrow asphalt road runs the length of the PRS, as does an asphalt drainage ditch. The firing area is level and covered with chamisa. Aerial photos show a catcher box on a small berm adjacent to bunker TA-33-87. No trace of this or other catcher boxes remains after the 1984 cleanup.

5.7.3 Previous Investigations

No previous investigations were conducted at this PRS.

5.7.4 Field Investigation

During a 1994 remote sensing radiological flyover of the entire LANL complex, the OU 1122 team requested that special attention be directed to the walls of White Rock Canyon at East Site in an attempt to determine if the missing cobalt-60 vial could be located. No radiological anomalies were detected. With a half-life of 5.26 years, cobalt-60 has decayed to low levels (approximately 1.5% of its original activity) since 1962.

A geophysical survey was conducted at a catcher box location near bunker TA-33-87 in an attempt to locate buried metallic objects. Data were obtained at 5-ft x 5-ft uniform spacing within a grid. The investigation area for PRS 33-007(a) was a 50-ft x 200-ft area that included the small berm adjacent to TA-33-87. Two anomalies not associated with surface structures were detected. Both anomalies covered small areas and were thought to have been representative of small, buried metal objects. No objects were recovered during trenching. All other anomalies detected in the area coincided with the location of structures/objects on the ground surface (interference).

Surface sampling at PRS 33-007(a) consisted of randomized grid sampling (24 samples) designed to determine distribution of potential surface contamination resulting from firing activities. In addition, biased samples were collected from a trench in the berm at the west end of the firing area and from north and south of the culvert draining the central part of the area (Figure 5.7.4-1). All samples were analyzed for metals, gamma emitters, uranium, SVOCs, and HE (Table 5.7.4-1). Four samples were analyzed for herbicides.

TABLE 5.7.4-1
SUMMARY OF SAMPLES TAKEN FOR PRS 33-007(a)

LOCATION ID	SAMPLE ID	DEPTH (ft)	MATRIX	INORGANICS	RADIO-NUCLIDES	SVOCs ^a	HE ^b	PESTICIDES	HERBICIDES
33-1376	AAA9618	0-0.5	Soil	19880	19473	17609	17608	NA ^c	NA
33-1387	AAA9619	0-0.5	Soil	19880	19473	17609	17608	NA	NA
33-1395	AAA9620	0-0.5	Soil	19880	19473	17609	17608	NA	NA
33-1396	AAA9621	0-0.5	Soil	19880	19473	17609	17608	NA	17609
33-1397	AAA9622	0-0.5	Soil	19253	19358	17674	17676	NA	NA
33-1453	AAA9623	0-0.5	Soil	19253	19358	17674	17676	NA	NA
33-1398	AAA9624	0-0.5	Soil	19253	19358	17674	17676	NA	NA
33-1399	AAA9625	0-0.5	Soil	17843	19352	17663	17665	NA	NA
33-1400	AAA9626	0-0.5	Soil	19253	19358	17674	17676	NA	17674
33-1401	AAA9627	0-0.5	Soil	17843	19352	17663	17665	NA	NA
33-1377	AAA9628	0-0.5	Soil	17843	19352	17663	17665	NA	NA
33-1454	AAA9629	0-0.5	Soil	17843	19352	17663	17665	NA	NA
33-1378	AAA9630	0-0.5	Soil	19257	19354	17669	17668	NA	NA
33-1379	AAA9631	0-0.5	Soil	19253	19358	17674	17676	NA	17674
33-1380	AAA9632	0-0.5	Soil	19253	19358	17674	17676	NA	NA
33-1381	AAA9633	0-0.5	Soil	19253	19358	17674	17676	NA	NA
33-1382	AAA9634	0-0.5	Soil	19253	19358	17674	17676	NA	NA
33-1383	AAA9635	0-0.5	Soil	19253	19358	17674	17676	NA	17674
33-1384	AAA9636	0-0.5	Soil	19253	19358	17674	17676	NA	NA
33-1385	AAA9637	0-0.5	Soil	19253	19358	17674	17676	NA	NA
33-1386	AAA9638	0-0.5	Soil	19253	19358	17674	17676	NA	NA
33-1388	AAA9639	0-0.5	Soil	19253	19358	17674	17676	NA	NA
33-1389	AAA9640	0-0.5	Soil	19253	19358	17674	17676	NA	NA
33-1390	AAA9641	0-0.5	Soil	19253	19358	17674	17676	NA	NA
33-1391	AAA9642	0-0.5	Soil	19253	19358	17674	17676	NA	NA
33-1392	AAA9643	0-0.5	Soil	19253	19358	17674	17676	NA	NA
33-1393	AAA9644	0-0.5	Soil	19253	19358	17674	17676	NA	NA
33-1394	AAA9645	0-0.5	Soil	19253	19358	17674	17676	NA	NA
33-1315	AAA9656	0-0.5	Sediment	19253	NA	17674	NA	17674	17674
33-1316	AAA9657	0-0.5	Sediment	19253	NA	17674	NA	NA	17674
33-1317	AAA9658	0-0.5	Sediment	19253	NA	17674	NA	NA	17674
33-1456	AAA9659	0-0.5	Sediment	19253	NA	17674	NA	NA	17674
33-1457	AAA9682	Trench	Soil	18590	18758	18104	18103	NA	NA
33-1457	AAA9683	Trench	Soil	18590	18758	18104	18103	NA	NA
33-1457	AAA9684	Trench	Soil	18590	18758	18104	18103	NA	NA

^a SVOCs = Semivolatile organic compounds.

^b HE = High explosives.

^c NA = Not analyzed.

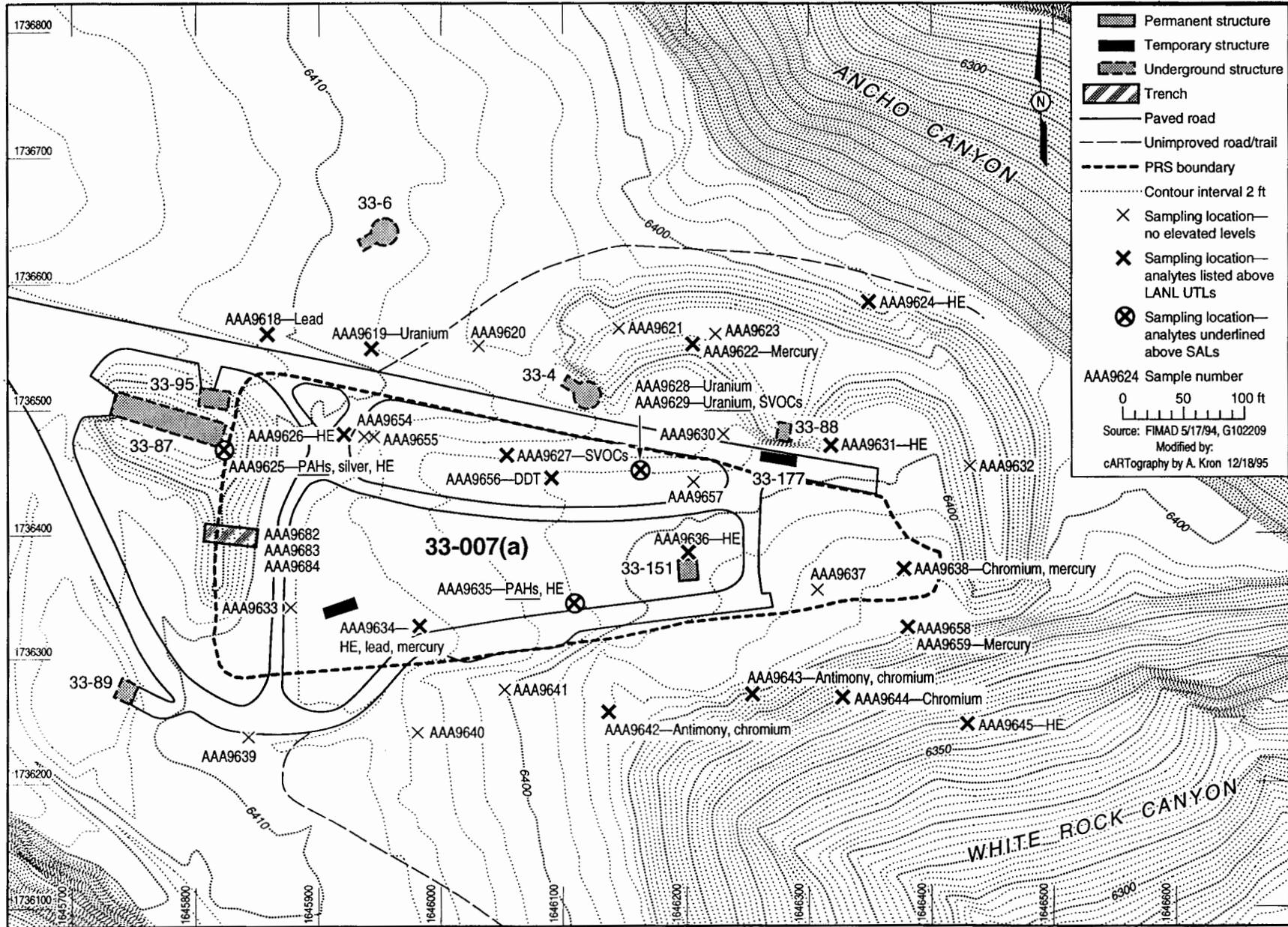


Fig. 5.7.4-1. East Site: PRS 33-007(a), firing area.

5.7.5 Background Comparison

Silver was detected in one sample. Chromium and lead were detected above LANL background UTLs. Trace levels of mercury were detected in scattered samples. Antimony was detected in one sample above background UTL, but not in a duplicate analysis of the same sample (Table 5.7.5-1).

TABLE 5.7.5-1
INORGANICS WITH CONCENTRATIONS GREATER THAN BACKGROUND UPPER TOLERANCE LIMITS FOR PRS 33-007(a)

SAMPLE ID	DEPTH (ft)	ANTIMONY (mg/kg)	CHROMIUM (mg/kg)	LEAD (mg/kg)	MERCURY (mg/kg)	SILVER (mg/kg)
LANL UTL ^a	N/A ^b	1	19.3	28.4	NA ^c	NA
TA-33 UTL	N/A	0.17	14.6	25.2	ND ^d	ND
SAL ^e	N/A	31	210	400	23	380
AAA9618	0-0.5	<0.4	4	38.9	<0.04	<0.07
AAA9622	0-0.5	<4.7	6.0	8.2	0.12	<0.82
AAA9625	0-0.5	<0.25	1.8	4.5	NA	2.4
AAA9634	0-0.5	<4.4	5.5	48.8	0.11	<0.77
AAA9638	0-0.5	<4.4	25.1	10.3	0.12	<0.78
AAA9642	0-0.5	<4.5	20.3	12.7	<0.02	<0.79
AAA9643	0-0.5	6	34.0	23.9	<0.02	<0.77
AAA9643D ^f	0-0.5	<4.4	32.4	26.1	<0.02	<0.77
AAA9644	0-0.5	<4.6	22.7	18.4	<0.05	<0.81
AAA9659	0-0.5	<4.4	6.4	13	0.11	<0.77

^a UTL = Upper tolerance limit.

^b N/A = Not applicable.

^c NA = Not analyzed.

^d ND = Not detected.

^e SAL = Screening action level.

^f D = Analyzed in duplicate.

Uranium was detected above background UTL in samples AAA9619 and AAA9628. Uranium was somewhat above SAL in sample AAA9629 (Table 5.7.5-2). Two of these samples, AAA9628 and AAA9629 are collocated, collected 1 ft apart, indicating a spotty nature for uranium distribution. Uranium was not detected above UTL in any other of the 35 samples collected for PRS 33-007(a). It was detected barely above background in one surface sample collected for adjoining PRS 33-006(b). Based on this uranium distribution, it can be concluded that uranium does not warrant calculation of a risk assessment.

TABLE 5.7.5-2

**URANIUM WITH CONCENTRATIONS GREATER THAN BACKGROUND UPPER TOLERANCE
LIMITS FOR PRS 33-007(a)**

SAMPLE ID	DEPTH (ft)	URANIUM (mg/kg)
LANL UTL ^a	N/A ^b	5.1
TA-33 UTL	N/A	4.1
SAL ^c	N/A	29
AAA9619	0-0.5	5.25
AAA9628	0-0.5	5.63
AAA9629	0-0.5	40.67

^a UTL = Upper tolerance limit.

^b N/A = Not applicable.

^c SAL = Screening action level.

5.7.6 Evaluation of Organics

Approximately 10% of the HE analytical results from the 1994 sampling season at TA-33 were compromised by missed holding times between the time the samples were extracted and time the extracts were analyzed. To address the problem, focused validation was performed on all HE data for TA-33. East Site HE data are discussed here.

HE results for PRS 33-006(b) were rejected for four samples, three from the west berm and one from the east berm: samples AAA9672, AAA9673, AAA9674 in request 18112 and sample AAA9707 in request 18103, respectively. No HE analytes were detected in these samples by inspection of the analytical HPLC scans during focused validation.

At PRS 33-007(a), DNT and tetryl in sample AAA9634, and nitrotoluenes in sample AAA9636 were detected. Inspection of the analytical scans found trace amounts of HMX in eight additional samples and RDX in sample AAA9636. Table 5.7.6-1 shows HE results as reported and additional results from reevaluation of the raw data during focused validation. The first qualifier (J = estimated) is provided during the reevaluation; the second qualifier (UJ = estimated as undetected) was applied at the original data validation. In many cases, results were reported although they were below the CRQL.

TABLE 5.7.6-1

POSITIVE HIGH EXPLOSIVES RESULTS FROM EAST SITE

DESCRIPTION	DEPTH (ft)	SAMPLE ID	HE ^a	RESULT (mg/kg)	SAL ^b (mg/kg)	EQL ^c (mg/kg)	QUALIFIERS	
East berm	0-0.6	AAA9706	HMX	0.11	3 259	1.1	J+ ^d	UJ ^e
East berm	0-0.7	AAA9708	HMX	0.10	3 259	1.1	N/A ^f	UJ
Gun mount	0-0.5	AAA9616	TIC9	N/A	N/A	N/A	N/A	N/A
West berm	0-0	AAA9912	HMX	0.23	3 259	1.1	J+	UJ
Operational release	0-0.5	AAA9624	HMX	0.16	3259	1.1	N/A	UJ
Operational release	0-0.5	AAA9625	TIC	N/A	N/A	N/A	N/A	N/A
Operational release	0-0.5	AAA9626	HMX	0.19	3 259	1.1	N/A	UJ
Operational release	0-0.5	AAA9631	HMX	0.16	3 259	1.1	N/A	UJ
Operational release	0-0.5	AAA9634	DNT	0.40	0.65	0.13	N/A	J ^h
			HMX	0.17	3 259	1.1	N/A	UJ
Operational release	0-0.5	AAA9635	HMX	0.16	3 259	1.1	N/A	UJ
Operational release	0-0.5	AAA9636	2-NT	0.79	NC ⁱ	0.13	N/A	J
			3-NT	0.61	650	0.13	N/A	J
			RDX	0.20	4.0	0.5	N/A	UJ
			Tetryl	0.59	650	0.33	N/A	J
Operational release	0-0.5	AAA9645	TIC	N/A	N/A	N/A	N/A	N/A

^a HE = High explosives.

^b J+ = Estimated quantity, biased high based on surrogate recovery.

^c UJ = Not detected, quantitation limit reported is estimated.

^d J = Estimated quantity.

Based on the HE focused validation efforts as described in Section 4.2.2 of this RFI report, these results may be low by a factor of ten. Even adjustment for an uncertainty of this magnitude does not bring concentrations to levels of concern, except in the case of DNT. Therefore, the HE data are considered adequate to support the decisions for NFA at both PRSs 33-006(b) and 33-007(a).

A trace of the pesticide DDT was detected in one sample. SVOCs were detected in five samples (Table 5.7.6-2). Two samples contained PAHs slightly above SALs. Sample AAA9625 was taken on top of the berm that encases bunker TA-33-87 and may be related to experiments being conducted at the time of sampling. The remaining samples were taken adjacent to paved roads or in the drainage along the north end of the PRS and are attributed to asphalt sources. The source of trace levels of benzoic acid is unknown but the results are insignificant in relation to the SAL of 100 000 mg/kg.

TABLE 5.7.6-2

PRS 33-007(a) SOIL CONCENTRATIONS FOR ORGANIC ANALYTES WITH VALUES GREATER THAN THE ESTIMATED QUANTITATION LIMIT

SAMPLE ID	ANALYTE	RESULT (mg/kg)	SAL ^a (mg/kg)	EQL ^b (mg/kg)
AAA9625	Acenaphthene	0.48	360	0.33
	Anthracene	0.74	19	0.33
	Benzoic acid	0.83	100 000	100
	Benzo[a]anthracene	1.7	0.6	0.33
	Benzo[a]pyrene	1.6	0.06	0.33
	Benzo[b]fluoranthene	2.1	0.6	0.33
	Benzo[g,h,i]perylene	0.77	ND ^c	0.33
	Benzo[k]fluoranthene	0.62	6.1	0.33
	Chrysene	1.3	24	0.33
	Fluoranthene	3.1	2 600	0.33
	Fluorene	0.56	300	0.33
	Ideno(1,2,3-cd)pyrene	0.81	0.6	0.33
	Naphthalene	0.47	800	0.33
	Phenanthrene	2.9	ND	0.33
	Pyrene	3	2 000	0.33
AAA9627	Benzoic acid	0.43	100 000	100
AAA9628	Benzoic acid	0.46	100 000	100
AAA9629	Benzoic acid	1.1	100 000	100
AAA9635	Benzo[a]pyrene	1.2	0.06	0.33
	Benzo[b]fluoranthene	1.9	0.6	0.33
	Benzo[g,h,i]perylene	0.44	ND	0.33
	Benzo[k]fluoranthene	0.6	6.1	0.33
	Bis(2-ethylhexyl)phthalate	1.4	32	0.33
	Chrysene	1.2	24	0.33
	Fluoranthene	2.5	2 600	0.33
	Ideno(1,2,3-cd)pyrene	0.54	0.6	0.33
	Phenanthrene	2.1	ND	0.33
Pyrene	2.1	2 000	0.33	
AAA9656	p,p'-DDT ^d	0.0055	1.3	0.03

^a SAL = Screening action level.

^b EQL = Estimated quantitation limit.

^c ND = Not determined.

^d Spike recovery was 46%. True result may be as much as 0.012 mg/kg.

5.7.7 Human Health Assessment

5.7.7.1 Screening Assessment

Organics above SALs are attributed to asphalt, considered as ongoing source. Uranium was detected somewhat above SAL at this PRS. Low uranium levels in other samples at East Site indicate that uranium is not widespread at East Site. Several samples have inorganic multiple constituents with results above background UTLs but below SALs. In all cases, MCE screening yields a value far less than the target limit of 1.

5.7.7.2 Risk Assessment

No risk assessment was performed for this PRS.

5.7.8 Ecological Assessment

5.7.8.1 Ecological Screening Assessment

This PRS will be included in EEU's defined for both ecological screening and ecological risk assessments. A site inspection of this PRS indicates that it will be adequately addressed in the EEU's.

5.7.8.2 Ecological Risk Assessment

No ecological risk assessment has been performed for this PRS. See Section 3.5 of this report for the approach to ecological risk to be implemented at TA-33.

5.7.9 Extent of Contamination

Biased sampling was performed at this PRS to support a screening decision. No attempt was made to determine the extent of contamination.

5.7.10 Conclusion and Recommendation

Based on NFA Criterion 4, a Class III permit modification is requested to remove PRS 33-007(a) from the HSWA Module of LANL's RCRA operating permit.

- No experimental material was found during trenching in the former catcherbox area at the small berm near TA-33-87.
- Subsurface and surface sampling were adequate to detect contamination at hazardous levels.

- Uranium was detected somewhat above SAL in one sample. Uranium concentrations in remaining samples for PRS 33-007(a) and adjacent surface samples for PRS 33-006(b) were near or below the LANL (95%, 0.95) UTL, indicating that uranium is not widespread at the PRS. No risk assessment was performed.
- Few other chemicals were detected above SAL. There are PAHs attributable to ongoing releases. Data validation suggests that HE results adequately support the NFA decision.

5.8 PRS 33-007(b) South Site Firing Area

PRS 33-007(b) consists of several gun-firing areas at South Site. Uranium above SAL was detected in berm/barricade TA-33-63 and in the tower area. Because uranium is the only contaminant of concern, the PRS is recommended for NFA under RCRA and removal from the HSWA Permit. A VCA of the radioactive component will be proposed to DOE to reduce uranium concentrations to acceptable levels.

5.8.1 History

The PRS is discussed in the RFI Work Plan for OU 1122, Subsections 3.4.2.5, 4.4.3.1, and 4.4.6. PRS 33-007(b) consists of two gun-firing areas at South Site. One area lies 600 ft north of shot pad TA-33-26. It includes pads within berm TA-33-43 and in an area west of the berm (tower area) that was used to test a free-recoil weapon. The other gun-firing area of PRS 33-007(b) is berm TA-33-63 located near gun building TA-33-25.

Berm TA-33-43 was built in August 1950 and shot pad TA-33-85 was completed in June 1952. Shots fired here contained uranium, beryllium, some titanium, and tritium, all encased in a thin steel shell. Penetrator tests were performed with a free-recoil weapon firing projectiles into the cliff (Ahlquist 1983, 02-006). Guns located in TA-33-25 fired projectiles into berm TA-33-63. These projectiles contained uranium, beryllium, and tungsten. It is not known what percentage of projectiles were recovered.

The firing area is inactive. A LANL atmospheric physics group presently maintains an antenna, TA-33-203, erected in 1987 for atmospheric physics measurements in a level area 450-ft north of TA-33-26. Trailers TA-33-201 and TA-33-202 are associated with the antenna.

Potential contaminants are uranium, inorganics, and HE.

5.8.2 Description

Four distinct features comprise PRS 33-007(b).

- The tower area is located at the north end of South Site. It is a 100 x 100 ft level area that was excavated into bedrock tuff during construction, creating a 10-ft vertical embankment at its north and west perimeter.
- Berm TA-33-43 is a semicircular berm inner diameter of approximately 125 ft, a width of 50 ft, and approximately 12 ft high. It is made of tuff and soil ranging from finely ground powder to tuff fragments 2 ft in diameter. It lies adjacent to the east side of the tower area.
- Berm/barricade TA-33-63 located east of TA-33-25 is a mound of soil approximately 50 x 50 ft x 10 ft high. A timbered barricade supports the south side of the mound.
- A catcher box was located on the north bank of the tower area. The soil that filled the catcher box remains on the tuff embankment.

5.8.3 Previous Investigations

No previous investigations were conducted at this PRS.

5.8.4 Field Investigation

Sampling at PRS 33-007(b) was designed to detect maximum contamination using reconnaissance sampling and to locate any contamination due to firing activities. Fourteen surface samples (three resampled in 1995) were collected in the tower area west of berm TA-33-43. Sample AAA9765 was biased to the gun mount pad in berm TA-33-43. Sample AAA9766 was collected adjacent to the tuff wall north of berm TA-33-43 that was used as a backstop for the gun-mount. Samples AAA9761, AAA9762, and AAA9767 were biased to gun mount pads in the tower area. Samples AAA9763, and AAA9764 were collocated on the west side of tower area that may also have been used as a backstop for one of the gun mounts. Samples AAA9741 and AAA9742 were collected in the drainage leading from berm TA-43 and the tower area (Table 5.8.4-1). Field screening for radionuclides indicated high activity in the drainage; sample AAA9742 was collected at that point. All samples were analyzed for metals, gamma emitters, uranium, SVOCs, and HE.

Focused validation for inorganics sample request 19113 cast doubt on arsenic results; resamples of three of the eight samples were collected 1.5 years later in 1995. These samples are designated by the prefix 0333-95 in Table 5.8.4-1.

Trenching in two berms and fill for a former catcher box was designed to determine if experimental materials or residues remained in the structures. Five samples were taken during trenching at berm TA-33-43 (Table 5.8.4-2). Twenty-three samples were taken during trenching at berm TA-33-63. Samples AAA9893 and AAA9894 were collected in drainages leading from the berm (Table 5.8.4-3). Five samples were collected at the catcher box site on the north edge of the tower area (Table 5.8.4-4). All samples were analyzed for inorganics, gamma emitters, isotopic uranium, and HE. Figure 5.8.4-1 shows the sampling points at PRS 33-007(b).

TABLE 5.8.4-1

SUMMARY OF SAMPLES TAKEN FOR PRS 33-007(b), TOWER AREA

LOCATION ID	SAMPLE ID	DEPTH (ft)	MATRIX	INORGANICS	RADIO-NUCLIDES	SVOCs ^a	HE ^b
33-1360	AAA9741	0-0.5	Sediment	20384	19433	NA ^c	17789
33-1362	AAA9742	0-0.5	Sediment	20384	19433	NA	17789
33-1402	AAA9761	0-0.5	Soil	19113	19472	17839	17839
33-1405	AAA9762	0-0.5	Soil	19113	19472	17839	17839
33-1405	0333-95-0078	0-0.5	Soil	14384	NA	NA	NA
33-1406	AAA9763	0-0.5	Soil	19113	19472	17839	17839
33-1406	0333-95-0079	0-0.5	Soil	14384	NA	NA	NA
33-1462	AAA9764	0-0.5	Soil	19113	19472	17839	17839
33-1409	AAA9765	0-0.5	Soil	19113	19472	17839	17839
33-1410	AAA9766	0-0.5	Soil	19113	19472	17839	17839
33-1411	AAA9767	0-0.5	Soil	19113	19472	17839	17839
33-1411	0333-95-0080	0-0.5	Soil	14384	NA	NA	NA
33-1403	AAA9768	0-0.5	Soil	19113	19472	17839	17839
33-1357	AAA9776	0-0.5	Soil	19405	19414	NA	17786

^a SVOCs = Semivolatile organic compounds.

^b HE = High explosives.

^c NA = Not analyzed.

TABLE 5.8.4-2
SUMMARY OF SAMPLES TAKEN FOR PRS 33-007(b), BERM TA-33-43

LOCATION ID	SAMPLE ID	DEPTH (ft)	MATRIX	INORGANIC	RADIO-NUCLIDES	HE ^a
33-1449	AAA9698	3	Soil	19399	19418	18859
33-1449	AAA9699	5	Soil	19399	19418	18859
33-1449	AAA9700	6	Soil	19399	19418	18859
33-1449	AAA9701	20	Soil	19399	19418	18859
33-1449	AAA9702	20	Soil	19399	19418	18859

^a HE = High explosives.

TABLE 5.8.4-3
SUMMARY OF SAMPLES TAKEN FOR PRS 33-007(b), BERM TA-33-63

LOCATION ID	SAMPLE ID	DEPTH (ft)	MATRIX	INORGANICS	RADIO-NUCLIDES	HE ^a
33-1448	AAA9685	4	Soil	19388	19469	18006
33-1448	AAA9686	7	Soil	19388	19469	18006
33-1448	AAA9687	11	Soil	19388	19469	18006
33-1448	AAA9688	19	Soil	19388	19469	18006
33-1487	AAA9689	0.08	Soil	19388	19469	18006
33-1487	AAA9690	0.5	Soil	19164	19165	NA
33-1407	AAA9691	0.5	Soil	19388	19469	18006
33-1408	AAA9692	0.5	Soil	19388	19469	18006
33-1490	AAA9893	0.5	Sediment	19388	19469	18006
33-1491	AAA9894	0.25	Sediment	19254	19977	18003
33-1492	AAA9895	0.5	Soil	19254	19977	18003
33-1493	AAA9896	6	Soil	19254	19977	18003
33-1494	AAA9897	12	Soil	19254	19977	18003
33-1495	AAA9898	17	Soil	19254	19977	18003
33-1496	AAA9899	24	Soil	19254	19977	18003
33-1497	AAA9900	0.5	Soil	19128	19313	18119
33-1498	AAA9901	0.5	Soil	19128	19313	18119
33-1499	AAA9902	0.5	Soil	19128	19313	18119
33-1500	AAA9903	0.5	Soil	19128	19313	18119
33-1501	AAA9904	0.5	Soil	19128	19313	18119
33-1502	AAA9905	27	Soil	19128	19313	18119
33-1504	AAA9907	3	Soil	18593	18760	18072
33-1505	AAA9908	3	Soil	18593	18760	18072

^a HE = High explosives.

TABLE 5.8.4-4

SUMMARY OF SAMPLES TAKEN FOR PRS 33-007(b), CATCHER BOX

LOCATION ID	SAMPLE ID	DEPTH (ft)	MATRIX	INOR- GANICS	RADIO- NUCLIDES	HE ^a
33-1404	AAA9693	6	Soil	19285	19361	17844
33-1404	AAA9694	6	Soil	19285	19361	17844
33-1404	AAA9695	6	Soil	19285	19361	17844
33-1404	AAA9696	6	Soil	19285	19361	17844
33-1404	AAA9697	6	Soil	19285	19361	17844

^a HE = High explosives.

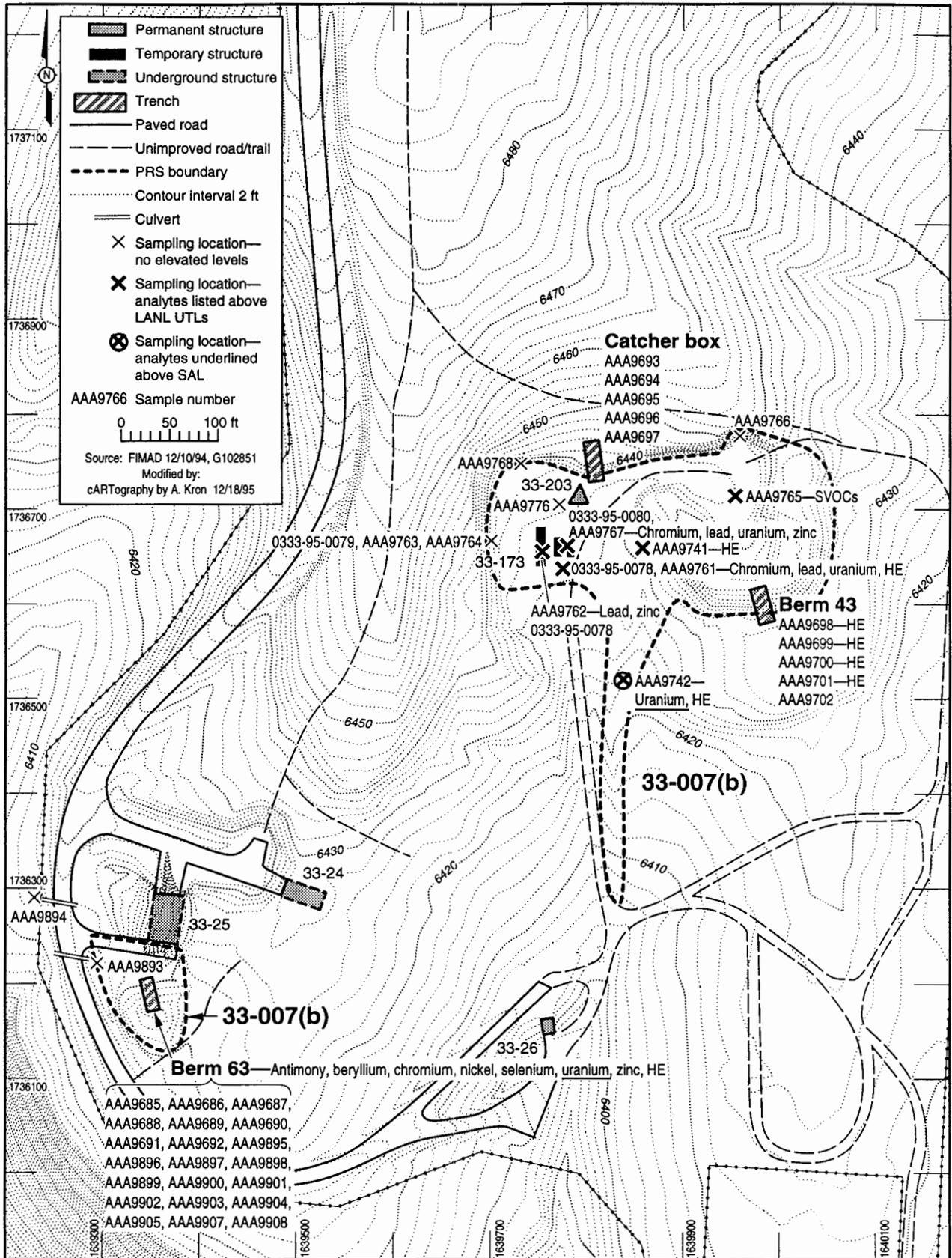


Fig. 5.8.4-1. South Site: PRS 33-007(b), firing areas.

5.8.5 Background Comparison

Tower Area surface samples: Chromium above background UTLs was detected in two samples. Lead slightly above background was detected in an area where vehicles parked over the years; the lead may represent leaded gasoline or lead bricks used for shielding. Zinc concentrations are within the TA-33 background UTL (Table 5.8.5-1).

Results for all samples in request 19113 for inorganic analyses are suspect as discussed in Section 4.1 of this RFI report. All arsenic results are considered unusable and other inorganic results appear to be biased upward. Because of these suspicions, three field points in the tower area were resampled and submitted to a different laboratory for analysis. The second data set was used to develop the decision at the tower area.

Uranium well above SAL was detected in one drainage sample (Table 5.8.5-2); yellow flakes were observed at the sampling point.

TABLE 5.8.5-1

INORGANICS WITH CONCENTRATIONS GREATER THAN BACKGROUND UPPER TOLERANCE LIMITS FOR PRS 33-007(b) IN THE TOWER AREA

SAMPLE ID	DEPTH (ft)	CHROMIUM (mg/kg)	LEAD (mg/kg)	ZINC (mg/kg)
LANL UTL ^a	N/A ^b	19.3	23.3	50.8
TA-33 UTL	N/A	14.6	25.2	57.3
SAL ^c	N/A	210	400	23 000
AAA9761	0-0.5	18.9	26.4	30.2
AAA9761D ^d	0-0.5	30.1	33.7	28.4
AAA9762	0-0.5	11.2	46.4	54.9
AAA9767	0-0.5	50.4	31.3	51.6

^a UTL = Upper tolerance limit.

^b N/A = Not applicable.

^c SAL = Screening action level.

^d D = Analyzed in duplicate by the analytical laboratory.

TABLE 5.8.5-2
URANIUM WITH CONCENTRATIONS GREATER THAN BACKGROUND UPPER TOLERANCE
LIMITS FOR PRS 33-007(b), TOWER AREA

SAMPLE ID	DEPTH (ft)	URANIUM (mg/kg)
LANL UTL ^a	N/A ^b	5.45
TA-33 UTL	N/A	4.12
SAL ^c	N/A	29
AAA9742	0-0.5	407.12
AAA9761	0-0.5	12.19
AAA9767	0-0.5	19.27

^a UTL = Upper tolerance limit.

^b N/A = Not applicable.

^c SAL = Screening action level.

Berm TA-33-43: No contamination above LANL UTLs was detected in any sample from berm TA-33-43. No experimental debris was found in the berm.

Berm TA-33-63: Inorganics, primarily low levels of nickel, were detected above LANL UTLs in 18 samples. Chromium and beryllium were detected above SAL in one sample each associated with high levels of uranium (Table 5.8.5-3). These chemicals are known to have been used experimentally at TA-33. Antimony was not found in a duplicate of one same sample and the chemical was not detected in any other sample. No evidence that antimony was used experimentally at TA-33 has been found.

Chunks of yellow uranium were found at one spot in the in the berm. High uranium concentrations were detected in several samples from this berm (Table 5.8.5-4). Six samples contained uranium only slightly above SAL.

Tower Area Catcherbox: No contamination above LANL UTLs was detected in any sample. No experimental debris was found in the catcherbox fill.

TABLE 5.8.5-3

INORGANICS WITH CONCENTRATIONS GREATER THAN BACKGROUND UPPER TOLERANCE LIMITS FOR PRS 33-007(b) IN BERM TA-33-63

SAMPLE ID	DEPTH (ft)	ANTIMONY (mg/kg)	BERYLLIUM (mg/kg)	CHROMIUM (mg/kg)	NICKEL (mg/kg)	SELENIUM (mg/kg)	SILVER (mg/kg)	ZINC (mg/kg)
LANL UTL ^a	N/A ^b	1	1.95	19.3	15.2	1.7	NA ^c	50.8
TA-33 UTL	N/A	0.17	1.22	14.6	11.1	0.92	NA	57.3
SAL ^d	N/A	31	Background	210	1 500	380	380	23 000
AAA9685	4	<5.5	0.74	6.9	28.8	<0.59	<0.87	21.4
AAA9685D ^e	4	6.9	<0.78	7.3	28.8	<0.59	<0.87	21.4
AAA9686	7	<5.5	<0.77	7.2	41.8	<0.6	<0.88	20
AAA9687	11	<9.3	<0.71	6.8	32.3	<0.58	<0.85	20.1
AAA9689	0.08	<12.4	<0.75	<1.3	17.9	<0.59	<0.88	17.8
AAA9690	0.5	<11.2	<0.54	4.8	19.9	2.2	<0.9	34.9
AAA9690D	0.5	<11.2	0.5	7.2	27.4	1.5	<0.9	26.4
AAA9691	0.5	<10.5	<0.64	5.8	26.7	<0.58	<0.86	22.4
AAA9692	0.5	<9.7	<0.75	4.7	27.2	<0.56	<0.83	21.8
AAA9893	0.5	<9.3	<0.67	10.8	28.4	<0.56	<0.83	26.5
AAA9894	0.25	<5.6	<0.83	34.4	17.3	<1	<0.87	93.1
AAA9895	0.5	<4.7	<0.98	5.7	16.8	<0.56	<0.82	48.4
AAA9896	6	<9.8	<0.88	8.3	34	<1.2	<0.93	25.8
AAA9897	12	<8.3	<0.9	5.8	16.7	<0.6	<0.89	24.9
AAA9900	0.5	<0.31	<0.39	11.5	28.5	0.73	<0.2	35.3
AAA9900D	0.5	<0.31	0.36	10.7	27.9	<0.97	<0.12	32.3
AAA9907	3	<1.2	3.7	<8	23	1	130	17
AAA9908	3	<1.2	1.1	<8	15	1	5	19

^a UTL = Upper tolerance limit.

^b N/A = Not applicable.

^c NA = Not analyzed.

^d SAL = Screening action level.

^e D = Analyzed in duplicate.

TABLE 5.8.5-4

**URANIUM CONCENTRATIONS GREATER THAN BACKGROUND UPPER TOLERANCE LIMITS
FOR PRS 33-007(b) IN BERM TA-33-63**

SAMPLE ID	DEPTH (ft)	URANIUM (mg/kg)
LANL UTL ^a	N/A ^b	5.45
TA-33 UTL	N/A	4.12
SAL ^c	N/A	29
AAA9686	7	36.33
AAA9687	11	442
AAA9689	0.083	6 721
AAA9690	0.5	327
AAA9690D ^d	0.5	392
AAA9691	0.5	607
AAA9692	0.5	176
AAA9893	0.5	36.
AAA9894	0.25	44
AAA9895	0.5	6.75
AAA9896	6	54
AAA9897	12	41
AAA9900	0.5	323
AAA9901	0.5	275.
AAA9902	0.5	6.75
AAA9903	0.5	6.41
AAA9904	0.5	36
AAA9907	3	581
AAA9908	3	3 967
AAA9908D	3	4 170

^a UTL = Upper tolerance limit.

^b N/A = Not applicable.

^c SAL = Screening action level.

^d D = Analyzed in duplicate.

5.8.6 Evaluation of Organics

Low levels of a common plasticizers were detected in one sample in the tower area (Table 5.8.6-1).

TABLE 5.8.6-1

PRS 33-007(b) TOWER AREA SOIL CONCENTRATIONS FOR ORGANIC ANALYTES WITH VALUES GREATER THAN THE ESTIMATED QUANTITATION LIMIT

SAMPLE ID	SVOC ^a , HE ^b	RESULT (mg/kg)	SAL ^c (mg/kg)	EQL ^d (mg/kg)
AAA9765	Di-n-butylphthalate	4.1	NC ^e	0.33

^a SVOC = Semivolatile organic compound.

^b HE = High explosives.

^c SAL = Screening action level.

^d EQL = Estimated quantitation limit.

^e NC = Not calculated.

Some HE analyses at South Site were compromised by missed holding times. However, after initial routine validation, 61% of subsurface data for PRS 33-007(b) was accepted as uncompromised. [Surface samples are reassigned to PRS 33-006(a).] Rejections include the six samples from berm TA-33-63 that were submitted on request 18003, and the five tower area catcher box samples that were submitted on request 17844. There are 16 other berm TA-33-63 samples in three other requests (18006, 18119, 18072) for which data were not rejected.

Review of data scans identified HMX and DNT at very low levels (qualified J+ by the reviewer) in three samples: two trench samples in 18003 and one surface sample in 18006. No HE was identified by focused review of scans from catcher box samples. Focused data validation also identified RDX at low levels (J- qualified by the reviewer) in three TA-33-43 trench samples that were originally qualified UJ. The J-qualified RDX result of 0.23 mg/kg in the original data from TA-33-43 is a surface sample.

Focused validation indicates that data are sufficiently complete to determine that while there may be trace amounts of explosives in subsurface parts of PRS 33-007(b) (berms, catcher box), they are not at levels of concern. Table 5.8.6-2 lists all subsurface HE results (unadjusted) detected at South Site, including samples that were originally reported with detected HE and those that were added as a result of reevaluation of the raw data as described in Section 4.2. The first qualifier is that provided during the reevaluation; the second qualifier was applied by the data validators to the original result, which in many cases was reported as below the CRQL. See Section 4.2.2 of this RFI report for a discussion of focused data validation for the HE samples.

TABLE 5.8.6-2

HIGH EXPLOSIVES DETECTED IN BERMS AT PRS 33-007(b)

PRS	DESCRIPTION	SAMPLE ID	HE ^a	RESULT (mg/kg)	SAL ^b (mg/kg)	EQL ^c (mg/kg)	QUALIFIERS	
33-007(b)	Berm TA-33-43	AAA9698	RDX	0.20	4.0	0.5	N/A ^d	UJ ^e
33-007(b)	Berm TA-33-43	AAA9699	RDX	0.22	4.0	0.5	J ^f	UJ
33-007(b)	Berm TA-33-43	AAA9700	RDX	0.14	4.0	0.5	J ⁻	UJ
33-007(b)	Berm TA-33-43	AAA9701	RDX	0.22	4.0	0.5	N/A	UJ
33-007(b)	Berm TA-33-63	AAA9689	HMX	0.30	3259	1.1	J ⁺ g	UJ
33-007(b)	Berm TA-33-63	AAA9896	HMX	0.10	3259	1.1	J ⁺	R ^h
33-007(b)	Berm TA-33-63	AAA9898	DNT	0.10	0.65	0.13	J ⁺	R
			TIC ⁱ	N/A	N/A	N/A	N/A	N/A

^a HE = High explosives.

^b UJ = Not detected, quantitation limit reported is estimated.

^c J⁻ = Estimated quantity, biased low based on surrogate recovery.

^d J = Estimated quantity.

^e J⁺ = Estimated quantity, biased high based on surrogate recovery.

^f R = Rejected.

5.8.7 Human Health Assessment

5.8.7.1 Screening Assessment

In berm TA-33-63, uranium was detected above SAL in many soil samples. Yellow uranium chunks were found buried in the berm. In the drainage near the tower area, uranium was detected above SAL and uranium flakes were found on the surface.

Low levels of nickel were detected above the background (95%, 0.95) UTL in 17 samples. Sample AAA9907 contained beryllium above background (95%, 0.95) UTL. Four samples have multiple constituents with results above background UTLs but below SALs. In all cases, MCE screening yields a value far less than the target limit of 1.

HE focused validation indicates that subsurface trace levels of HE are present in the berms.

5.8.7.2 Risk Assessment

No risk assessment for RCRA constituents was performed for this PRS. Uranium cleanup will be proposed to DOE.

5.8.8 Ecological Assessment

5.8.8.1 Ecological Screening Assessment

This PRS will be included in EEU's defined for both ecological screening and ecological risk assessments. A site inspection of this PRS indicates that it will be adequately addressed in the EEU's.

5.8.8.2 Ecological Risk Assessment

No ecological risk assessment has been performed for this PRS. An ecological risk assessment will be evaluated when an approach is approved by regulators.

5.8.9 Extent of Contamination

No significant contamination was found at berm TA-33-43, the tower area, or the catcher box. Uranium above SAL at AAA9742 is considered as part of the south-site uranium evaluation in Section 5.5.

At berm TA-33-63, yellow uranium flakes were noted at small areas on the surface of the berm prior to trenching and yellow uranium chunks were encountered during trenching. Sampling and analysis confirmed that uranium is present at elevated levels. Isotopic analysis indicated natural enrichment for the uranium. Sample AAA9894, taken on the south side of the culvert near the rim of Chaquehui Canyon, contained uranium above SAL and low levels of inorganics, indicating that contaminants are migrating from the berm.

5.8.10 Conclusion and Recommendation

Based on NFA Criterion 4, a Class III permit modification is requested to remove PRS 33-007(b) from the HSWA Module of LANL's RCRA operating permit. HE contamination appears minimal as is expected to be confirmed by HE resampling proposed for PRS 33-006(a). No other RCRA-regulated contaminants are present at levels of concern. A VCA plan to reduce uranium to acceptable levels will be presented to DOE.

5.9 PRS 33-010(a) East Site Canyonside Disposal

PRS 33-010(a) is scheduled for a VCA cleanup in fiscal year 1996. Uranium, cadmium, and chromium were found above SAL. Lead was found above SAL and radionuclide-contaminated debris is present in the unit. The VCA will consist of debris removal. A final report will be issued prior to September 30, 1996. Debris will be picked up in a VCA.

5.10 PRS 33-010(b) East Site Canyonside Disposal

PRS 33-010(b) is scheduled for a VCA cleanup in fiscal year 1996. Uranium, cadmium, and chromium were found above SAL. Radionuclide-contaminated debris is present in the unit. The VCA will consist of debris removal. A final report will be issued prior to September 30, 1996.

5.11 PRS 33-010(c) South Site Surface Disposal

PRS 33-010(c) is a drainageside surface disposal area at South Site. Uranium and copper were detected above SALs. A risk assessment indicates that levels do not pose an unacceptable risk. A VCA cleanup is recommended to prevent uranium-contaminated pieces from migrating into Chaquehui Canyon.

5.11.1 History

PRS 33-010(c) is discussed in the RFI Work Plan for OU 1122, Subsections 3.4.2.7 and 4.4.7. The PRS lies 230 ft south of the shot pad, PRS 33-006(a). Because of this proximity, it is presumed that PRS 33-010(c) received debris associated with the shots. The shot pad was the location of a series of implosion studies conducted in the mid-1950s. Two to three shots per week were detonated, a few containing in excess of 1 000 lb of TNT. Experimental apparatus and HE were encased in a uranium container and surrounded by neutron detectors on aluminum stands. This assemblage was put in a large copper can to electrically isolate the experiment. A wooden shack was built over the can, and the HE was detonated. Debris from the shots covered a wide area, but much of it was deposited near the shot pad. This debris was scraped away to clean the area for the next shot. Surface disposal area PRS 33-010(c) was the destination of the debris.

5.11.2 Description

Debris is spread along the rim and west slope of the main arroyo serving South Site. The disposal pile consists of commercial (road grade) gravel, shrapnel (primarily copper and aluminum), shattered pieces of electronic cable, and bits of wood. The PRS is approximately 50 ft x 30 ft in extent and an estimated 2 ft to 4 ft deep.

5.11.3 Previous Investigations

Previous investigations are discussed in Subsection 3.4.4 of the RFI Work Plan for OU 1122 (LANL 1992, 0784). Poorly documented, unpublished studies were conducted in 1989. Three composite samples consisting of four subsamples each were taken across the face of the pile. The samples were analyzed for radionuclides and inorganics. Elevated levels of uranium (150 to 380 mg/kg) and copper (1 500 to 7 900 mg/kg) were detected in the debris pile (LANL 1989, 0425).

5.11.5 Field Investigation

The RFI work plan specified trenching at this PRS to determine the depth of the pile and the subsurface distribution of the debris. Closer inspection of the pile indicated that it is shallow (2 to 4 ft) and relatively homogeneous, with gravel a large component of the matrix material. For several reasons, the decision was made not to trench.

- Disruption of the pile could mobilize debris into a drainage leading directly to Chaquehui Canyon.
- The loose gravel nature of the pile would allow the trench to collapse as it was being dug, defeating the intent to characterize a cross section of the pile.
- The appearance of the pile indicated that distribution of debris is fairly even throughout the pile and that the pile is shallow.

Six soil samples were collected on the face of the disposal pile. An additional six samples were collected in the drainage below the PRS (Figure 5.11.4-1). All samples were analyzed for inorganics, uranium, and cesium-137. Two samples were analyzed for pesticides and herbicides (Table 5.11.4-1). No debris was sampled.

TABLE 5.11.4-1
SUMMARY OF SAMPLES TAKEN FOR PRS 33-010(c)

LOCATION ID	SAMPLE ID	DEPTH (ft)	MATRIX	INORGANIC	RADIO-NUCLIDES	HE ^a	PESTICIDES	HERBICIDES
33-1421	AAA9713	1	Soil	18593	18760	18072	NA ^b	NA
33-1477	AAA9714	1	Soil	18593	18760	18072	NA	NA
33-1478	AAA9715	0.5	Soil	18593	18760	18072	NA	NA
33-1479	AAA9716	1	Soil	18593	18760	18072	NA	NA
33-1480	AAA9717	1	Soil	18593	18760	18072	NA	NA
33-1481	AAA9718	1	Soil	18593	18760	18072	NA	NA
33-1364	AAA9744	0.5	Sediment	19264	19357	17733	NA	NA
33-1364	AAA9745	0.5	Sediment	19264	19357	17733	NA	NA
33-1367	AAA9748	0.5	Sediment	19264	19357	17733	17728	17728
33-1368	AAA9749	0.5	Sediment	19264	19357	17733	NA	NA
33-1369	AAA9750	0.5	Sediment	19264	19357	17733	NA	NA
33-1361	AAA9751	0.5	Sediment	19264	19357	17733	17728	17728

^a HE = High explosives.

^b NA = Not analyzed.

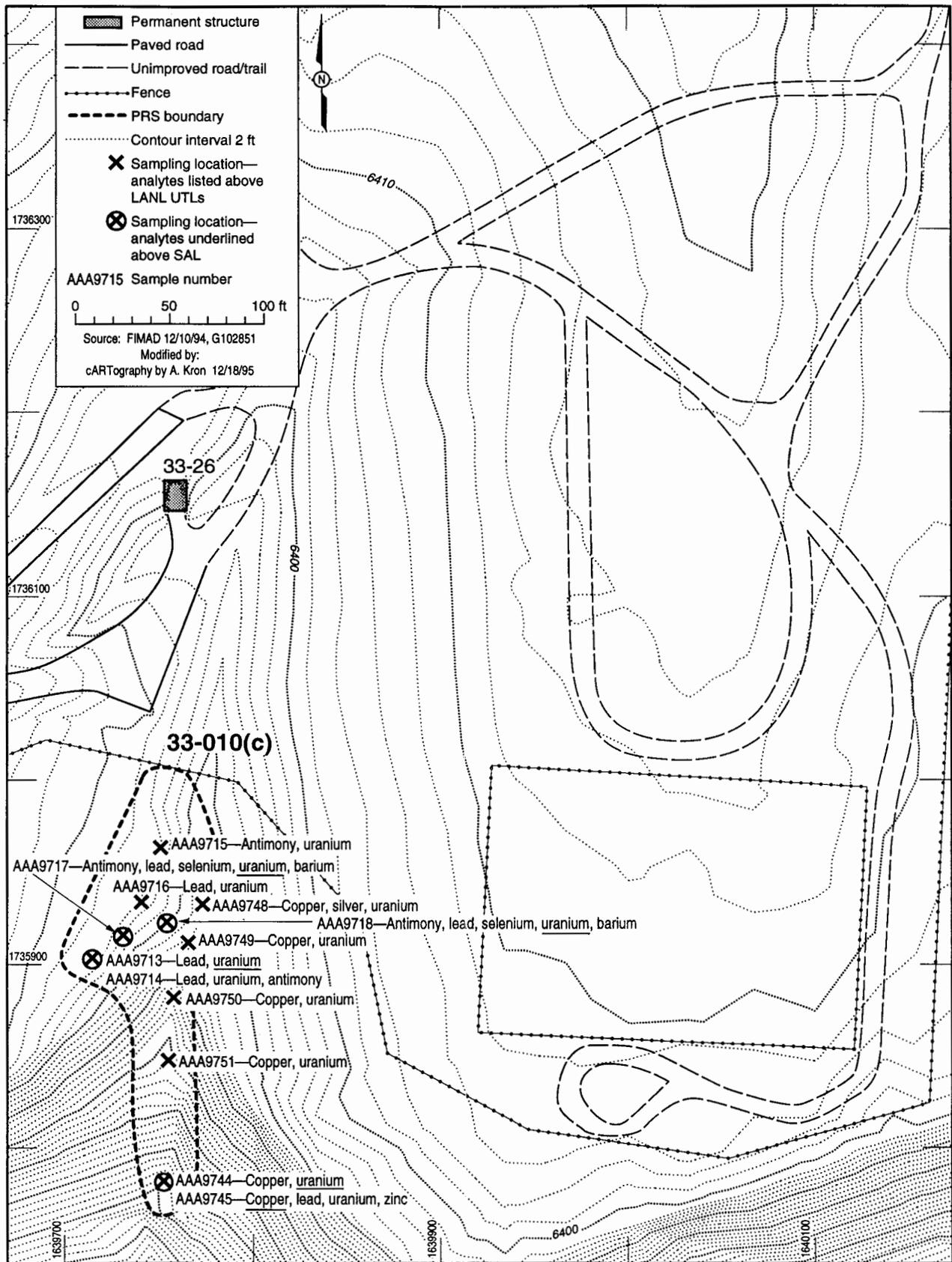


Fig. 5.11.4-1. South Site: PRS 33-010(c), drainside disposal.

5.11.5 Background Comparison

Copper was detected at high levels in most samples. These data are provided in Appendix C in conjunction with risk assessment calculations. Large chunks of copper shrapnel are visible on the pile. Other inorganics, including low levels of silver, were detected above LANL UTLs but below SALs (Table 5.11.5-1).

Uranium above UTL was detected in all samples at this PRS and above SAL in five samples (Table 5.11.5-2). Uranium-contaminated shrapnel is present in the debris pile and pieces have been found in Chaquehui Canyon near the confluence of this drainage and the main Chaquehui channel.

TABLE 5.11.5-1

INORGANICS WITH CONCENTRATIONS GREATER THAN BACKGROUND UPPER TOLERANCE LIMITS FOR PRS 33-010(c)

SAMPLE ID	DEPTH (ft)	ANTIMONY (mg/kg)	BARIUM (mg/kg)	COPPER (mg/kg)	LEAD (mg/kg)	SELENIUM (mg/kg)	SILVER (mg/kg)	ZINC (mg/kg)
LANL UTL ^a	N/A ^b	1	315	30.7	23.3	1.7	NA ^c	50.8
TA-33 UTL	N/A	0.17	139	NA	25.2	0.92	ND ^d	57.3
SAL ^e	N/A	31	5 340	2 848	400	380	380	23 000
AAA9713	1	<1.2	89	NA	24	1	<4	50
AAA9714	1	2	54	NA	14	0.6	<4	33
AAA9715	0.5	1.3	140	NA	21	0.4	<4	48
AAA9716	1	<1.2	48	NA	26	0.6	<4	36
AAA9717	1	10.4	460	NA	39	3	<4	71
AAA9718	1	1.9	340	NA	38	2	<4	100
AAA9744	0-0.5	<4.2	57.1	NA	6.1	<0.51	<0.85	18.5
AAA9745	0-0.5	<4.2	102	5 760	31.5	<0.51	<0.75	1 160
AAA9748	0.5	<4.3	66	1 380	5.7	<0.51	0.8	43.1
AAA9749	0.5	<4.2	67.1	494	6.7	<0.5	<1.7	21.8
AAA9750	0.5	<4.3	49.6	60.1	4.9	<0.51	<0.76	18.3
AAA9751	0.5	<4.3	69.2	1 270	8.3	<0.51	<0.76	50.7

^a UTL = Upper tolerance limit.

^b N/A = Not applicable.

^c NA = Not analyzed.

^d ND = Not detected.

^e SAL = Screening action level.

TABLE 5.11.5-2

URANIUM WITH CONCENTRATIONS GREATER THAN BACKGROUND UPPER TOLERANCE LIMITS FOR PRS 33-010(c)

SAMPLE ID	DEPTH (ft)	URANIUM (mg/kg)
LANL UTL ^a	N/A ^b	4.45
TA-33 UTL	N/A	4.12
SAL ^c	N/A	29
AAA9713	1	54.8
AAA9713D ^d	1	56.3
AAA9714	1	18.7
AAA9715	0.5	74.8
AAA9716	1	11.6
AAA9717	1	215
AAA9718	1	185
AAA9744	0.5	21.48
AAA9744D	0.5	31.78
AAA9745	0.5	16.68
AAA9748	0.5	22.74
AAA9749	0.5	20.93
AAA9750	0.5	6.24
AAA9750D	0.5	7.55
AAA9751	0.5	21.43

^a UTL = Upper tolerance limit.

^b N/A = Not applicable.

^c SAL = Screening action level.

^d D = Analyzed in duplicate.

5.11.6 Evaluation of Organics

No HE results for this PRS missed holding times; no HE results were rejected or otherwise qualified. Herbicides and pesticides were not detected at this PRS.

5.11.7 Human Health Assessment

5.11.7.1 Screening Assessment

Uranium and copper were detected above SAL in the samples collected for this PRS, and will therefore be carried forward through the screening assessment.

Other chemicals identified to be greater than LANL background UTL were submitted for an MCE for noncarcinogenic effects. The sum of the maxima for the noncarcinogenic group of chemicals is 0.48. This result is well below the target value of 1, which indicates a low potential for adverse effects due to exposure to this multiple grouping. No carcinogens or other radionuclides were detected above LANL UTLs; no MCE has been performed for these groupings. Results of the MCE for noncarcinogens are summarized in Table 5.11.7-1.

TABLE 5.11.7-1

**MULTIPLE CONSTITUENT EVALUATION FOR NONCARCINOGENIC EFFECTS AT
PRS 33-010(c)**

ANALYTE	MAXIMUM SOIL CONCENTRATION (mg/kg)	SOIL SAL ^a (mg/kg)	CONCENTRATION NORMALIZED TO SAL
Antimony	10.4	31	0.335
Barium	460	5 340	0.086
Lead	39	400	0.098
Selenium	3	380	0.008
Silver	0.8	380	0.002
Zinc	1 160	23 000	0.050
Sum of normalized concentrations			0.579

^a SAL = Screening action level.

5.11.7.2 Risk Assessment

A risk assessment was performed in accordance with the guidance presented in the Risk-Based Corrective Action Process document (ER Project Decision Support Council In preparation 02-111). Radionuclides are evaluated by comparing the estimated annual radiation dose to a target dose limit. Nonradionuclides are evaluated by comparison of estimated dose (noncarcinogens) or risks (carcinogens) to a target dose. For this assessment, dose and risk estimates are conservatively presented in terms of a reasonable maximum exposure (RME). As discussed in Section 3.4.2 of this RFI report, four steps comprised the human health risk assessment:

- Identification of chemicals of potential concern
- Exposure assessment
- Toxicity assessment
- Risk characterization

The results of each of these steps is provided in the following sections.

5.11.7.2.1 Identification of Chemicals of Potential Concern

Uranium and copper at levels of potential concern were identified in the screening assessment presented above. Because uranium and copper concentrations at this PRS exceeded SALs in the screening assessment, a human health risk assessment was performed to determine whether exposure to uranium and copper under future site conditions might present a human health risk.

Values for source term concentrations used in the risk assessment are the 95% UCL of the mean of the underlying contaminant distribution in the contaminated area. The UCLs for uranium and copper were calculated at 81.5 mg/kg, and 3 760 mg/kg respectively (Appendix C).

5.11.7.2.2 Exposure Assessment

An exposure unit corresponding to a likely area of activity is traditionally defined in a risk assessment. In this case, however, it is more feasible to evaluate exposure within the actual bounds of the contaminated area rather than calculate a fraction of a pre-defined exposure area corresponding to the contaminated zone. This decision is based on the size and topography of the contaminated area.

Because this PRS is in an inactive area of TA-33, few human exposures are currently occurring. Because of the close proximity of this PRS to Bandelier National Monument, future exposures at PRS 33-010(c) are evaluated for the recreational trail user. Potential exposure pathways evaluated for a trail user in the canyon exposure area include ingestion of soil, dermal contact with soil, inhalation of fugitive dust, and exposure to external gamma radiation.

5.11.7.2.3 Toxicity Assessment

The toxicity value used to evaluate noncarcinogenic effects for a contaminant is the reference dose (RfD). The RfD has been developed based upon 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 RfDs were utilized in this risk assessment because of the length of the exposure periods involved (9 years). EPA's Integrated Risk Information System (IRIS) and Health Effects Assessment Summary Tables were used to identify RfD values (EPA 1994, 1167).

No RfD values for copper were located in these sources. An oral RfD for copper of 3.7E-02 mg/kg-day was adopted from the Region IX and Region III PRG tables. Copper is an

essential element in human nutrition. A daily copper intake of 2 mg is considered to be adequate for health and normal copper metabolism. Limited data are available on the chronic toxicity of copper, however, chronic exposure may cause anemia.

The ratio of radionuclide exposure to dose is expressed as a dose conversion factor (DCF). DCFs used in this risk assessment are default values provided in the RESRAD code and are listed in the RESRAD summary output files in Attachment C-1 of this appendix. The RESRAD output files contain DCFs for the radionuclides identified as contaminants as well as DCFs for important progeny of the contaminants. Additional information regarding DCFs is provided in the Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0 (Yu et. al., 1993, 1177).

5.11.7.2.4 Risk and Dose Characterization

Copper

A hazard quotient (HQ) of unity is used to evaluate potential noncarcinogenic health risk from exposure to copper at this PRS. The HQ is calculated according to the following equation.

$$HQ = \frac{\text{Intake (mg/kg-d)}}{\text{RfD (mg/kg-d)}}$$

The HQ summed across all pathways for exposure to copper is 0.004, indicating that exposure by a trail user will not result in adverse noncarcinogenic health effects.

Radionuclides

Human health risks associated with radionuclides are evaluated in a dose-based manner. The RESRAD computer code, Version 5.6, was used to calculate committed effective dose for natural uranium. Dose contribution by daughter products is included in the dose estimates for the primary radionuclides. The calculated 95% UCL of 81.5 mg/kg was converted to isotopic concentrations in pCi/g assuming the following abundances and specific activities for natural uranium (Table 5.11.7-2).

TABLE 5.11.7-2
SPECIFIC ACTIVITIES AND ABUNDANCES OF ISOTOPES OF NATURAL URANIUM

ISOTOPE	SPECIFIC ACTIVITY (pCi/g)	% ABUNDANCE
Uranium-234	6.23E+09	0.0057
Uranium-235	2.16E+06	0.71
Uranium-238	3.36E+05	99.28

The calculated dose is compared to a 15 mrem/year dose level, which is the annual dose limit proposed in EPA's Radiation Site Cleanup Regulation, 40 CFR 196. The dose estimate for uranium at this PRS is 0.11 mrem/year, well below the annual dose limit proposed by EPA.

5.11.7.2.5 Conclusions

The goal of this risk evaluation was to determine whether PRSs 33-010(c) poses a risk to human health or the environment, or could be recommended for NFA. Based on the environmental data collected the human health screening assessment identified two contaminants in soil, uranium and copper, that are present at concentrations greater than SALs. The results of the multiple chemical evaluations suggest that the presence of other chemicals in soil at concentrations below SALs should not result in adverse human health effects.

The human health risk assessment evaluated potential exposure to the contamination by a trail user, which is the most likely exposure scenario. The steepness and instability of the area preclude residential or commercial development. Quantitative estimates of risk (nonradionuclide) and dose (radionuclide) were calculated for the contaminants in soil. The results of the human health risk assessment suggest that potential exposure to contamination in soil at this PRS will not result in adverse noncarcinogenic health effects or an unacceptable radiation dose to trail users under reasonable maximum exposure (RME) conditions. The RME assumptions represent reasonable worst-case conditions, and should be evaluated at the upper bound of the dose range calculated within the constraints of the RESRAD model using the exposure assumptions presented.

Based on the results of the human health screening assessment and human health risk assessment, PRSs 33-010(c) is proposed for NFA.

5.11.8 Ecological Assessment

5.11.8.1 Ecotoxicological Screening Assessment

This PRS will be included in EEU's defined for both ecological screening and ecological risk assessments. A site inspection of this PRS indicates that it will be adequately addressed in the EEU's.

5.11.8.2 Ecological Risk Assessment

No ecological risk assessment has been performed for this PRS. An ecological risk assessment will be evaluated when an approach is approved by regulators.

5.11.9 Extent of Contamination

Uranium and copper are present throughout the pile. Downgradient sediment samples from the drainage indicate that uranium is being mobilized and may be moving off-site. Uranium-contaminated debris has been found in the drainage leading into Chaquehui Canyon.

5.11.10 Conclusion and Recommendation

Based on NFA Criterion 4, a Class III permit modification is requested to remove PRS 33-010(c) from the HSWA Module of LANL's RCRA operating permit. Except for copper, no nonradioactive chemicals were detected at hazardous levels. A screening assessment indicated that elevated copper levels do not pose a human risk. The risk due to copper under a recreational scenario is represented by a hazard index of 0.004. Elevated copper as a potential ecotoxicological risk will be addressed separately.

A screening assessment indicates that uranium in soil does not pose a human risk under a recreational scenario. The calculated dose is 0.11 mrem/year. However, because this PRS containing elevated uranium is located on the side of the major South Site drainage leading to Chaquehui Canyon, the State of New Mexico Water Quality Division has expressed concerns about contaminant migration into surface waters. A VCA plan to stabilize and prevent debris from the entering drainage will be considered.

5.12 PRS 33-010(d) East Site Canyonside/Surface Disposal

PRS 33-010(d) is scheduled for a VCA cleanup in fiscal year 1996. No contamination above SAL was found. The VCA will consist of debris removal. A final report will be issued prior to September 30, 1996.

5.13 PRS 33-010(g) South Site Canyonside Disposal

PRS 33-010(g) is scheduled for a VCA cleanup in fiscal year 1996. No contamination above SAL was found. The VCA will consist of debris removal. A final report will be issued prior to September 30, 1996.

5.14 PRS 33-010(h) South Site Surface Disposal

PRS 33-010(h) is listed as a surface disposal area at South Site. Little surface debris was found in the area by the OU 1122 sampling team. The PRS is recommended for NFA because no chemicals were detected above LANL or TA-33 UTLs in any samples.

5.14.1 History

The PRS is discussed in the RFI Work Plan for OU 1122, Subsections 3.4.2.6 and 4.4.7. PRS 33-010(h) is a surface disposal area located adjacent to berm TA-33-43 at South Site. The unit resembles a large mound of dirt, approximately 100 ft square, that has been leveled on top. It is now covered with chamisa. Some operational debris, mostly bits of cabling, lies on the western slope of the mound. Shrapnel from PRS 33-006(a) is scattered about. No information concerning this PRS could be found during archival searches for the work plan, and no disposal area of any consequence was ever located.

5.14.2 Description

The mound is located on the level mesa south of, and adjacent, to berm TA-33-43. It is bounded on the west by the main drainage at South Site and on the east by an unimproved road. Pinyon and juniper trees surround the unit and chamisa grows upon it. The base of the mound appears to be near bedrock.

5.14.3 Previous Investigations

No previous investigations were conducted at this PRS.

5.14.4 Field Investigation

Sampling at PRS 33-010(h) was designed to determine maximum contamination using reconnaissance sampling. Prior to sampling, a geophysical survey was performed to detect subsurface anomalies. No anomalies were found. Because nothing was known of the unit, a trench was dug perpendicular to the back wall of the center of the berm (Figure 5.14.4-1). Because no debris was encountered and no elevated radioactivity detected by field screening, two random samples were taken from the backhoe bucket (Table 5.14.4-1). A nearby surface sample from PRS 33-006(a) is relevant to this PRS (Sample AAA9743).

TABLE 5.14.4-1
SUMMARY OF SAMPLES TAKEN FOR PRS 33-010(h)

LOCATION ID	SAMPLE ID	DEPTH (ft)	MATRIX	INOR-GANICS	RADIO-NUCLIDES	SVOCs ^a	HE ^b
33-1486	AAA9723	Trench	Soil	19284	19419	17929	18005
33-1487	AAA9724	Trench	Soil	19284	19419	17929	18005
33-1325	AAA9783	0-0.5	Soil	19405	19414	NA ^c	17786

^a SVOCs = Semivolatile organic compounds.

^b HE = High explosives.

^c NA = Not analyzed.

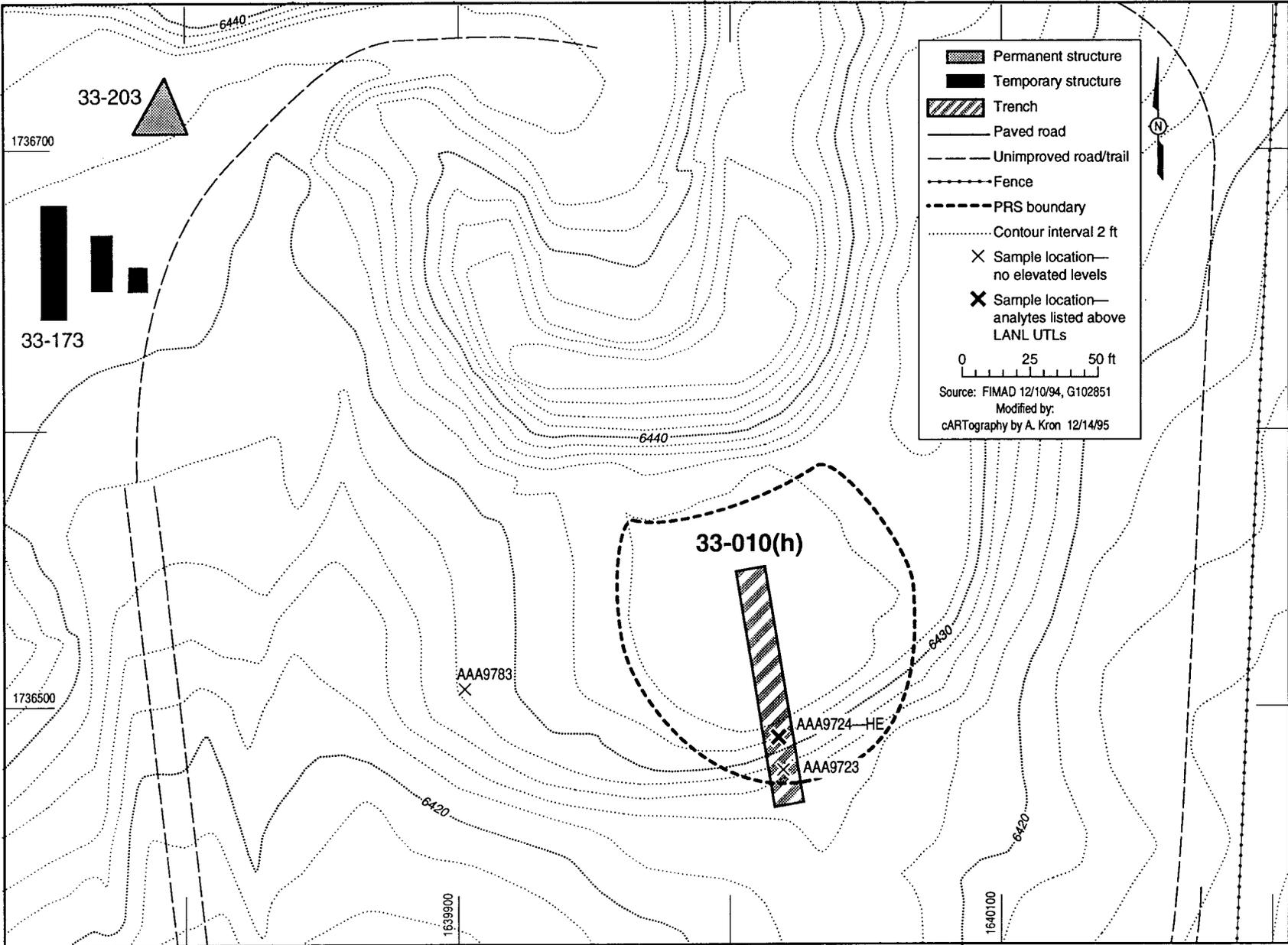


Fig. 5.14.4-1. South Site: PRS 33-010(h), surface disposal.

5.14.5 Background Comparison

No inorganic or radiological chemical was detected above LANL UTLs.

5.14.6 Evaluation of Organics

A small amount of HMX was found based on examination of HPLC scans (see Table 5.5.6-1). No HE results were rejected or otherwise qualified during data validation. No other organic chemicals were detected.

5.14.7 Human Health Assessment

5.14.7.1 Screening Assessment

No chemical was detected above SAL at this PRS. No debris was found during trenching.

5.14.7.2 Risk Assessment

No risk assessment was performed for this PRS.

5.14.8 Ecological Assessment

5.14.8.1 Ecotoxicological Screening Assessment

This PRS will be included in EEU's defined for both ecological screening and ecological risk assessments. A site inspection of this PRS indicates that it will be adequately addressed in the EEU's.

5.14.8.2 Ecological Risk Assessment

No ecological risk assessment has been performed for this PRS. An ecological risk assessment will be evaluated when an approach is approved by regulators.

5.14.9 Extent of Contamination

Biased sampling was performed at this PRS to support a screening decision. No attempt was made to determine the extent of contamination.

5.14.10 Conclusion and Recommendation

Based on NFA Criterion 4, a Class III permit modification is requested to remove PRS 33-010(h) from the HSWA Module of LANL's RCRA operating permit.

- No experimental or operational material was detected during trenching.
- No chemicals were detected above background UTLs in surface or subsurface samples.

5.15 PRS 33-011(b) Storage Area at NRAO

PRS 33-011(b) is scheduled for a VCA cleanup in fiscal year 1996. Soil sampling indicated no contaminants above SAL. Radionuclide-contaminated shrapnel is present at the site. The VCA involves removal of such debris. A final report will be issued prior to September 30, 1996.

5.16 PRS 33-011(c) South Site Blivit Storage Area

PRS 33-011(c) was a temporary storage area for leaking tritium vessels. It is recommended for NFA because only low levels of tritium were detected at the site.

5.16.1 History

The PRS is discussed in the RFI Work Plan for OU 1122, Subsections 3.4.2.11 and 4.4.3.1 (LANL 1992, 0784). Tritium containers underwent acceleration tests at TA-33. After the tests, any leaking containers, called blivits, were set in this fenced storage area and allowed to discharge (Ahlquist 1983, 02-006). The physical form of the tritium was as a gas (Hoard 1990, 02-022).

5.16.2 Description

The blivit area lies between berm TA-33-63, gun building TA-33-25, and control building TA-33-24. The blivit area is highly disturbed and is now covered with chamisa. A gravel road once served the area and the gravel is still in place. Remains of fencing line the boundaries of the PRS. The area is slightly dished with the lowest point near the center of the unit. Soil at the sampling points ranges from loamy with some pebbles and organic matter to loamy with many rocks and pebbles.

5.16.3 Previous Investigations

No previous investigations were conducted at this PRS.

5.16.4 Field Investigation

Sampling at PRS 33-011(c) was designed to detect maximum contamination using reconnaissance sampling. Two surface samples and one collocated sample were collected (Figure 5.16.4-1). All samples were analyzed for gamma emitters and tritium (Table 5.16.4-1).

**TABLE 5.16.4-1
SUMMARY OF SAMPLES TAKEN FOR PRS 33-011(c)**

LOCATION ID	SAMPLE ID	DEPTH (ft)	MATRIX	RADIONUCLIDES
33-1442	AAA9754	0-0.5	Soil	19421
33-1443	AAA9755	0-0.5	Soil	19421
33-1461	AAA9756	0-0.5	Soil	19421

5.16.5 Background Comparison

Only trace levels of tritium (0.015 to 0.060 pCi/g) were detected in the three samples collected in the blivit area.

5.16.6 Evaluation of Organics

No organics were analyzed for this PRS.

5.16.7 Human Health Assessment

5.16.7.1 Screening Assessment

Tritium was not detected above SAL at this PRS.

5.16.7.2 Risk Assessment

No risk assessment was performed for this PRS.

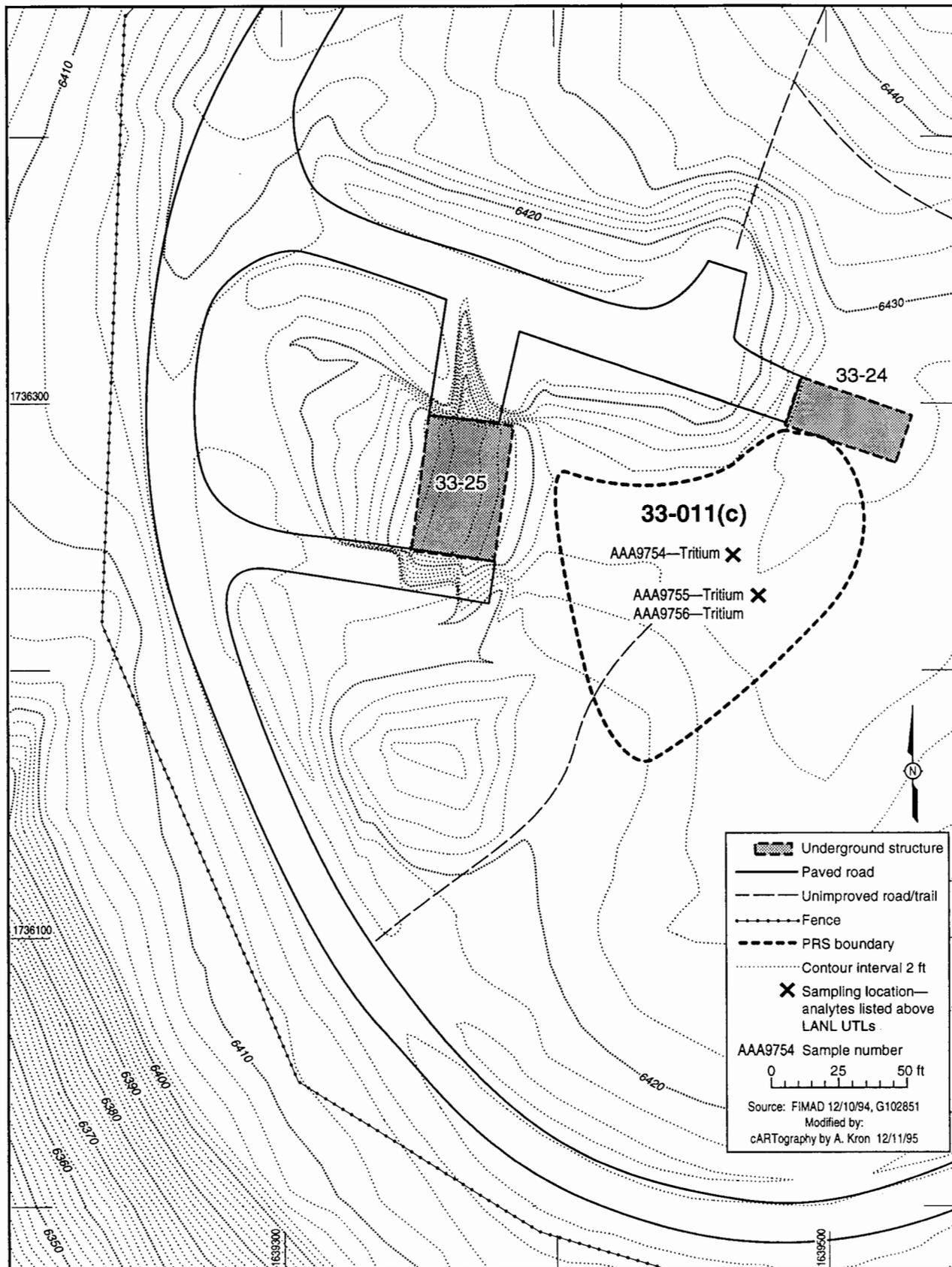


Fig. 5.16.4-1. South Site: PRS 33-011(c), blivit storage.

5.16.8 Ecological Assessment

5.16.8.1 Ecotoxicological Screening Assessment

This PRS will be included in EEU's defined for both ecological screening and ecological risk assessments. A site inspection of this PRS indicates that it will be adequately addressed in the EEU's.

5.16.8.2 Ecological Risk Assessment

No ecological risk assessment has been performed for this PRS. An ecological risk assessment will be evaluated when an approach is approved by regulators.

5.16.9 Extent of Contamination

Tritium contamination was far below SAL at the blivit area. Biased sampling was performed at this PRS to support a screening decision. No attempt was made to determine the extent of contamination.

5.16.10 Conclusion and Recommendation

Based on NFA Criterion 4, a Class III permit modification is requested to remove PRS 33-011(c) from the HSWA Module of LANL's RCRA operating permit.

- Sampling was performed at locations most likely to be contaminated with tritium.
- Tritium concentrations were far below regional backgrounds.

5.17 PRS 33-014 South Site Burn Pit

PRS 33-014 was a burn pit at South Site. Low levels of inorganics were detected and uranium was detected above SAL in one sample but is considered in sitewide uranium discussed in overlapping PRS 33-006(a), Section 5.5 of this RFI report. The burn pit is recommended for NFA.

5.17.1 History

PRS 33-014 is discussed in the RFI Work Plan for OU 1122, Subsections 3.4.2.9 and 4.4.3.1 (LANL 1992, 0784). A burn pit is not a pit, but a U-shaped soil-bermed area large enough to accommodate a dump truck. The berm is constructed of soil. No records or photos were found to describe the TA-33 burn pit; it is assumed to have been of standard design. The TA-33 burn

pit was probably established in 1950 when South Site was built and served the entire technical area. Various types of materials were burned, including wooden buildings, timbers, sawdust used in catcher boxes, black powder, etc. These materials may have been contaminated with uranium, beryllium, propellant powders, and high explosives (LANL 1990, 0145). The burn pit was demolished at an unknown time.

5.17.2 Description

The TA-33 burn pit was located on the crest of the low ridge on the east half of the South Site valley, about 300 ft north of the fence surrounding MDA E. The area has been scraped to bedrock, some is blackened from burning. Geophysical surveys conducted in 1989 by Weston personnel in the area of the suspected burn pit did not indicate the presence of a pit (LANL 1989, 02-020). The burn pit was located on a slight ridge north of the unused chambers at South Site. At demolition, the area was scraped to bedrock. Berming material from the pit appears to have been spread in PRS 33-010(g), at which a VCA pickup was performed in fiscal 1996.

5.17.3 Previous Investigations

Except for a 1989 geophysical survey searching for a pit, no previous investigations were conducted at this PRS. No pit was found.

5.17.4 Field Investigation

Sampling at PRS 33-014 was designed to detect maximum contamination using reconnaissance sampling. Five surface samples were collected in the location of the burn pit, including samples taken near charred bedrock (Figure 5.17.4-1). All samples were analyzed for inorganics, uranium, gamma emitters, and HE. One sample was analyzed for herbicides (Table 5.17.4-1).

TABLE 5.17.4-1
SUMMARY OF SAMPLES TAKEN FOR PRS 33-014

LOCATION ID	SAMPLE ID	DEPTH (ft)	MATRIX	INORGANICS	RADIO-NUCLIDES	HE ^a	HERBICIDES
33-1444	AAA9757	0-0.5	Soil	19264	19357	17733	NA ^b
33-1445	AAA9758	0-0.5	Soil	19264	19357	17733	NA
33-1446	AAA9759	0-0.5	Soil	19264	19357	17733	NA
33-1447	AAA9760	0-0.5	Soil	19264	19357	17733	17728
33-1333	AAA9792	0-0.5	Soil	19403	19360	17791	17771

^a HE = High explosives.

^b NA = Not analyzed.

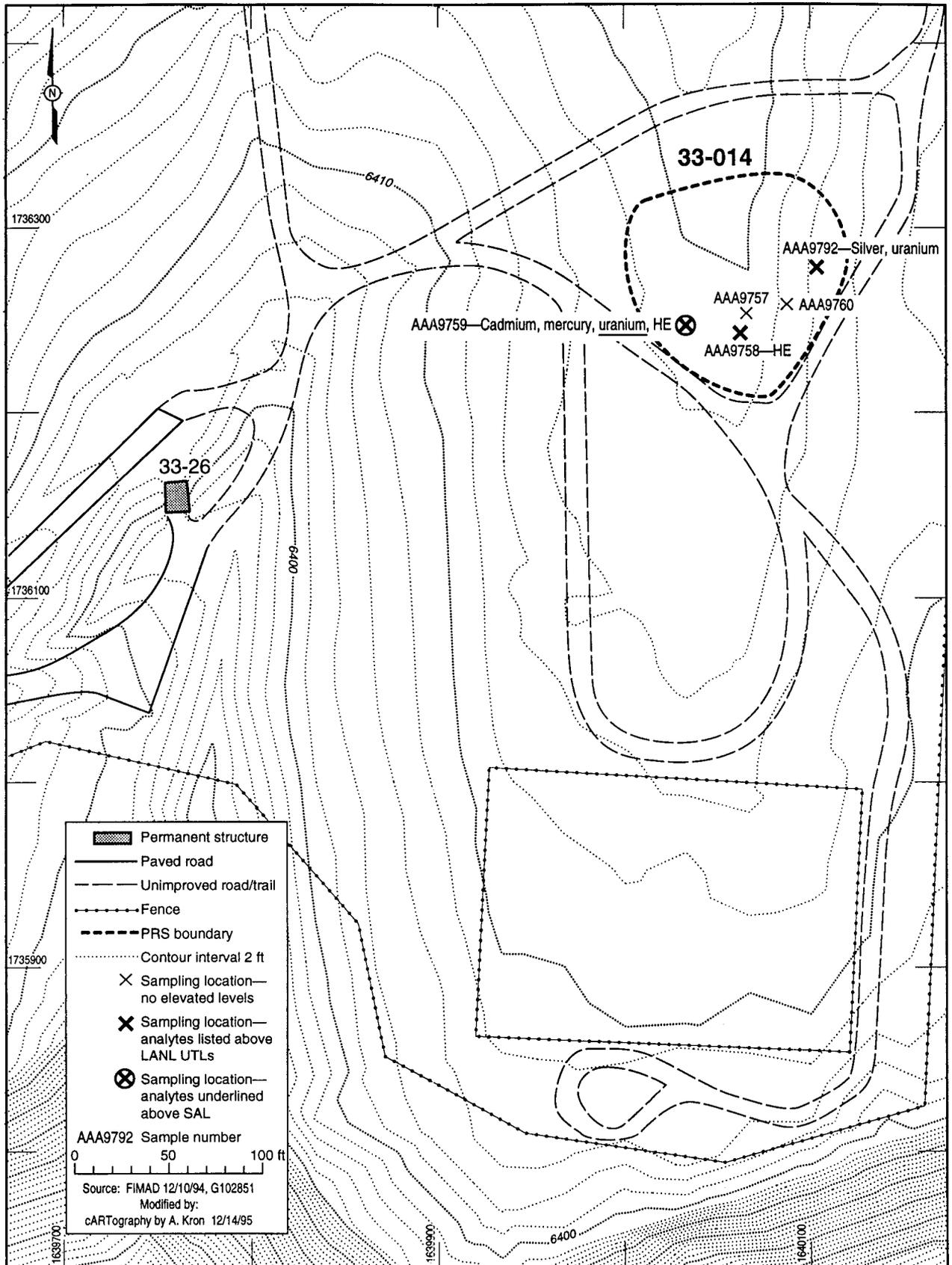


Fig. 5.17.4-1. South Site: PRS 33-014, burn pit.

5.17.5 Background Comparison

Cadmium, silver, and mercury were detected at PRS 33-014 (Table 5.17.5-1). Uranium above SAL (Table 5.17.5-2) is considered in the sitewide discussion of uranium in PRS 33-006(a) Section 5.5.9 of this RFI report. [PRS 33-006(a) is considered to cover the whole of South Site including PRS 33-014 (Figure 5.17.4-1.)]

TABLE 5.17.5-1

INORGANICS WITH CONCENTRATIONS GREATER THAN BACKGROUND UPPER TOLERANCE LIMITS FOR PRS 33-014

SAMPLE ID	DEPTH (ft)	CADMIUM (mg/kg)	MERCURY (mg/kg)	SILVER (mg/kg)
LANL UTL ^a	N/A ^b	2.7	0.1	NA ^c
TA-33 UTL	N/A	ND ^d	ND	ND
SAL ^e	N/A	38	24	380
AAA9759	0-0.5	9.8	0.14	<0.79
AAA9792	0-0.5	<0.89	<0.02	2.3

^a UTL = Upper tolerance limit.

^b N/A = Not applicable.

^c NA = Not analyzed.

^d ND = Not detected.

^e SAL = Screening action level.

TABLE 5.17.5-2

URANIUM WITH CONCENTRATIONS GREATER THAN BACKGROUND UPPER TOLERANCE LIMITS FOR PRS 33-014

SAMPLE ID	DEPTH (ft)	URANIUM (mg/kg)
LANL UTL ^a	N/A ^b	5.45
TA-33 UTL	N/A	4.12
SAL ^c	N/A	29
AAA9759	0-0.5	72.39 (J) ^d
AAA9792	0-0.5	7.88

^a UTL = Upper tolerance limit.

^b N/A = Not applicable.

^c SAL = Screening action level.

^d J = Estimated quantity.

5.17.6 Evaluation of Organics

No organics were detected except low levels of HE based on examination of HPLC scans. All HE results for PRS 33-014 were rejected. The HE for these surface samples have been reassigned to overlapping PRS 33-006(a), discussed in Section 5.5 of this RFI report.

5.17.7 Human Health Assessment

5.17.7.1 Screening Assessment

No chemical was detected above SAL at this PRS except uranium, is assigned to overlapping PRS 33-006(a) which covers the entire lower valley at South Site. Several samples have multiple constituents with results above background UTLs but below SALs. In all cases, MCE screening yields a value far less than the target limit of 1.

5.17.7.2 Risk Assessment

No risk assessment was performed for this PRS.

5.17.8 Ecological Assessment

5.17.8.1 Ecotoxicological Screening Assessment

This PRS will be included in EEU's defined for both ecological screening and ecological risk assessments. A site inspection of this PRS indicates that it will be adequately addressed in the EEU's.

5.17.8.2 Ecological Risk Assessment

No ecological risk assessment has been performed for this PRS. An ecological risk assessment will be evaluated when an approach is approved by regulators.

5.17.9 Extent of Contamination

Except for uranium, contamination was low-level and spotty at this PRS. Uranium contamination is addressed in overlapping PRS 33-006(a). Biased sampling was performed at this PRS to support a screening decision. No attempt was made to determine the extent of additional contamination.

5.17.10 Conclusion and Recommendation

Based on NFA Criterion 4, a Class III permit modification is requested to remove PRS 33-014 from the HSWA Module of LANL's RCRA operating permit.

- Sampling was performed at locations most likely to be contaminated.
- No chemicals were detected at hazardous levels. Although uranium was detected above SAL at this PRS, it is addressed in the South Site sitewide discussion of overlapping PRS 33-006(a) in Section 5.5 of this RFI report.

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APPENDIX A RAW DATA

Environmental Restoration raw data are available from the Facility for Information Management, Analysis, and Display (FIMAD). If FIMAD is not accessible, data will be provided upon request.

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APPENDIX B DATA QUALITY EVALUATION TABLES

1.0 INTRODUCTION

The following tables summarize the results of quality assurance/quality control (QA/QC) data validation for all analytical results used to support recommendations in this RFI report. The tables list the request number and report number associated with each sample delivery group submitted for analyses. The request numbers are referenced in Section 5 of this RFI report in the tables entitled Summary of Samples Taken provided with the description of the field investigation for each PRS.

Summaries are included for inorganic analyses (Table B-1); volatile organic analyses (VOA) in Table B-2; semivolatile organic analyses (SVOA) in Table B-4; high explosives analyses (Table B-4); herbicides, PCBs, and pesticides (Table B-5); and radiological analyses (Table B-6).

TABLE B-1

DATA QUALITY EVALUATION FOR INORGANIC ANALYSES AT TA-33

SUITE	REQUEST NUMBER	REPORT NUMBER	COMMENTS
Inorganics	14384	None	All analytes were under control. QA/QC criteria were met. The data are considered valid.
Antimony	17843	25940	The analyte was under control in the non-blind QC sample. QA/QC criteria were met. The data are considered valid.
Inorganics	17843	26560	All analytes were under control in the non-blind QC sample. QA/QC criteria were met. The data are considered valid. Three of eight analytes in PE ^a sample AAA9852 (barium, lead, zinc) were below lower control limits.
Arsenic Selenium	17843	26675	All analytes were under control in non-blind QC sample. QA/QC criteria were met. The data are considered valid. Units for matrix spike for arsenic and selenium are incorrect in FIMAD ^b . The reported recovery of 80% was acceptable.
Cyanide	18124	26239	This was liquid sample AAA9597 in septic tank of PRS 33-004(c). Analytes were under control in non-blind QC sample. QA/QC criteria were met. The data are considered valid.
Inorganics	18358	26793	QA/QC criteria were met. The data are considered valid. Units are reported incorrectly in FIMAD for sample AAB1205.

TABLE B-1 (CONTINUED)

DATA QUALITY EVALUATION FOR INORGANIC ANALYSES AT TA-33

SUITE	REQUEST NUMBER	REPORT NUMBER	COMMENTS
Inorganics	18590	27600	All analytes were under control in blind and non-blind QC samples. QA/QC criteria were met. The data are considered valid.
Arsenic Selenium	18590	28037	Analytes were under control in blind and non-blind QC samples. QA/QC criteria were met. The data are considered valid.
Antimony	18590	28099	The analyte was under control in blind and non-blind QC samples. QA/QC criteria were met. The data are considered valid.
Inorganics	18593	27547	Zinc was reported out of control in the QC blind sample. All other analytes were under control in non-blind QC sample. All other QA/QC criteria were met. The data are considered valid.
Arsenic Selenium	18593	28002	Selenium was reported out of control in the QC blind sample. All other QA/QC criteria were met. The data are considered valid.
Antimony	18593	28101	The analyte was under control in the non-blind QC sample. QA/QC criteria were met. The data are considered valid.
Inorganics	18616	27284	All analytes were under control in the non-blind QC sample. QA/QC criteria were met. The data are considered valid.
Inorganics	18616	27342	All analytes were under control in the non-blind QC sample. QA/QC criteria were met. The data are considered valid.
Arsenic, Selenium	18616	28031	Analytes were under control in blind and non-blind QC samples. The value of 12 mg/kg for sample AAA9710 was not reproduced in replicate analyses; the second value was 3 mg/kg. The discrepancy was ascribed to inhomogeneity of the sample. QA/QC criteria were met. The data are considered valid.
Antimony	18616	28100	The analyte was under control in non-blind QC sample. QA/QC criteria were met. The data are considered valid.
Cyanide	18837	28083	Analytes were under control in non-blind QC sample. QA/QC criteria were met. The data are considered valid.
Antimony, Lead	18837	28410	Analytes were under control in non-blind QC samples. In the sample AAA9601 matrix spike for antimony, the amount spiked was <2.5 µg/g; The amount recovered was 0.5 µg/g. For lead, the amount spiked was 2.5 µg/g; the amount recovered was 2 µg/g. The results were not qualified.

TABLE B-1 (CONTINUED)

DATA QUALITY EVALUATION FOR INORGANIC ANALYSES AT TA-33

SUITE	REQUEST NUMBER	REPORT NUMBER	COMMENTS
Inorganics	18837	28489	The replicate analysis of sample AAA9601 produced above background values for beryllium. Cadmium was not detected in the original analysis but was present (3.9 mg/kg) in the replicate. Nickel was also higher in the replicate. QA/QC criteria were met. The data are considered valid.
Arsenic, Selenium	18837	28797	A 20% recovery of 5 mg/kg arsenic and 300% recovery of 1 mg/kg selenium was reported for the spike of sample AAA9601. Replicated measurement for selenium was 0.6 mg/kg compared to original measurement of <0.3 mg/kg, so the recovery may have been overestimated.
Antimony	19095	28297	The analyte was under control in non-blind QC sample. QA/QC criteria were met. The data are considered valid.
Inorganics	19095	28343	Analytes were under control in non-blind QC sample. QA/QC criteria were met. The data are considered valid.
Arsenic Selenium	19095	28682	Analytes were under control in non-blind QC sample. QA/QC criteria were met. The data are considered valid.
Inorganics	19113	30921	The PE sample was out of control in eight of thirteen analytes. New samples were collected at three sampling points and were analyzed by a separate laboratory. Those data were used to make decisions at PRS 33-007(b). With the exception of arsenic, no results were above LANL background UTLs ^c in the original samples. Arsenic results were rejected in the original samples. Arsenic data from the resamples were used to make the decisions.
Inorganics	19128	30335	Copper and sodium were reported out of control in the QC blind. Copper, potassium, and sodium results are J-qualified ^d . A 0.4% recovery of cadmium was reported for the matrix spike of sample AAA9900.
Inorganics	19164	30380	All analytes were under control in non-blind QC sample. QA/QC criteria were met. The data are considered valid.
Inorganics	19253	31346	A <30% recovery of lead was reported in the matrix spike of sample AAA9643. Replicate analysis of sample AAA9657 produced elevated cadmium (2.36 mg/kg) where the original analysis was < 0.36 mg/kg. Also, 12.3 mg/kg of lead was reported in the replicate compared to 5.3 mg/kg in first analysis. The data were accepted at validation.

TABLE B-1 (CONTINUED)

DATA QUALITY EVALUATION FOR INORGANIC ANALYSES AT TA-33

SUITE	REQUEST NUMBER	REPORT NUMBER	COMMENTS
Inorganics	19254	31407	All analytes were under control in non-blind QC sample. QA/QC criteria were met. The data are considered valid.
Inorganics	19257	31309	The original result for lead in sample AAA9646 (326 mg/kg) was not replicated; the replicate result was 16 mg/kg. Both results were accepted at validation; a particulate lead distribution was hypothesized. QA/QC criteria were met. The data are considered valid.
Inorganics	19264	31466	All analytes were under control in the non-blind QC sample. QA/QC criteria were met. The data are considered valid.
Inorganics	19283	32262	All analytes were under control in the non-blind QC sample. QA/QC criteria were met. The data are considered valid.
Inorganics	19284	32201	All analytes were under control in the non-blind QC sample. QA/QC criteria were met. The data are considered valid.
Inorganics	19285	31310	The holding times for mercury were exceeded. Results for mercury at > detection limit are J-qualified, and results < detection limit are UJ-qualified ^e . All other analytes were under control in the non-blind QC sample. QA/QC criteria were met. The data are considered valid.
Inorganics	19320	34248	Silver recovery was 36% in the matrix spike of QA sample AAB1205. All other analytes were under control in the non-blind QC sample. QA/QC criteria were met. The data are considered valid.
Inorganics	19388	33908	Mercury results are UJ-qualified due to missed holding time. All analytes were under control in the non-blind QC sample.
Inorganics	19393	33831	Mercury results are UJ-qualified due to missed holding time. All analytes were under control in the non-blind QC sample. Cyanide holding time was exceeded. Sample results above detection limit are J-qualified; results below detection limits are UJ-qualified. All analytes were under control in the non-blind QC sample. QA/QC criteria were met. The data are considered valid.
Inorganics	19396	33906	Mercury results are UJ-qualified due to missed holding time. Sample results above detection limit are J-qualified; results below detection limits are UJ-qualified. All analytes were under control in the non-blind QC sample.

TABLE B-1 (CONTINUED)

DATA QUALITY EVALUATION FOR INORGANIC ANALYSES AT TA-33

SUITE	REQUEST NUMBER	REPORT NUMBER	COMMENTS
Inorganics	19399	33822	Mercury results are UJ-qualified due to missed holding time. Sample results above detection limit are J-qualified; results below detection limits are UJ-qualified. All analytes were under control in the non-blind QC sample.
Inorganics	19403	34061	Calcium and mercury results are J- and UJ-qualified. There was a 328% recovery of mercury in the matrix spike of sample AAA9877. However, sample AAA9877 is a PE sample, and the reference value for mercury is 4.7 mg/kg. The measured value of 6.6 mg/kg is slightly above recommended 95% control limits (3 to 6.4 mg/kg) in spite of being UJ-qualified.
Inorganics	19405	34018	Mercury results are UJ-qualified due to missed holding time. Sample results above detection limit are J-qualified; results below detection limits are UJ-qualified. All analytes were under control in the non-blind QC sample. The data are considered valid.
Cyanide	19569	31280	The sample missed holding time. The analyte was under control in non-blind QC sample. All other QA/QC criteria were met. The data are considered valid.
Inorganics	19569	31525	All analytes were under control in the non-blind QC sample. QA/QC criteria were met. The data are considered valid.
Antimony Lead	19569	31662	Analytes were under control in the non-blind QC sample. QA/QC criteria were met. The data are considered valid.
Arsenic Selenium	19569	31703	Analytes were under control in the non-blind QC sample. QA/QC criteria were met. The data are considered valid.
Inorganics	19640	31159	Selenium and mercury results were out of control in the QC blind. Selenium results for sample AAA9851 were rejected; chromium, copper, mercury, nickel, lead, and antimony results were J-qualified. However, this is a PE sample. Reported copper and mercury results are above suggested control limits but other results are acceptable. The data were accepted at validation.
Inorganics	19880	33383	Mercury results are UJ-qualified because of missed holding times. The original lead result for sample AAA9618 (38.9 mg/kg) was not replicated (12.5 mg/kg in replicate). Chromium results (9.5 mg/kg) was not replicated (4 mg/kg). These results were attributed to sample inhomogeneity. All other QA/QC criteria were met. The data are considered valid.

TABLE B-1 (CONTINUED)

DATA QUALITY EVALUATION FOR INORGANIC ANALYSES AT TA-33

SUITE	REQUEST NUMBER	REPORT NUMBER	COMMENTS
Inorganics	20384	34988	Mercury results are rejected and all other results are J-qualified because of missed holding times.

^a PE = Performance evaluation.

^b FIMAD = Facility for Information Management, Analysis, and Display.

^c UTLs = Upper tolerance limits.

^d J-qualified = Estimated.

^e UJ-qualified = Undetected. The quantitation limit is estimated.

TABLE B-2
DATA QUALITY EVALUATION FOR VOLATILE ORGANICS AT TA-33

SUITE	REQUEST NUMBER	REPORT NUMBER	COMMENTS
VOA ^a	17774	27772	Acetone (22-23 µg/L) was detected in two blanks. Some results for sample AAA9819 are UJ-qualified ^b because surrogate recovery was low.
VOA	17798	27853	Trace levels of acetone and methylene chloride were detected in the blank. QA/QC criteria were met. The data are considered valid.
VOA	17970	27856	All surrogates were in control. No contaminants were found in the blank. QA/QC criteria were met. The data are considered valid.
VOA	17992	27353	All surrogates were in control. No contaminants were found in the blank. QA/QC criteria were met. The data are considered valid.
VOA	18085	27855	All surrogates were in control. Acetone (16 µg/kg) and methylene chloride (13 µg/kg) were detected in the blank. QA/QC criteria were met. The data are considered valid.
VOA	18115	28581	All surrogates were in control. No contaminants were found in the blank. QA/QC criteria were met. The data are considered valid.
VOA	18353	28632	All surrogates were in control. No contaminants were found in the blank. QA/QC criteria were met. The data are considered valid.

^a VOA = Volatile organic analysis.

^b UJ-qualified = Undetected. The quantitation limit is estimated.

TABLE B-3

DATA QUALITY EVALUATION FOR SEMIVOLATILE ORGANICS AT TA-33

SUITE	REQUEST NUMBER	REPORT NUMBER	COMMENTS
SVOA ^a	17609	27613	Thirteen compounds were out of control in the QC blind. Dichlorobenzene and methylphenol results were rejected; several other compounds were UJ-qualified because of low blind recovery.
SVOA	17663	26382	Twelve compounds including phenol were out of control in the QC blind. Phenol was detected in the blank at 1.5 mg/kg. Low surrogate recoveries were reported for samples AAA9627 and AAA9628.
SVOA	17669	26430	Twelve compounds including phenol were out of control in the QC blind. Phenol was detected in blank at 1.5 mg/kg. Generally low surrogate recoveries were reported.
SVOA	17674	27629	Multiple compounds were out of control in two QC blinds. The data were not qualified.
SVOA	17764	26343	Bis(2-ethylhexyl)phthalate was detected in the blank at 1.5 mg/kg. One tentatively-identified compound was also detected. Results for m-benzidine were UJ-qualified because of low response during the continuing calibration.
SVOA	17774	27755	A 141% recovery of surrogate terphenyl-d14 from sample AAA9819 and low recoveries of other surrogates in samples AAA9819 and AAA9889 were reported.
SVOA	17798	28013	Pyrene, benzo[b]fluoranthene and phenanthrene were detected in the blank at less than 0.6 mg/kg. Other QA/QC criteria were met. The data are considered valid.
SVOA	17839	28676	Eleven compounds, including hexachloroethane, were out of control in the QC blind. Hexachloroethane results were rejected and several other compounds were UJ-qualified because spike recovery in the blank was less than 50%.
SVOA	17929	27558	QA/QC criteria were met. The data are considered valid.
SVOA	17970	27868	QA/QC criteria were met. The data are considered valid.
SVOA	17992	27292	Methylphenol was out of control in the QC blind. No data were qualified. Other QA/QC criteria were met. The data are considered valid.
SVOA	18061	28372	QA/QC criteria were met. The data are considered valid.
SVOA	18085	27915	Low surrogate recoveries occurred in sample AAA9605. No data were qualified. All other QA/QC criteria were met. The data are considered valid.

TABLE B-3 (CONTINUED)

DATA QUALITY EVALUATION FOR SEMIVOLATILE ORGANICS AT TA-33

SUITE	REQUEST NUMBER	REPORT NUMBER	COMMENTS
SVOA	18104	27971	Because of blank contamination of this analyte, di-n-butylphthalate was reported as undetected at 370 µg/kg in sample AAA9684. QA/QC criteria were met. The data are considered valid.
SVOA	18109	28533	Thirteen compounds were J-qualified ^c in sample AAA9672 because of low surrogate recovery.
SVOA	18115	28570	The samples were received at 11°C instead of 4°C. The laboratory was instructed to analyze the samples anyway. No results were qualified. EPA methods specify that samples for organic analyses should be preserved by storing the samples at 4°C +/-2 degrees. Based on acceptable QC performance, the data package was rated as acceptable.
SVOA	18353	28587	Bis(2-ethylhexyl)phthalate was detected in the blank at 19 µg/L in QA sample AAB1205. QA/QC criteria were met. The data are considered valid.

^a SVOA = Semivolatile organic analysis.

^b UJ-qualified = Undetected. The quantitation limit is estimated.

^c J-qualified = Estimated.

TABLE B-4

DATA QUALITY EVALUATION FOR HIGH EXPLOSIVES AT TA-33

SUITE	REQUEST NUMBER	REPORT NUMBER	COMMENTS
High explosives	17608	32186	Dinitrotoluene and nitrobenzene were out of control in the QC blind. Nitrobenzene and trinitrobenzene results were UJ-qualified ^a because of low spike recovery.
High explosives	17610	32674	All results were rejected because of missed holding time for extract analysis. All results were subsequently reviewed by focused validation.
High explosives	17665	32691	No results were qualified.
High explosives	17668	33216	No results were qualified.
High explosives	17676	35739	All results were J-qualified ^b because of missed holding time before extraction.
High explosives	17732	35623	Nitrobenzene and trinitrobenzene were out of control in one of two QC blinds. The surrogate was not recovered from the QC blank included with this request. Surrogate recovery was 140% for sample AAA9803; for other samples recovery was in the acceptable range of 108% to 124%. HMX and trinitrobenzene were UJ-qualified. Results for nitrotoluene, aminodinitrotoluenes, nitrobenzene and tetryl(methyltrinitrophenyl)nitramine) were rejected except for hits in samples AAA9804 and AAA9808, which were J-qualified.
High explosives	17733	36386	All results were rejected because of missed holding time for extract analysis. All results were subsequently reviewed by focused validation.
High explosives	17786	37602	Surrogate recoveries were less than 33% for all samples except sample AAA9772 (73%). All results were rejected, except results for sample AAA9772 which were J-qualified.
High explosives	17789	36387	Surrogate recovery was 140% for sample AAA9741. All results were rejected except for two detected analytes for sample AAA9741 which were J-qualified.
High explosives	17791	35782	Results for samples AAA9786, AAA9789, AAA9790, AAA9792, AAA9793, and AAA9891 were rejected because surrogate recoveries were below 50%. All others results were J-qualified. Surrogate recovery for sample AAA9785 was 155%.

TABLE B-4 (CONTINUED)

DATA QUALITY EVALUATION FOR HIGH EXPLOSIVES AT TA-33

SUITE	REQUEST NUMBER	REPORT NUMBER	COMMENTS
High explosives	17831	35550	Surrogate recovery for sample AAA9811 was 166%. All results were rejected because of missed extract holding time except for detected analytes, which were J-qualified and include 7 compounds for sample AAA9811 and 2 for sample AAA9813 (86% surrogate recovery). The laboratory could not separate the two isomers, 4-amino-2,6-dinitrotoluene and 2-amino-4,6 dinitrotoluene. When a detection occurred, it was reported for both of the isomers even though only one of the two isomers could be present.
High explosives	17839		No results were rejected.
High explosives	17840	36389	All results were rejected because of missed holding time for extract analysis. All results were subsequently reviewed by focused validation. Surrogate recoveries were below 50% except for samples AAA9765 and AAA9761.
High explosives	17844	36385	All results were rejected because of missed holding time for extract analysis. All results were subsequently reviewed by focused validation.
High explosives	18003	34985	All results were rejected because of missed holding time for extract analysis. All results were subsequently reviewed by focused validation.
High explosives	18005	36905	All results were J-qualified because surrogate recoveries were 140% and 122% respectively.
High explosives	18006	37023	Surrogate recovery for sample AAA9689 was 177%, and all other surrogate recoveries were above 108%. All results were J-qualified.
High explosives	18072	37029	All results were J-qualified. Surrogate recovery was 154% for sample AAA9714.
High explosives	18103	36845	Results for sample AAA9707 were rejected because of a 254% surrogate recovery. Recoveries were 156% for sample AAA9911 and above 105% for the remaining samples which were J-qualified.
High explosives	18112	34938	All results were rejected because of missed holding time for extract analysis. All results were subsequently reviewed by focused validation.

TABLE B-4 (CONTINUED)

DATA QUALITY EVALUATION FOR HIGH EXPLOSIVES AT TA-33

SUITE	REQUEST NUMBER	REPORT NUMBER	COMMENTS
High explosives	18119	37983	All results were J-qualified because of missed holding times for extraction.
High explosives	18355	36950	All results were rejected because of missed holding time for extract analysis. All results were subsequently reviewed by focused validation.
High explosives	18859	36823	Dinitrotoluene out of control in QC blind. All results were J-qualified.

^a UJ-qualified = Undetected, the quantitation limit is estimated.

^b J-qualified = Estimated.

TABLE B-5

**DATA QUALITY EVALUATION FOR HERBICIDES, PCBs, AND PESTICIDES
AT TA-33**

SUITE	REQUEST NUMBER	REPORT NUMBER	COMMENTS
Herbicides	17609	26927	QA/QC criteria were met. The data are considered valid.
Herbicides	17674	27669	Dinoseb results were UJ-qualified ^a because recovery from the QA blind sample was below 50%. All other analytes were under control
Herbicides	17728	27740	QA/QC criteria were met. The data are considered valid.
Herbicides	17770	27714	QA/QC criteria were met. The data are considered valid.
Herbicides	17771	27758	QA/QC criteria were met. The data are considered valid.
Herbicides	17798	27891	QA/QC criteria were met. The data are considered valid.
Herbicides	17897	32565	Holding times were exceeded for this request. Data were not qualified because all QC requirements were met.
Herbicides	17899	32475	QA/QC criteria were met. The data are considered valid.
Herbicide	18353	28645	QA/QC criteria were met. The data are considered valid.
PCBs Pesticides	17674	27622	The pesticide p,p'-DDT was out of control in the QC blind with only 46% surrogate recovery.
PCBs Pesticides	17728	27748	QA/QC criteria were met. The data are considered valid.
PCBs Pesticides	17774	27769	QA/QC criteria were met. The data are considered valid.
PCBs Pesticides	18353	28639	Because of a 7% surrogate recovery, all results were UJ-qualified.

^a UJ-qualified = Undetected, the quantitation limit is estimated.

TABLE B-6

DATA QUALITY EVALUATION FOR RADIOCHEMISTRY ANALYSIS AT TA-33

SUITE	REQUEST NUMBER	REPORT NUMBER	COMMENTS
Gamma spectroscopy	18756	29763	QA/QC criteria were met. The data are considered valid.
Total uranium	18758	30322	QA/QC criteria were met. The data are considered valid.
Isotopic uranium	18758	30327	QA/QC criteria were met. The data are considered valid.
Gamma spectroscopy	18758	30336	QA/QC criteria were met. The data are considered valid.
Isotopic uranium	18760	29765	Isotopic uranium results are J-qualified ^a because the amount of uranium in the sample overwhelmed the uranium-232 tracer. Results are clearly well above background. All data were accepted at validation.
Total uranium	18760	29767	QA/QC criteria were met. The data are considered valid.
Gamma spectroscopy	18760	29771	QA/QC criteria were met. The data are considered valid.
Gamma spectroscopy	19026	35067	Cesium-137 and radon-226 results were J-qualified because the laboratory control sample results were 67.6 and 71.8%, respectively, outside of the 80-120% contractual requirements.
Gamma spectroscopy	19076	30972	QA/QC criteria were met. The data are considered valid.
Isotopic uranium	19076	30973	QA/QC criteria were met. The data are considered valid.
Total uranium	19165	31492	The recovery of the matrix spike was 936%, significantly outside the 80-120% contract limit. Because the concentration of uranium in sample AAA9690 (392 mg/kg) was far greater than the spike concentration, the results were not qualified.
Gamma spectroscopy	19165	31493	QA/QC criteria were met. The data are considered valid.
Total uranium	19313	30080	QA/QC criteria were met. The data are considered valid.
Gamma spectroscopy	19313	30081	QA/QC criteria were met. The data are considered valid.

TABLE B-6 (CONTINUED)

DATA QUALITY EVALUATION FOR RADIOCHEMISTRY ANALYSIS AT TA-33

SUITE	REQUEST NUMBER	REPORT NUMBER	COMMENTS
Gamma spectroscopy	19352	31402	QA/QC criteria were met. The data are considered valid.
Total uranium	19352	31403	QA/QC criteria were met. The data are considered valid.
Total uranium	19354	30558	QA/QC criteria were met. The data are considered valid.
Gamma spectroscopy	19354	30568	QA/QC criteria were met. The data are considered valid.
Total uranium	19357	32058	The duplicate analysis of sample AAA9744 did not agree within 3-sigma of the original analysis; therefore, all uranium results were J-qualified.
Gamma spectroscopy	19357	32059	QA/QC criteria were met. The data are considered valid.
Soil moisture	19357	32060	QA/QC criteria were met. The data are considered valid.
Tritium	19357	32061	Tritium results for samples AAA9746, AAA9747, and AAA9749 are J-qualified. The samples were too dry for a sufficient quantity of soil moisture to be distilled for analysis. Several milliliters of water were added as a carrier to each sample. While this procedure did allow the recovery of tritium, it also diluted sample, causing the tritium activity per volume of soil moisture to be biased low.
Gamma spectroscopy	19358	33233	The reported results for cesium-137 and cobalt-60 for sample AAA9639 are -16.8 and -27.7 pCi/g. These results are highly negative because the software biased the calculated background level high. The reported value is J-qualified.
Total uranium	19358	33239	During data validation, results for samples AAA9638, AAA9642, AAA9643, and AAA 9644 were rejected because of questions of proper use of the dilution factor. No other results were qualified.
Gamma spectroscopy	19360	30700	QA/QC criteria were met. The data are considered valid.
Total uranium	19360	30702	During data validation, the uranium result for sample AAA9793 was adjusted upward by a factor of 10 (to 1.1 mg/kg) because of questions of proper use of the dilution factor. No results were qualified.
Total uranium	19361	30557	QA/QC criteria were met. The data are considered valid.

TABLE B-6 (CONTINUED)

DATA QUALITY EVALUATION FOR RADIOCHEMISTRY ANALYSIS AT TA-33

SUITE	REQUEST NUMBER	REPORT NUMBER	COMMENTS
Gamma spectroscopy	19352	31402	QA/QC criteria were met. The data are considered valid.
Total uranium	19352	31403	QA/QC criteria were met. The data are considered valid.
Total uranium	19354	30558	QA/QC criteria were met. The data are considered valid.
Gamma spectroscopy	19354	30568	QA/QC criteria were met. The data are considered valid.
Total uranium	19357	32058	The duplicate analysis of sample AAA9744 did not agree within 3-sigma of the original analysis; therefore, all uranium results were J-qualified.
Gamma spectroscopy	19357	32059	QA/QC criteria were met. The data are considered valid.
Soil moisture	19357	32060	QA/QC criteria were met. The data are considered valid.
Tritium	19357	32061	Tritium results for samples AAA9746, AAA9747, and AAA9749 are J-qualified. The samples were too dry for a sufficient quantity of soil moisture to be distilled for analysis. Several milliliters of water were added as a carrier to each sample. While this procedure did allow the recovery of tritium, it also diluted sample, causing the tritium activity per volume of soil moisture to be biased low.
Gamma spectroscopy	19358	33233	The reported results for cesium-137 and cobalt-60 for sample AAA9639 are -16.8 and -27.7 pCi/g. These results are highly negative because the software biased the calculated background level high. The reported value is J-qualified.
Total uranium	19358	33239	During data validation, results for samples AAA9638, AAA9642, AAA9643, and AAA 9644 were rejected because of questions of proper use of the dilution factor. No other results were qualified.
Gamma spectroscopy	19360	30700	QA/QC criteria were met. The data are considered valid.
Total uranium	19360	30702	During data validation, the uranium result for sample AAA9793 was adjusted upward by a factor of 10 (to 1.1 mg/kg) because of questions of proper use of the dilution factor. No results were qualified.
Total uranium	19361	30557	QA/QC criteria were met. The data are considered valid.

TABLE B-6 (CONTINUED)

DATA QUALITY EVALUATION FOR RADIOCHEMISTRY ANALYSIS AT TA-33

SUITE	REQUEST NUMBER	REPORT NUMBER	COMMENTS
Gamma spectroscopy	19469	30662	QA/QC criteria were met. The data are considered valid.
Total uranium	19469	30667	QA/QC criteria were met. The data are considered valid.
Total uranium	19471	30369	QA/QC criteria were met. The data are considered valid.
Gamma spectroscopy	19471	30371	QA/QC criteria were met. The data are considered valid.
Gamma spectroscopy	19472	30417	The cesium-137 result for sample AAA9767 is J-qualified because background subtraction resulted in a large negative value (-16 pCi/g). No other anomalies were noted.
Total uranium	19472	30427	QA/QC criteria were met. The data are considered valid.
Total uranium	19473	32896	QA/QC criteria were met. The data are considered valid.
Gamma spectroscopy	19473	32898	The analytical laboratory reported significant activities of cesium-137 and cobalt-60 in sample AAA9621. Review of the data showed that the results matched the activity and isotopic composition of the check source used as a laboratory control source. Therefore, no results were reported for this sample. No other anomalies were noted.
Total uranium	19977	32298	QA/QC criteria were met. The data are considered valid.
Gamma spectroscopy	19977	32299	QA/QC criteria were met. The data are considered valid.
Gamma spectroscopy	20173	33333	QA/QC criteria were met. The data are considered valid.

^a J-qualified = Estimated.

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APPENDIX C RISK ASSESSMENT CALCULATIONS

1.0 Risk Assessment for PRSs 33-006(a) and PRS 33-010(c)

A risk assessment was performed in accordance with the guidance presented in the Risk-Based Corrective Action Process document (ER Project Decision Support Council 1995, 02-111). Radionuclides are evaluated by comparing the estimated annual radiation dose to a target dose limit. Nonradionuclides are evaluated by comparison of estimated dose (noncarcinogens) or risks (carcinogens) to a target dose. Because this PRS is in an inactive area of TA-33, few human exposures are currently occurring. Because of the close proximity of this PRS to Bandelier National Monument, future exposures at PRS 33-010(c) are evaluated for the recreational trail user.

Appendix C contains supporting data and calculation methodology for PRSs 33-006(a), the South Site shot pad, and PRS 33-0010(c), a disposal area that received shot pad debris. Section 5.5 of this RFI report discusses PRS 33-006(a). Section 5.11 of this RFI report discusses PRS 33-010(c). At both PRSs, sampling and analysis indicated that uranium and copper are the only chemicals of concern. Both PRSs are considered in this assessment.

1.1 Analytical Results and Upper Confidence Limits

Table C-1 lists the sample results used to calculate upper confidence limits (UCL) for the risk assessment. Table C-2 presents the results of the calculations.

No separate risk assessment is performed for PRS 33-006(a) because the UCLs calculated for uranium (68.4 mg/kg) and copper (3194 mg/kg) are lower than that evaluated as the source term in the 33-010(c) analysis (81.5 mg/kg and 3760 mg/kg respectively).

1.2 Exposure Assessment

An exposure unit corresponding to a likely area of activity is traditionally defined in a risk assessment. In this case, however, it is more feasible to evaluate exposure within the actual bounds of the contaminated area rather than calculate a fraction of a pre-defined exposure area corresponding to the contaminated zone. This decision is based on the topography of the area which inhibits free access to a large, continuous area, and the sensitivity of radiological dose estimates to the true shape and area of the contaminated zone.

TABLE C-1
RESULTS USED FOR RISK ASSESSMENT CALCULATIONS
AT PRS 33-006(a) AND PRS 33-010(c)

USE ^a	PRS	SAMPLE	URANIUM	COPPER
	33-006a	AAA9772	11.54	183.0
	33-006a	AAA9773	3.76	11.1
	33-006a	AAA9776	2.74	8.8
	33-006a	AAA9782	14.14	39.2
	33-006a	AAA9783	1.18	10.0
	33-006a	AAA9786	8.25	539.0
	33-006a	AAA9787	52.41	2 500.0
	33-006a	AAA9788	30.44	300.0
	33-006a	AAA9789	4.20	1 320.0
	33-006a	AAA9790	3.12	25.6
	33-006a	AAA9791	23.34	23 300.0
	33-006a	AAA9792	7.88	18 100.0
	33-006a	AAA9794	35.24	409.0
	33-006a	AAA9795	90.94	1 140.0
	33-006a	AAA9796	208.85	3 180.0
	33-006a	AAA9798	6.05	58.7
	33-006a	AAA9799	58.50	3 340.0
	33-006a	AAA9800	84.33	1 210.0
	33-006a	AAA9801	26.66	41.0
	33-006a	AAA9802	9.69	40.2
	33-006a	AAA9803	1.20	33.0
	33-006a	AAA9806	6.05	91.5
	33-006a	AAA9807	3.93	69.8
	33-006a	AAA9808	1.27	11.5
	33-006a	AAA9809	15.05	5.5
	33-006a	AAA9891	678.30	1 330.0
	33-006a-dr	AAA9741	4.23	13.2
	33-006a-dr	AAA9742	407.12	27.5
	33-006a-dr	AAA9743	7.01	22.1
X	33-006a-dr	AAA9744	21.48	847.0
X	33-006a-dr	AAA9745	16.68	5 760.0

TABLE C-1 (CONTINUED)
RESULTS USED FOR RISK ASSESSMENT CALCULATIONS
AT PRS 33-006(a) AND PRS 33-010(c)

USE ^a	PRS	SAMPLE	URANIUM	COPPER
	33-006a-dr	AAA9746	13.51	817.0
	33-006a-dr	AAA9747	6.63	291.0
X	33-006a-dr	AAA9748	22.74	1 380.0
X	33-006a-dr	AAA9749	20.93	494.0
X	33-006a-dr	AAA9750	7.55	60.1
X	33-006a-dr	AAA9751	21.43	1 270.0
	33-007b	AAA9767	19.27	31.8
	33-007b-gm	AAA9761	12.19	27.1
	33-007b-gm	AAA9762	3.80	23.6
X	33-010c	AAA9713	54.80	NA ^b
X	33-010c	AAA9714	18.70	NA
X	33-010c	AAA9715	74.80	NA
X	33-010c	AAA9716	11.60	NA
X	33-010c	AAA9717	215.00	NA
X	33-010c	AAA9718	185.00	NA
	33-014	AAA9757	2.32	147.0
	33-014	AAA9758	1.14	31.6
	33-014	AAA9759	72.39	302.0
	33-014	AAA9760	3.86	1 450.0

^a All samples were used for assessment of risk due to surface contamination at 33-006(a).

X = Sample used for assessment of risk at 33-010(c).

^b NA = Not analyzed.

TABLE C-2
CALCULATIONS FOR RISK ASSESSMENT
AT 33-006(a) AND 33-010(c)

STATISTIC	PRS 33-006(a)		PRS 33-010(c) AND LOWER DRAINAGE	
	Uranium	Copper	Uranium	Copper
Number of samples	50	44	12	6
MVU ^a mean	46.1	1 758	51.4	1 852
MVU variance	13.3	854	16.8	1 071
95% UCL ^b for mean	68.4	3 194	81.5	3 760

^a MVU = Minimum variance unbiased.

^b UCL = Upper confidence limit.

Potential exposure pathways that are evaluated for recreational receptors hiking the trails in this area include ingestion of soil, dermal contact with soil, inhalation of fugitive dust, and exposure to external gamma radiation.

1.2.1 Estimation of Contaminant Intake

Intake of nonradioactive analytes (copper) is calculated in a deterministic manner as described in the Risk Assessment Guidance for Superfund document, Part A (EPA 1989, 0305). Radionuclides are evaluated using the RESRAD computer code, Version 5.6, developed for the DOE by Argonne National Laboratory. The RESRAD code provides output directly in the form of annual radiation dose as a function of the dose from the radionuclide of interest and its decay products.

Exposure frequency along the trail is assumed to be 50 days per year. Exposure time for the trail user along the approximately 50 ft portion of trail potentially intersecting the contaminated area is assumed to be 10 minutes per day, which corresponds to 2 daily walks. Exposure duration is assumed to be 9 years which corresponds to an upper-bound estimate on residence time in one location (EPA 1989, 0304). Exposure duration is relevant only to nonradionuclides, because radionuclide dose is calculated on an annual basis. The exposure parameters used in the calculation of intake for nonradionuclides are provided in Table C-3.

TABLE C-3

EXPOSURE PARAMETERS FOR NONRADIONUCLIDE CONTAMINANT INTAKE FOR PRS
33-010(c)

PARAMETER	ASSUMPTION	REFERENCE
Soil ingestion rate	100 mg/d	LANL 1993
Fraction of daily ingested soil for contaminated zone	0.1	BPJ ^a
Inhalation rate	2.1 m ³ /hr	LANL 1993
Absorption factor	0.01 for inorganics	EPA default
Adherence factor	0.2 mg/cm ²	EPA default
Surface area exposed	5 000 cm ²	EPA default
Exposure frequency	50 d/year	BPJ
Exposure time	10 min/d	BPJ
Exposure duration	9 year	LANL 1993
Body weight	70 kg	LANL 1993
Particulate emission factor	1E+07 m ³ /kg	LANL 1993

^a BPJ = Best professional judgment.

Intake of copper via soil ingestion is calculated according to Equation C-1.

$$Intake_{ing} = \frac{C_i \times IR_s \times CF \times FI \times EF \times ED}{BW \times AT}, \quad (C-1)$$

where,

$Intake_{ing}$ = intake from ingestion of chemical, *i*, in soil (milligrams per kilogram-day),

C_i = soil exposure concentration of chemical, *i* (milligrams per kilogram),

IR_s = soil ingestion rate (milligrams per day),

CF = conversion factor (10⁻⁶ kilograms per milligram),

FI = fraction from contaminated source, calculated using scenario specific exposure units (Section 3.2.4) (unitless),

EF = exposure frequency (days per year),

ED = exposure duration (years),

BW = body weight (kilograms), and

AT = averaging time (365 days per year x years).

Intake_{ing} for copper is calculated at 7.4E-05 mg/kg-day.

Intake of copper via inhalation of fugitive dust is calculated according to Equation C-2.

$$Intake_{inh} = \frac{C_i \times IR_a \times ET \times EF \times ED}{BW \times AT \times PEF} \quad , \quad (C-2)$$

where,

Intake_{inh} = intake from inhalation of chemical, i, in air (milligrams per kilogram-day),

C_i = concentration of chemical, i, in soil (milligrams per kilogram),

IR_a = inhalation rate (cubic meters per hour),

ET = exposure time (hours per day),

EF = exposure frequency (days per year),

ED = exposure duration (years),

BW = body weight (kilograms), and

AT = averaging time (365 days per year x years)

PEF = particulate emission factor (m³/kg)

Intake_{inh} for copper is calculated at 2.6E-07 mg/kg-day.

Intake of copper via dermal absorption is calculated according to Equation C-3.

$$Intake_{derm} = \frac{C_i \times CF \times ADF \times ABS \times EF_d \times ED \times SA_s}{BW \times AT} \quad , \quad (C-3)$$

where,

Intake_{derm} = absorbed dose from exposure to chemical, i, in soil (milligram per kilogram-day)

C_i = soil exposure concentration of chemical, i (milligrams per kilogram),

CF = conversion factor (10^{-6} kilograms/milligram),

ADF = adherence factor of soil to skin (milligrams per square centimeter per event),

ABS = absorption fraction (unitless, chemical-specific),

EF_d = exposure frequency for soil dermal contact (days per year),

ED = exposure duration (years),

SA = skin surface area available for soil contact (square centimeter),

BW = body weight (kilograms), and

AT = averaging time (365 days per year x years).

Intake_{derm} for copper is calculated at $7.4E-05$ mg/kg-day.

Although intake parameters are not provided for radionuclide contaminants, selected input parameters specific to the RESRAD code is provided in Table C-4. Copies of the summary RESRAD output files, including all input parameters, are provided in Attachment C-1 of this appendix.

TABLE C-4

SELECTED RESRAD CODE INPUT PARAMETERS FOR PRS 33-010(c)

PARAMETER	ASSUMPTION
Area of contaminated zone	1 500 m ²
Thickness of contaminated zone	3 m
Depth of uncontaminated cover soil,	0 m
Evapotranspiration coefficient	0.999 (RESRAD maximum)
Contaminated zone erosion rate	0 m/year
Soil ingestion rate	35 g/year
Inhalation rate	18 400 m ³ /year
Time fraction of year, indoors	0
Time fraction of year, outdoors	0.00665

1.3 Toxicity Assessment

The toxicity value used to evaluate noncarcinogenic effects for a contaminant is the reference dose (RfD). The RfD has been developed based upon 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 RfDs were utilized in this risk assessment because of the length of the exposure periods involved (9 years). EPA's Integrated Risk Information System (IRIS) and Health Effects Assessment Summary Tables were used to identify RfD values.

No RfD values for copper were located in these sources. An oral RfD for copper of 3.7E-02 mg/kg-day was adopted from the Region IX and Region III PRG tables. Copper is an essential element in human nutrition. A daily copper intake of 2 mg is considered to be adequate for health and normal copper metabolism. Limited data are available on the chronic toxicity of copper, however, chronic exposure may cause anemia.

The ratio of radionuclide exposure to dose is expressed as a dose conversion factor (DCF). DCFs used in this risk assessment are default values provided in the RESRAD code and are listed in the RESRAD summary output files in Attachment C-1 of this appendix. The RESRAD output files contain DCFs for the radionuclides identified as contaminants as well as DCFs for important daughters of the contaminants. Additional information regarding DCFs is provided in the Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0 (Yu et. al., 1993, 1177).

1.4 Risk and Dose Characterization

1.4.1 Copper

A hazard quotient (HQ) of unity is used to evaluate potential noncarcinogenic health risk from exposure to copper at this PRS. The HQ is calculated according to the following equation.

$$HQ = \frac{\text{Intake (mg/kg-d)}}{\text{RfD (mg/kg-d)}}$$

The HQ summed across all pathways for exposure to copper is 0.004, indicating that exposure by a trail user will not result in adverse noncarcinogenic health effects. The uncertainties associated with this risk is discussed in the next Section.

1.4.2 Radionuclides

Human health risks associated with radionuclides are evaluated in a dose-based manner. The RESRAD computer code, Version 5.6, was used to calculate committed effective dose for natural uranium. Dose contribution by daughter products is included in the dose estimates for the primary radionuclides. The calculated 95% UCL of 81.5 mg/kg was converted to isotopic concentrations in pCi/g assuming the following abundances and specific activities for natural uranium:

The calculated dose is compared to a 15 mrem/year dose level, which is the annual dose limit proposed in EPA's Radiation Site Cleanup Regulation, 40 CFR 196. The dose estimate for uranium at this PRS is 0.11 mrem/year, well below the annual dose limit proposed by EPA.

1.5 Assessment of Uncertainty

Uncertainty is inherent in many aspects of the risk assessment process and generally arises from a lack of knowledge concerning:

- site conditions;
- toxicology of the contaminants; and
- the degree to which an individual will be exposed to those contaminants as rejected in the exposure scenario.

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 much less. The assumptions that introduce the greatest amount of uncertainty and their effect on radiation 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.

1.5.1 Toxicology of Copper and Uranium

Limited data are available on the chronic toxicity of copper. The oral RfD used for this assessment was adopted from the EPA Region IX PRG data base, and the type of toxicity studies and uncertainty factors applied to calculate this toxicity criteria are unknown. Uncertainty factors account for the quality of available data and differences between study animals and human populations, and are designed to provide a conservative bias.

The DCFs used in the evaluation of radionuclide doses are associated with assumptions that contribute to uncertainty in dose estimates. Separate DCFs exist for internal and external exposure to radiation. DCFs do not evaluate the effects of radiation on children. Although external DCFs are applicable to both men and women, internal DCFs are based on radiation effects for an adult male. Gender differences which contribute to uncertainty in applying internal DCFs to women include potential differences in sensitivity of sexual organs and effects on offspring relating to pregnancy and lactation.

1.5.2 Exposure Characteristics

Risks associated with dermal exposure are likely biased in a conservative manner, because the adherence factor has not been corrected for exposure time in the contaminated area as was the daily soil ingestion rate, and the contaminants at this site are inorganic. Therefore, chronic dermal exposure to soil originating in the contaminated zone is unlikely.

1.6 Conclusions

The goal of this risk evaluation was to determine whether PRSs 33-010(c) and 33-006(a) pose a risk to human health or the environment or could be recommended for NFA. Based on the environmental data collected, the human health screening assessment identified two contaminants in soil, uranium and copper, that are present at concentrations greater than SALs. The results of the multiple chemical evaluations suggest that the presence of other chemicals in soil at concentrations below SALs should not result in adverse human health effects.

The human health risk assessment evaluated potential exposure to the contaminants by a trail user, which is the most likely exposure scenario. The proximity to Bandelier suggests that a recreational scenario is most likely. Quantitative estimates of risk (nonradionuclide) and dose (radionuclide) were calculated for the contaminants in soil. The results of the human health risk assessment suggest that potential exposure to copper and uranium in soil at these PRSs will not result in adverse noncarcinogenic health effects or an unacceptable radiation dose to trail users under RME conditions. The RME assumptions represent reasonable worst-case conditions, and should be evaluated at the upper bound of the dose range calculated within the constraints of the RESRAD model using the exposure assumptions presented.

2.0 REFERENCES

Environmental Restoration Assessments Council, in preparation. "Risk-Based Corrective Action Process" (draft), Los Alamos National Laboratory Report LA-UR-95-XXXX, Los Alamos, New Mexico. **(ER Assessments Council, in preparation, 02-111)**

Yu, C., A. J. Zielen, J. J. Cheng, Y.C. Yuan, L. G. Jones, D. J. LePoire, Y. Y. Wang, C. O. Loueiro, E. Gnanapragasam, E. Faillace, A. Wallo III, W. A. Williams, and H. Peterson, September 1993. "A Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0," ANL/EAD/LD-2, DOE/CH/8901, Environmental Assessment Division, Argonne National Laboratory, Argonne, Illinois. **(Yu et al. 1993, 1177)**

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**ATTACHMENT C-1 RESULTS OF RESRAD CALCULATIONS FOR URANIUM AT THE
PRS 33-010(c) EXPOSURE UNIT**

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Time = 1.000E+00	13
Time = 5.000E+00	14
Time = 1.000E+01	15
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Dose Conversion Factor (and Related) Parameter Summary
 File: DOSFAC.BIN

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ac-227+D	6.720E+00	6.720E+00	DCF2(1)
B-1	Pa-231	1.280E+00	1.280E+00	DCF2(2)
B-1	Pb-210+D	2.320E-02	2.320E-02	DCF2(3)
B-1	Ra-226+D	8.600E-03	8.600E-03	DCF2(4)
B-1	Th-230	3.260E-01	3.260E-01	DCF2(5)
B-1	U-234	1.320E-01	1.320E-01	DCF2(6)
B-1	U-235+D	1.230E-01	1.230E-01	DCF2(7)
B-1	U-238+D	1.180E-01	1.180E-01	DCF2(8)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ac-227+D	1.480E-02	1.480E-02	DCF3(1)
D-1	Pa-231	1.060E-02	1.060E-02	DCF3(2)
D-1	Pb-210+D	7.270E-03	7.270E-03	DCF3(3)
D-1	Ra-226+D	1.330E-03	1.330E-03	DCF3(4)
D-1	Th-230	5.480E-04	5.480E-04	DCF3(5)
D-1	U-234	2.830E-04	2.830E-04	DCF3(6)
D-1	U-235+D	2.670E-04	2.670E-04	DCF3(7)
D-1	U-238+D	2.690E-04	2.690E-04	DCF3(8)
D-34	Food transfer factors:			
D-34	Ac-227+D , plant/soil concentration ratio, dimensionless	2.500E-05	2.500E-05	RTF(1,1)
D-34	Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,2)
D-34	Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,3)
D-34				
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(2,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(2,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(2,3)
D-34				
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(3,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(3,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(3,3)
D-34				
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(4,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(4,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(4,3)
D-34				
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(5,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(5,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(5,3)
D-34				
D-34	U-234 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(6,1)
D-34	U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(6,2)
D-34	U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(6,3)
D-34				
D-34	U-235+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(7,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(7,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(7,3)
D-34				

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

Menu	Parameter	Current Value	Default	Parameter Name
D-34	U-238+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(8,1)
D-34	U-238+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(8,2)
D-34	U-238+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(8,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ac-227+D , fish	1.500E+01	1.500E+01	BIOFAC(1,1)
D-5	Ac-227+D , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(2,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(2,2)
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(3,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(3,2)
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(4,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(4,2)
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(5,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(5,2)
D-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC(6,1)
D-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(6,2)
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(7,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(7,2)
D-5	U-238+D , fish	1.000E+01	1.000E+01	BIOFAC(8,1)
D-5	U-238+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(8,2)

Site-Specific Parameter Summary:

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	1.500E+03	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	3.000E+00	2.000E+01	---	THICK0
R011	Length parallel to aquifer flow (m)	1.000E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	1.500E+01	3.000E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+01	---	TI
R011	Times for calculations (yr)	1.000E-01	1.000E+00	---	T(2)
R011	Times for calculations (yr)	5.000E-01	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+00	1.000E+01	---	T(4)
R011	Times for calculations (yr)	5.000E+00	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+01	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+01	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+02	1.000E+03	---	T(8)
R011	Times for calculations (yr)	1.000E+03	0.000E+04	---	T(9)
R011	Times for calculations (yr)	5.000E+03	0.000E+05	---	T(10)
R012	Initial principal radionuclide (pCi/g): U-234	2.900E+01	0.000E+00	---	S1(6)
R012	Initial principal radionuclide (pCi/g): U-235	1.300E+00	0.000E+00	---	S1(7)
R012	Initial principal radionuclide (pCi/g): U-238	2.720E+01	0.000E+00	---	S1(8)
R012	Concentration in groundwater (pCi/L): U-234	not used	0.000E+00	---	W1(6)
R012	Concentration in groundwater (pCi/L): U-235	not used	0.000E+00	---	W1(7)
R012	Concentration in groundwater (pCi/L): U-238	not used	0.000E+00	---	W1(8)
R013	Cover depth (m)	0.000E+00	0.000E+01	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+01	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-01	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.600E+00	1.500E+01	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	0.000E+00	1.000E-01	---	VCE
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TECZ
R013	Contaminated zone effective porosity	2.000E-01	2.000E-01	---	EPCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	4.400E+02	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	4.050E+00	5.300E+01	---	ECZ
R013	Humidity in air (g/cm**3)	not used	8.000E+01	---	HUMID
R013	Evapotranspiration coefficient	9.990E-01	5.000E-01	---	EWAPTR
R013	Precipitation (m/yr)	4.800E-01	1.000E+01	---	PRECIP
R013	Irrigation (m/yr)	0.000E+00	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	5.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+05	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-01	---	EPS
R014	Density of saturated zone (g/cm**3)	1.600E+00	1.500E+01	---	DENSAQ
R014	Saturated zone total porosity	3.000E-01	4.000E-01	---	TFSZ
R014	Saturated zone effective porosity	3.000E-01	2.000E-01	---	EPSZ
R014	Saturated zone hydraulic conductivity (m/yr)	1.000E+02	1.000E+01	---	HCSZ
R014	Saturated zone hydraulic gradient	2.000E-02	2.000E-01	---	HGWT
R014	Saturated zone b parameter	4.050E+00	5.300E+01	---	BSZ
R014	Water table drop rate (m/yr)	3.000E-03	1.000E-01	---	VWT
R014	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+01	---	WU

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Number of unsaturated zone strata	not used	1	---	NS
R015	Unsat. zone 1, thickness (m)	not used	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	not used	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	not used	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	not used	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	not used	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	not used	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for U-234				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(6)
R016	Unsat. zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(6,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.986E-07	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R016	Distribution coefficients for U-235				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(7)
R016	Unsat. zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(7,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.986E-07	ALEACH(7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(7)
R016	Distribution coefficients for U-238				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(8)
R016	Unsat. zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(8,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(8)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.986E-07	ALEACH(8)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(8)
R016	Distribution coefficients for daughter Ac-227				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCC(1)
R016	Unsat. zone 1 (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.491E-06	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for daughter Pa-231				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(2)
R016	Unsat. zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.986E-07	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC(3)
R016	Unsat. zone 1 (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.997E-07	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter Ra-226				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC (4)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU (4,1)
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS (4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.136E-07	ALEACH (4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK (4)
R016	Distribution coefficients for daughter Th-230				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC (5)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU (5,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS (5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	8.333E-10	ALEACH (5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK (5)
R017	Inhalation rate (m**3/yr)	1.840E+04	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	1.000E-04	2.000E-04	---	MLINH
R017	Dilution length for airborne dust, inhalation (m)	2.000E+00	3.000E+00	---	LM
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	7.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	0.000E+00	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	6.655E-03	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	-1.000E+00	1.000E+00	-1 shows non-circular AREA.	FS
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	1.000E+00	5.000E+01	---	RAD_SHAPE (1)
R017	Outer annular radius (m), ring 2:	2.500E+00	7.071E+01	---	RAD_SHAPE (2)
R017	Outer annular radius (m), ring 3:	5.000E+00	3.000E+00	---	RAD_SHAPE (3)
R017	Outer annular radius (m), ring 4:	1.000E+01	3.000E+00	---	RAD_SHAPE (4)
R017	Outer annular radius (m), ring 5:	2.000E+01	3.000E+00	---	RAD_SHAPE (5)
R017	Outer annular radius (m), ring 6:	0.000E+00	0.000E+00	---	RAD_SHAPE (6)
R017	Outer annular radius (m), ring 7:	0.000E+00	0.000E+00	---	RAD_SHAPE (7)
R017	Outer annular radius (m), ring 8:	0.000E+00	0.000E+00	---	RAD_SHAPE (8)
R017	Outer annular radius (m), ring 9:	0.000E+00	0.000E+00	---	RAD_SHAPE (9)
R017	Outer annular radius (m), ring 10:	0.000E+00	0.000E+00	---	RAD_SHAPE (10)
R017	Outer annular radius (m), ring 11:	0.000E+00	0.000E+00	---	RAD_SHAPE (11)
R017	Outer annular radius (m), ring 12:	0.000E+00	0.000E+00	---	RAD_SHAPE (12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	1.000E+00	1.000E+00	---	FRACA (1)
R017	Ring 2	1.000E+00	2.732E-01	---	FRACA (2)
R017	Ring 3	8.500E-01	0.000E+00	---	FRACA (3)
R017	Ring 4	2.000E-01	0.000E+00	---	FRACA (4)
R017	Ring 5	0.000E+00	0.000E+00	---	FRACA (5)
R017	Ring 6	0.000E+00	0.000E+00	---	FRACA (6)
R017	Ring 7	0.000E+00	0.000E+00	---	FRACA (7)
R017	Ring 8	0.000E+00	0.000E+00	---	FRACA (8)
R017	Ring 9	0.000E+00	0.000E+00	---	FRACA (9)
R017	Ring 10	0.000E+00	0.000E+00	---	FRACA (10)
R017	Ring 11	0.000E+00	0.000E+00	---	FRACA (11)
R017	Ring 12	0.000E+00	0.000E+00	---	FRACA (12)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R018	Fruits, vegetables and grain consumption (kg/yr)	not used	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	not used	1.400E+02	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+01	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E+01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	3.500E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	not used	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	not used	1.000E+00	---	FDW
R018	Contamination fraction of household water	0.000E+00	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	not used	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	not used	-1	---	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	not used	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	not used	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E-00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E-00	---	FGWHH
R019	Livestock water fraction from ground water	1.000E+00	1.000E-00	---	FGWLW
R019	Irrigation fraction from ground water	not used	1.000E-00	---	FGWIR
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-15	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-07	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	not used	1.400E-01	---	STOR_T(1)
STOR	Leafy vegetables	not used	1.000E-01	---	STOR_T(2)
STOR	Milk	not used	1.000E-01	---	STOR_T(3)
STOR	Meat and poultry	not used	2.000E-01	---	STOR_T(4)
STOR	Fish	not used	7.000E-01	---	STOR_T(5)
STOR	Crustacea and mollusks	not used	7.000E-01	---	STOR_T(6)
STOR	Well water	not used	1.000E-01	---	STOR_T(7)
STOR	Surface water	not used	1.000E-01	---	STOR_T(8)
STOR	Livestock fodder	not used	4.500E-01	---	STOR_T(9)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	2.000E-06	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	2.000E+00	2.000E+00	---	HMIX
R021	Average annual wind speed (m/sec)	3.000E+00	2.000E+00	---	WIND
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	code computed (time dependent)	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	code computed (time dependent)	DMFL
R021	Emanating power of Rn-222 gas	2.500E-01	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)

Summary of Pathway Selections

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

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	1500.00 square meters	U-234	2.900E+01
Thickness:	3.00 meters	U-235	1.300E+00
Cover Depth:	0.00 meters	U-238	2.720E+01

Total Dose TDOSE(t), mrem/yr
 Basic Radiation Dose Limit = 15 mrem/yr
 Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E-01	5.000E-01	1.000E+00	5.000E+00	1.000E+01	3.000E+01	1.000E+02	1.000E+03	5.000E+03
TDOSE(t):	1.116E-01	1.116E-01	1.116E-01	1.116E-01	1.116E-01	1.116E-01	1.117E-01	1.120E-01	1.183E-01	1.747E-01
M(t):	7.440E-03	7.440E-03	7.440E-03	7.440E-03	7.441E-03	7.442E-03	7.445E-03	7.464E-03	7.887E-03	1.165E-02

Maximum TDOSE(t): 1.747E-01 mrem/yr at t = 5.000E+03 years

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

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	6.299E-05	0.0006	4.457E-02	0.3994	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.912E-03	0.0171
U-235	5.164E-03	0.0463	1.862E-03	0.0167	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.085E-05	0.0007
U-238	1.887E-02	0.1691	3.737E-02	0.3349	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.704E-03	0.0153
===== Total	2.410E-02	0.2160	8.381E-02	0.7509	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.697E-03	0.0331

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

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.										
U-234	0.000E+00	0.0000	4.655E-02	0.4171										
U-235	0.000E+00	0.0000	7.106E-03	0.0637										
U-238	0.000E+00	0.0000	5.795E-02	0.5193										
===== Total	0.000E+00	0.0000	1.116E-01	1.0000										

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
 As mrem/yr and Fraction of Total Dose At t = 1.000E-01 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	6.299E-05	0.0006	4.457E-02	0.3994	3.599E-15	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.912E-03	0.0171
U-235	5.164E-03	0.0463	1.862E-03	0.0167	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.086E-05	0.0007
U-238	1.887E-02	0.1691	3.737E-02	0.3349	4.904E-21	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.704E-03	0.0153
===== Total	2.410E-02	0.2160	8.381E-02	0.7509	3.599E-15	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.697E-03	0.0331

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
 As mrem/yr and Fraction of Total Dose At t = 1.000E-01 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.										
U-234	0.000E+00	0.0000	4.655E-02	0.4171										
U-235	0.000E+00	0.0000	7.107E-03	0.0637										
U-238	0.000E+00	0.0000	5.795E-02	0.5193										
===== Total	0.000E+00	0.0000	1.116E-01	1.0000										

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
 As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	6.308E-05	0.0006	4.458E-02	0.3994	8.992E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.912E-03	0.0171
U-235	5.164E-03	0.0463	1.865E-03	0.0167	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.122E-05	0.0007
U-238	1.887E-02	0.1691	3.737E-02	0.3348	3.978E-17	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.704E-03	0.0153
Total	2.410E-02	0.2159	8.381E-02	0.7509	8.992E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.697E-03	0.0331

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
 As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.										
U-234	0.000E+00	0.0000	4.655E-02	0.4171										
U-235	0.000E+00	0.0000	7.110E-03	0.0637										
U-238	0.000E+00	0.0000	5.795E-02	0.5192										
Total	0.000E+00	0.0000	1.116E-01	1.0000										

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
 As mrem/yr and Fraction of Total Dose At $t = 1.000E+01$ years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	6.332E-05	0.0006	4.458E-02	0.3994	3.594E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.912E-03	0.0171
U-235	5.164E-03	0.0463	1.869E-03	0.0167	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.166E-05	0.0007
U-238	1.887E-02	0.1691	3.737E-02	0.3348	3.180E-16	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.704E-03	0.0153
===== Total	2.410E-02	0.2159	8.382E-02	0.7509	3.594E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.698E-03	0.0331

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
 As mrem/yr and Fraction of Total Dose At $t = 1.000E+01$ years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.										
U-234	0.000E+00	0.0000	4.656E-02	0.4171										
U-235	0.000E+00	0.0000	7.115E-03	0.0637										
U-238	0.000E+00	0.0000	5.795E-02	0.5192										
===== Total	0.000E+00	0.0000	1.116E-01	1.0000										

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
 As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	6.589E-05	0.0006	4.460E-02	0.3993	3.225E-10	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.912E-03	0.0171
U-235	5.167E-03	0.0463	1.897E-03	0.0170	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.389E-05	0.0008
U-238	1.887E-02	0.1690	3.737E-02	0.3347	8.567E-15	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.704E-03	0.0153
===== Total	2.411E-02	0.2159	8.387E-02	0.7510	3.225E-10	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.701E-03	0.0331

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
 As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.										
U-234	0.000E+00	0.0000	4.658E-02	0.4171										
U-235	0.000E+00	0.0000	7.148E-03	0.0640										
U-238	0.000E+00	0.0000	5.795E-02	0.5189										
===== Total	0.000E+00	0.0000	1.117E-01	1.0000										

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
 As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	9.455E-05	0.0008	4.466E-02	0.3989	3.546E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.915E-03	0.0171
U-235	5.186E-03	0.0463	2.053E-03	0.0183	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.423E-05	0.0003
U-238	1.887E-02	0.1686	3.738E-02	0.3339	3.148E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.705E-03	0.0152
===== Total	2.415E-02	0.2157	8.409E-02	0.7511	3.547E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.714E-03	0.0332

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
 As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.										
U-234	0.000E+00	0.0000	4.666E-02	0.4163										
U-235	0.000E+00	0.0000	7.333E-03	0.0653										
U-238	0.000E+00	0.0000	5.796E-02	0.5177										
===== Total	0.000E+00	0.0000	1.120E-01	1.0000										

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
 As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	2.826E-03	0.0239	4.540E-02	0.3838	3.117E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.031E-03	0.0172
U-235	5.458E-03	0.0461	4.324E-03	0.0365	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.385E-04	0.0020
U-238	1.886E-02	0.1594	3.745E-02	0.3166	2.856E-10	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.708E-03	0.0144
===== Total	2.714E-02	0.2294	8.718E-02	0.7369	3.120E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.977E-03	0.0336

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
 As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.										
U-234	0.000E+00	0.0000	5.026E-02	0.4249										
U-235	0.000E+00	0.0000	1.002E-02	0.0847										
U-238	0.000E+00	0.0000	5.802E-02	0.4904										
===== Total	0.000E+00	0.0000	1.183E-01	1.0000										

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
 As mrem/yr and Fraction of Total Dose At t = 5.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	4.251E-02	0.2433	4.880E-02	0.2793	4.789E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.532E-03	0.0202
U-235	6.602E-03	0.0378	1.387E-02	0.0794	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.451E-04	0.0048
U-238	1.900E-02	0.1088	3.780E-02	0.2164	2.454E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.730E-03	0.0099
Total	6.811E-02	0.3899	1.005E-01	0.5752	4.814E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.106E-03	0.0350

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
 As mrem/yr and Fraction of Total Dose At t = 5.000E+03 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.										
U-234	0.000E+00	0.0000	9.485E-02	0.5429										
U-235	0.000E+00	0.0000	2.132E-02	0.1220										
U-238	0.000E+00	0.0000	5.853E-02	0.3350										
Total	0.000E+00	0.0000	1.747E-01	1.0000										

*Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways
 Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Branch Fraction	DSR(j,t) (mrem/yr)/(pCi/g)									
			t= 0.000E+00	1.000E-01	5.000E-01	1.000E+00	5.000E+00	1.000E+01	3.000E+01	1.000E+02	1.000E+03	5.000E+03
U-234	U-234	1.000E+00	1.605E-03	1.605E-03	1.605E-03	1.605E-03	1.605E-03	1.605E-03	1.605E-03	1.604E-03	1.599E-03	1.575E-03
U-234	Th-230	1.000E+00	0.000E+00	3.538E-09	1.769E-08	3.538E-08	1.769E-07	3.538E-07	1.061E-06	3.535E-06	3.515E-05	1.713E-04
U-234	Ra-226	1.000E+00	0.000E+00	1.107E-12	2.768E-11	1.107E-10	2.766E-09	1.106E-08	9.922E-08	1.091E-06	9.589E-05	1.473E-03
U-234	Pb-210	1.000E+00	0.000E+00	4.065E-17	5.021E-15	4.001E-14	4.848E-12	3.733E-11	8.728E-10	2.131E-08	3.174E-06	5.129E-05
U-234	DSR(j)		1.605E-03	1.605E-03	1.605E-03	1.605E-03	1.605E-03	1.605E-03	1.606E-03	1.609E-03	1.733E-03	3.271E-03
U-235	U-235	1.000E+00	5.467E-03	5.467E-03	5.467E-03	5.467E-03	5.466E-03	5.466E-03	5.466E-03	5.466E-03	5.461E-03	5.439E-03
U-235	Pa-231	1.000E+00	0.000E+00	3.882E-08	1.941E-07	3.882E-07	1.941E-06	3.881E-06	1.164E-05	3.877E-05	3.837E-04	1.833E-03
U-235	Ac-227	1.000E+00	0.000E+00	3.099E-10	7.714E-09	3.069E-08	7.358E-07	2.797E-06	2.079E-05	1.359E-04	1.863E-03	9.129E-03
U-235	DSR(j)		5.467E-03	5.467E-03	5.467E-03	5.467E-03	5.469E-03	5.473E-03	5.499E-03	5.641E-03	7.708E-03	1.640E-02
U-238	U-238	1.000E+00	2.131E-03	2.131E-03	2.131E-03	2.131E-03	2.131E-03	2.131E-03	2.131E-03	2.130E-03	2.128E-03	2.120E-03
U-238	U-234	1.000E+00	0.000E+00	4.541E-10	2.271E-09	4.541E-09	2.271E-08	4.541E-08	1.362E-07	4.540E-07	4.530E-06	2.243E-05
U-238	Th-230	1.000E+00	0.000E+00	5.006E-16	1.251E-14	5.004E-14	1.251E-12	5.004E-12	4.503E-11	5.002E-10	4.981E-08	1.223E-06
U-238	Ra-226	1.000E+00	0.000E+00	1.609E-18	8.609E-18	1.091E-16	1.305E-14	1.043E-13	2.810E-12	1.033E-10	9.369E-08	8.051E-06
U-238	Pb-210	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.730E-17	2.680E-16	1.933E-14	1.690E-12	3.004E-09	2.783E-07
U-238	DSR(j)		2.131E-03	2.131E-03	2.131E-03	2.131E-03	2.131E-03	2.131E-03	2.131E-03	2.131E-03	2.133E-03	2.152E-03

Branch Fraction is the cumulative factor for the j'th principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
 The DSR includes contributions from associated (half-life 0.5 yr) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
 Basic Radiation Dose Limit = 15 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E-01	5.000E-01	1.000E+00	5.000E+00	1.000E+01	3.000E+01	1.000E+02	1.000E+03	5.000E+03
U-234	9.345E+03	9.345E+03	9.345E+03	9.345E+03	9.344E+03	9.344E+03	9.340E+03	9.322E+03	8.655E+03	4.586E+03
U-235	2.744E+03	2.744E+03	2.744E+03	2.744E+03	2.743E+03	2.741E+03	2.728E+03	2.659E+03	1.946E+03	9.146E+02
U-238	7.040E+03	7.040E+03	7.040E+03	7.040E+03	7.040E+03	7.040E+03	7.040E+03	7.040E+03	7.032E+03	6.970E+03

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
 and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
 at tmin = time of minimum single radionuclide soil guideline
 and at tmax = time of maximum total dose = 5.000E+03 years

Nuclide (i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
U-234	2.900E+01	5.000E-03	3.271E-03	4.586E+03	3.271E-03	4.586E+03
U-235	1.300E+00	5.000E-03	1.640E-02	9.146E+02	1.640E-02	9.146E+02
U-238	2.720E+01	5.000E-03	2.152E-03	6.970E+03	2.152E-03	6.970E+03

Individual Nuclide Dose Summed Over All Pathways
 Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr									
			t= 0.000E+00	1.000E-01	5.000E-01	1.000E+00	5.000E+00	1.000E+01	3.000E+01	1.000E+02	1.000E+03	5.000E+03
U-234	U-234	1.000E+00	4.655E-02	4.655E-02	4.655E-02	4.655E-02	4.655E-02	4.655E-02	4.654E-02	4.653E-02	4.637E-02	4.567E-02
U-234	U-238	1.000E+00	0.000E+00	1.235E-08	6.176E-08	1.235E-07	6.176E-07	1.235E-06	3.705E-06	1.235E-05	1.232E-04	6.102E-04
U-234	DOSE(j):		4.655E-02	4.655E-02	4.655E-02	4.655E-02	4.655E-02	4.655E-02	4.655E-02	4.654E-02	4.649E-02	4.628E-02
Th-230	U-234	1.000E+00	0.000E+00	1.026E-07	5.130E-07	1.026E-06	5.130E-06	1.026E-05	3.077E-05	1.025E-04	1.019E-03	4.968E-03
Th-230	U-238	1.000E+00	0.000E+00	1.362E-14	3.403E-13	1.361E-12	3.403E-11	1.361E-10	1.225E-09	1.361E-08	1.355E-06	3.326E-05
Th-230	DOSE(j):		0.000E+00	1.026E-07	5.130E-07	1.026E-06	5.130E-06	1.026E-05	3.077E-05	1.025E-04	1.021E-03	5.001E-03
Ra-226	U-234	1.000E+00	0.000E+00	3.211E-11	8.028E-10	3.211E-09	8.023E-08	3.207E-07	2.877E-06	3.164E-05	2.781E-03	4.273E-02
Ra-226	U-238	1.000E+00	0.000E+00	4.375E-17	2.342E-16	2.968E-15	3.549E-13	2.837E-12	7.644E-11	2.809E-09	2.548E-06	2.190E-04
Ra-226	DOSE(j):		0.000E+00	3.211E-11	8.028E-10	3.211E-09	8.023E-08	3.207E-07	2.877E-06	3.164E-05	2.783E-03	4.295E-02
Pb-210	U-234	1.000E+00	0.000E+00	1.179E-15	1.456E-13	1.160E-12	1.406E-10	1.083E-09	2.531E-08	6.179E-07	9.204E-05	1.488E-03
Pb-210	U-238	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.705E-16	7.290E-15	5.258E-13	4.598E-11	8.171E-08	7.570E-06
Pb-210	DOSE(j):		0.000E+00	1.179E-15	1.456E-13	1.160E-12	1.406E-10	1.083E-09	2.531E-08	6.179E-07	9.212E-05	1.495E-03
U-235	U-235	1.000E+00	7.106E-03	7.106E-03	7.106E-03	7.106E-03	7.106E-03	7.106E-03	7.106E-03	7.106E-03	7.099E-03	7.071E-03
Pa-231	U-235	1.000E+00	0.000E+00	5.046E-08	2.523E-07	5.046E-07	2.523E-06	5.046E-06	1.513E-05	5.040E-05	4.988E-04	2.382E-03
Ac-227	U-235	1.000E+00	0.000E+00	4.028E-10	1.003E-08	3.990E-08	9.566E-07	3.636E-06	2.702E-05	1.767E-04	2.422E-03	1.187E-02
U-238	U-238	1.000E+00	5.795E-02	5.795E-02	5.795E-02	5.795E-02	5.795E-02	5.795E-02	5.795E-02	5.795E-02	5.789E-02	5.766E-02

BRF(i) is the branch fraction of the parent nuclide.

Individual Nuclide Soil Concentration
 Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g											
			t= 0.000E+00	1.000E-01	5.000E-01	1.000E+00	5.000E+00	1.000E+01	3.000E+01	1.000E+02	1.000E+03	5.000E+03		
U-234	U-234	1.000E+00	2.900E+01	2.900E+01	2.900E+01	2.900E+01	2.900E+01	2.900E+01	2.900E+01	2.900E+01	2.900E+01	2.899E+01	2.889E+01	2.845E+01
U-234	U-238	1.000E+00	0.000E+00	7.695E-06	3.848E-05	7.695E-05	3.348E-04	7.695E-04	2.308E-03	7.693E-03	7.677E-02	3.802E-01		
U-234	S(j):		2.900E+01	2.900E+01	2.900E+01	2.900E+01	2.900E+01	2.900E+01	2.900E+01	2.900E+01	2.900E+01	2.897E+01	2.883E+01	
Th-230	U-234	1.000E+00	0.000E+00	2.611E-05	1.305E-04	2.611E-04	1.305E-03	2.610E-03	7.830E-03	2.609E-02	2.594E-01	1.264E+00		
Th-230	U-238	1.000E+00	0.000E+00	3.465E-12	8.659E-11	3.464E-10	8.659E-09	3.463E-08	3.117E-07	3.462E-06	3.448E-04	8.462E-03		
Th-230	S(j):		0.000E+00	2.611E-05	1.305E-04	2.611E-04	1.305E-03	2.610E-03	7.830E-03	2.609E-02	2.597E-01	1.273E+00		
Ra-226	U-234	1.000E+00	0.000E+00	5.655E-10	1.414E-08	5.654E-08	1.413E-06	5.646E-06	5.067E-05	5.571E-04	4.897E-02	7.524E-01		
Ra-226	U-238	1.000E+00	0.000E+00	7.704E-16	4.123E-15	5.226E-14	6.250E-12	4.996E-11	1.346E-09	4.946E-08	4.487E-05	3.856E-03		
Ra-226	S(j):		0.000E+00	5.655E-10	1.414E-08	5.654E-08	1.413E-06	5.646E-06	5.067E-05	5.572E-04	4.901E-02	7.562E-01		
Pb-210	U-234	1.000E+00	0.000E+00	5.906E-13	7.295E-11	5.813E-10	7.044E-08	5.424E-07	1.268E-05	3.096E-04	4.611E-02	7.453E-01		
Pb-210	U-238	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.357E-13	3.652E-12	2.634E-10	2.303E-08	4.094E-05	3.793E-03		
Pb-210	S(j):		0.000E+00	5.906E-13	7.295E-11	5.813E-10	7.044E-08	5.424E-07	1.268E-05	3.096E-04	4.615E-02	7.491E-01		
U-235	U-235	1.000E+00	1.300E+00	1.300E+00	1.300E+00	1.300E+00	1.300E+00	1.300E+00	1.300E+00	1.300E+00	1.300E+00	1.299E+00	1.294E+00	
Pa-231	U-235	1.000E+00	0.000E+00	2.747E-06	1.374E-05	2.747E-05	1.374E-04	2.747E-04	8.239E-04	2.744E-03	2.716E-02	1.297E-01		
Ac-227	U-235	1.000E+00	0.000E+00	4.376E-09	1.089E-07	4.335E-07	1.039E-05	3.950E-05	2.936E-04	1.919E-03	2.631E-02	1.289E-01		
U-238	U-238	1.000E+00	2.720E+01	2.720E+01	2.720E+01	2.720E+01	2.720E+01	2.720E+01	2.720E+01	2.720E+01	2.720E+01	2.717E+01	2.706E+01	

BRF(i) is the branch fraction of the parent nuclide.