TA-10

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Date: November 23, 2005
Refer to: ER2005-0885

Mr. James Bearzi
NMED – Hazardous Waste Bureau
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505-6303

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SUBJECT: RESPONSE TO THE NOTICE OF DISAPPROVAL FOR THE INVESTIGATION WORK PLAN FOR THE BAYO CANYON AGGREGATE AREA AND REVISION TO SAME

Dear Mr. Bearzi:

Enclosed please find two printed copies with electronic files of the response of the Los Alamos National Laboratory and the Department of Energy to the New Mexico Environment Department's Notice of Disapproval (NOD) of the "Investigation Work Plan for the Bayo Canyon Aggregate Area," dated October 20, 2005. This response includes replacement pages for the main text of the work plan. The appendices in the original work plan have not been changed. A table detailing the revisions to the original work plan and cross-referencing the numbered comments from the NOD letter is also included.

If you have questions, please contact Becky Coel-Roback at (505) 665-5011 (becky_cr@lanl.gov) or Bob Enz at (505) 667-7640 (renz@doeal.gov).

Sincerely,

David McInroy, Deputy Program Director
Environmental Remediation & Surveillance
Los Alamos National Laboratory

Sincerely,

for

David Gregory, Federal Project Director
Department of Energy
Los Alamos Site Office

3422

BCR/jk

Enclosures: 1) Two hard copies with electronic files — Response to the Notice of Disapproval for the "Investigation Work Plan for the Bayo Canyon Aggregate Area" including replacement pages for the main text of the work plan and crosswalk table (ER2005-0848)

Cy: (w/enc)
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T. Mortillaro, Los Alamos County (2 copies)
T. Taylor, DOE LASO (3 copies)
L. King, EPA Region 6 (electronic file only)
P. Reneau, ENV-ECR, MS M992 (electronic file only)
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Response to the Notice of Disapproval, Investigation Work Plan for the Bayo Canyon Aggregate Area, Los Alamos National Laboratory (LANL), Dated October 20, 2005

INTRODUCTION

This submittal is the response by Los Alamos National Laboratory (LANL or the Laboratory) to the "Notice of Disapproval, Investigation Work Plan for the Bayo Canyon Aggregate Area, Los Alamos National Laboratory (LANL)," issued by the New Mexico Environment Department (NMED) Hazardous Waste Bureau on October 20, 2005. The "Investigation Work Plan for Bayo Canyon Aggregate Area" (LANL 2005, 89659) was submitted by LANL to NMED in July 2005.

To facilitate review of these responses, NMED's comments are included verbatim. The comments are divided into general and specific categories as presented by NMED. LANL's responses follow each NMED comment. Table 1 details where revisions have been made to the work plan and cross-references NMED's comments. Attachment 1 contains the revised main text, figures, and tables of the work plan.

GENERAL COMMENTS

NMED Comment

1. *The Permittees must provide a brief description of investigation, sampling or analytical methods and procedures in documents submitted to NMED that includes sufficient detail to evaluate the quality of the acquired data in accordance with Section IX.A, Standard Operating Procedures, of the March 1, 2005 Consent Order (Consent Order). Table 5.0-1 is not sufficient to fulfill this requirement. (Submit replacement pages to NMED within 30 days of receipt of this letter.)*

LANL Response

1. LANL has revised Table 5.0-1 in accordance with Section IX.A, Standard Operating Procedures, of the March 1, 2005, Consent Order. The revised Table 5.0-1 is provided as part of the revised work plan that is included with this response.

NMED Comment

2. *According to the Aggregate Areas List; Maps of TAs, SWMUs/AOCs, dated August 2005 and referenced by ER2005-0226, SWMU 10-006 is located within the Bayo Canyon Aggregate Area. SWMU 10-006 has not been addressed in this Work Plan, an explanation for its exclusion has not been provided, and the Permittees have not proposed to address this site in a separate work plan. Therefore, the Permittees must include investigation of SWMU 10-006 as part of this Work Plan.*

LANL Response

2. LANL has revised the work plan to include Solid Waste Management Unit (SWMU) 10-006. No specific sampling is proposed because the location of this SWMU is unknown. The revised work plan states that if evidence of the location of SWMU 10-006 is identified as a result of the radiological and/or or geophysical surveys, sampling will be conducted based on the field data to define the nature and extent of contamination.

NMED Comment

3. *Figures must include all applicable features and structures, underground utilities, and existing well and/or borehole locations. This includes fence-lines, SWMU and AOC locations, and former structure locations. For example, Figure 4.2-2 (1994 RFI boreholes and proposed boreholes in the Central Area) does not depict the location of SWMUs 10-003(a) and 10-007. This information is necessary to evaluate if proposed borehole and sampling locations are adequate or if additional sampling locations are required. The Permittees must ensure these changes are also reflected in the Investigation Report. (Submit replacement pages to NMED within 30 days of receipt of this letter.)*

LANL Response

3. LANL has revised Figure 4.2-2 to show the location of SWMU 10-003(a) and the general area of SWMU 10-007. The figure also shows the locations of former lines, pits, and other pertinent structures. No active utilities are known to be located within the investigation area. The fenceline in the area, which is not pertinent to defining the nature and extent of contamination, is omitted to improve the clarity of the figure. Other figures show pertinent features appropriate to the scale of the drawing. The revised Figure 4.2-2 is provided as part of the revised work plan that is included with this response.

SPECIFIC COMMENTS

NMED Comment

1. Section 2.3 Relationship to Other SWMUs and AOCs, page 4:

Permittees' Statement: *"However, the upper portions of the Bayo Canyon may be impacted by the northern portion of the Los Alamos townsite. These potential impacts will not be addressed in this work plan."*

NMED Comment: *The Permittees must address the potential impacts of the Los Alamos townsite on upper Bayo Canyon as part of this Work Plan. Townsite impacts to Bayo Canyon must be addressed in order to fully understand the total risk associated with sites at the LANL Facility as the risk from the townsite may make human health or ecological risk unacceptable within the Bayo Canyon Aggregate Area. (Submit replacement pages to NMED within 30 days of receipt of this letter.)*

LANL Response

1. LANL has revised section 2.3 to note that the impacts of the Los Alamos townsite on upper Bayo Canyon are addressed in the North Canyons work plan (LANL 2001, 71060, p. 7-11), which was delivered to the NMED on September 21, 2001, and approved on July 19, 2005.

NMED Comment

2. Section 4.2.1 Borehole Sampling, Page 17-18:

NMED Comment: *The boreholes proposed by the Permittees are not sufficient to meet the objectives outlined in the executive summary of this Work Plan. There are SWMUs missing from Figure 4.2-4 (See general comment 3) and there are no proposed investigation activities (i.e. boreholes, surface/subsurface sampling) for several SWMUs/AOCs (e.g. 10-003(h)) in the Work Plan. The*

Permittees must complete the additional boreholes in the approximate locations proposed by NMED as shown on Figure 1 attached (19 proposed boreholes) as well as propose borehole locations for SWMUs 10-003(a) and 10-008. Finally, sites that have not received an NFA determination from the RCRA Administrative Authority (i.e., NMED or EPA), must be evaluated and/or investigated as part of the Work Plan.

LANL Response

2. LANL will add the 19 additional boreholes identified by NMED in the attachment to the notice of disapproval (NOD). Two of these additional boreholes, located north of SWMU 10-003(a), will help to define the nature and extent of contamination in the vicinity of SWMU 10-003(a). LANL also will add four shallow sampling locations (Figure 4.2-4) to improve the spatial distribution of sample data across the Bayo Canyon Aggregate, which will further define the nature and extent of contamination around SWMU 10-008. In addition, samples will be collected at SWMU 10-006 if its location is determined (see response to General Comment #2).

NMED Comment

3. Section 4.3 Preliminary Corrective Action Evaluation for TA-I0, Pages 18-21:

NMED Comment: *The Order required the Permittees to evaluate the need for removal of the landfill material at 10-007 for disposal at an approved landfill. This section of the Work Plan satisfies this requirement. However, NMED reminds the Permittees that this investigation is preliminary and is not necessarily considered a final remedy for SWMU 10-007 and AOC 10-009. NMED may still require removal of landfill material or some other remedy in the future.*

LANL Response

3. LANL acknowledges the above comment.

NMED Comment

4. Table 4.0-1 Crosswalk between Consent Order and Investigation Work Plan, IV.C.5.c.iii Technical Area 10 Drilling Explorations, Pages 49-50:

NMED Comment: *Previous boreholes drilled at SWMUs 10-002(b), 10-004(b), and the leach field may not be used to satisfy the borehole requirements of Section IV.C.5.c.iii of the Order. The Permittees must advance the number of boreholes at each site as required in the Order or by NMED. According to the NOD issued by EPA dated May 19, 1997, the RFI data had numerous QA/QC problems, and therefore cannot be used in lieu of current drilling and sampling requirements. The RFI data may be used to guide sampling activities; however, it may not be used to make decisions regarding nature and extent of contamination or in the risk assessment. (See specific comment #2 regarding borehole locations).*

LANL Response

4. LANL will revalidate the data from SWMUs 10-002(b), 10-004(b), and the leach field [SWMU 10-003(n)] to current standards for data usability. Based on the results of the revalidation, LANL will use the data for screening and planning purposes or for decision-making purposes, as appropriate. Data that do not meet quality requirements will not be used for the purposes of decision-making or calculating site risk. As noted in our response to Specific Comment #2, LANL will add 19

additional boreholes, per the NOD. These additional boreholes along with the boreholes proposed in the work plan satisfy the requirements of the Consent Order. Table 4.0-1 of the investigation work plan has been revised to include the additional boreholes.

Table 1
NMED Comment Cross Reference

Comment Number	Summary of NMED Comment	Location in Original Report	Revision Location	Nature of Revision
General Comment 1	LANL must provide a brief description of investigation, sampling, and analytical procedures	Table 5.0-1	Revised Table 5.0-1, p. 56	Revised according to previously accepted format
General Comment 2	SWMU 10-006 was not included in the work plan. Discussion of SWMU 10-006 must be included in the revised work plan.	Not applicable	Revised Table 4.2-1, p. 54 – Executive Summary, p. v – Section 1.0, p. 2 – Section 4.1, p. 16	Added 10-006 to Table 4.2-1. Included SWMU 10-006 discussion – Executive Summary – Section 1.0 (Last Paragraph) – Section 1.1 – Section 4.1
General Comment 3	LANL shall revise the figures to identify all SWMUs and the utilities that may impact the investigation of Bayo Canyon.	Figures 2.5-3, 4.2-2, and 4.2-4	Revised Figures 2.5-3 (p. 40), 4.2-2 (p. 45), and 4.2-4 (p. 47) (attached)	Added missing 10-003(a) Corrected location of 10-003(d, m) Noted approximate location of 10-007 (locations of known structures are shown)
Specific Comment 1	The permittees must address the potential impacts of the Los Alamos townsite on upper Bayo Canyon.	Section 2.3	Section 2.3, p. 4	Added specific reference to the North Canyons Work Plan
Specific Comment 2	The boreholes presented by the permittees are not sufficient to meet the objectives outlined in the executive summary of the WP.	Sections 4.2.1 and Figures 4.2-2 and Figure 4.2-4	Revised Figures 4.2-1 (p. 44), 4.2-2 (p. 45), and 4.2-4 (p. 47) (attached)	Added 19 boreholes to section 4.2.1 and Figure 4.2-2 Added 4 shallow sample locations to Figure 4.2-4
Specific Comment 3	NMED statement that characterization of the landfills and the preferred alternative may not be the final solution for SWMUs 10-007 or 10-009.	Section 4.3, pp. 18–21	Not applicable	No response required
Specific Comment 4	Previously drilled boreholes at SWMUs 10-002(b), 10-004(b), and the 10-003(n) leach field may not be used for decision-making or risk-calculation purposes.	Tables 4.0-1 and 4.2-1	Section 4.2.1, p. 17, Table 4.0-1, p. 49, Table 4.2-1, p. 54	LANL will drill additional boreholes. The text has been revised to change number of boreholes (see specific comment #2). Table 4.0-1 has been revised to include additional borehole locations. Table 4.2-1 has been revised to reflect the increase in the number of boreholes and samples. [Note that the data from SWMUs 10-002(b), 10-004(b) and 10-003(n) will be revalidated to the current standards and used as appropriate.]

Attachment 1

Revised Main Text, Figures, and Tables

LA-UR-05-4761
July 2005
ER2005-0300

Investigation Work Plan for the Bayo Canyon Aggregate Area

Updated November 2005

Los Alamos
NATIONAL LABORATORY
EST. 1943

CD included with this document

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This document contains data on radioactive materials, including source, special nuclear, and by-product material. The management of these materials is regulated under the Atomic Energy Act and is specifically excluded from regulation under the Resource Conservation and Recovery Act and the New Mexico Hazardous Waste Act. Information on radioactive materials and radionuclides, including the results of sampling and analysis of radioactive constituents, is voluntarily provided to the New Mexico Environment Department in accordance with U.S. Department of Energy policy.

Prepared by
Environmental Stewardship Division–
Environmental Remediation and Surveillance Program

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LA-UR-05-4761
ER2005-0300

Investigation Work Plan for the Bayo Canyon Aggregate Area

July 2005

Responsible project leader:

Printed Name	Signature	Title	Organization	Date
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Responsible UC representative:

Printed Name	Signature	Title	Organization	Date
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Responsible DOE representative:

Printed Name	Signature	Title	Organization	Date
David Gregory	for	Federal Project Director	DOE-LASO	28 JULY 05

EXECUTIVE SUMMARY

This investigation work plan prescribes characterization activities for the Bayo Canyon Aggregate Area at Los Alamos National Laboratory. This area includes Consolidated Units 10-001(a)-99 and 10-002(a)-99, Solid Waste Management Unit (SWMU) 10-004(a), SWMU 10-006, and Areas Of Concern (AOCs) C-10-001 and 10-009, located in Bayo Canyon within Technical Area (TA) 10, 0.5 mi. west of the Los Alamos County Sewage Treatment Plant. Three additional sites, AOCs 00-008 and 00-026 and SWMU 00-011(d), are also included in the Bayo Canyon Aggregate Area but are not addressed in this work plan. AOCs 00-008 and 00-026 have been approved for no further action by the U.S. Environmental Protection Agency, and SWMU 00-011(d) is being addressed in the Guaje/Barrancas/Rendija Aggregate Area work plan. SWMU 10-006 was withdrawn from a 1995 NFA proposal in 2002 because of uncertainties related to its location and assumed status. Since this SWMU's location is unknown, no specific sampling has been identified for this site. However, if evidence of this site is discovered during field activities (geophysical and radiological surveys), sampling will be conducted at SWMU 10-006.

TA-10 was used as a firing site from 1943 through 1961, and the area and all related structures were constructed to test assemblies that contained conventional high explosives, including components made from depleted or natural uranium, and radioactive diagnostic sources. The former facilities of most concern for this investigation are the radiochemistry laboratory, the associated liquid waste disposal system, and the firing pads.

This investigation work plan has the following two primary objectives: (1) to prescribe additional investigation activities necessary to complete the characterization of contamination associated with the TA-10 consolidated units, SWMUs, and AOCs, and (2) to prescribe the collection of additional data necessary to support the selection of a corrective action. This work plan explicitly identifies data required to meet these objectives and the requirements of the Compliance Order on Consent signed by the New Mexico Environment Department, the U.S. Department of Energy, and the Regents of the University of California on March 1, 2005. Prescribed investigation activities include geodetic, geophysical, and radiological surveys; borehole drilling and sampling; and surface and shallow subsurface sampling.

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1.0 INTRODUCTION

Los Alamos National Laboratory (LANL or the Laboratory) is a multidisciplinary research facility owned by the U.S. Department of Energy (DOE) and managed by the University of California. The Laboratory is located in north-central New Mexico, approximately 60 mi northeast of Albuquerque and 20 mi northwest of Santa Fe. The Laboratory covers 40 sq mi of the Pajarito Plateau, which consists of a series of finger-like mesas separated by deep canyons containing perennial and intermittent streams running from west to east. Mesa tops range in elevation from 6200 ft to 7800 ft above sea level.

The Laboratory's Environmental Stewardship (ENV) Division–Environmental Remediation and Surveillance (ERS) Program is participating in a national effort by DOE to clean up sites and facilities formerly involved in weapons research and development. The goal of ENV-ERS is to ensure that past operations under DOE do not threaten human or environmental health and safety in and around Los Alamos County, New Mexico. To achieve this goal, ENV-ERS is currently investigating sites potentially contaminated by past Laboratory operations. These sites under investigation are designated as SWMUs or AOCs.

This investigation work plan prescribes investigation activities for SWMUs and AOCs in the Bayo Canyon Aggregate Area. The sites addressed in this investigation work plan contain both hazardous and radioactive components. The New Mexico Environment Department (NMED) has authority under the New Mexico Hazardous Waste Act (NMHWA) over the cleanup of hazardous waste or hazardous constituents, including the hazardous waste portion of mixed waste (i.e., waste contaminated with both radioactive and hazardous constituents). DOE has authority over the cleanup of radioactive contamination. Radionuclides are regulated under DOE Orders 5400.5, "Radiation Protection of the Public and the Environment," and 435.1, "Radioactive Waste Management."

NMED enforces requirements for the investigation and cleanup activities at the Laboratory through the Compliance Order on Consent (hereafter, the Consent Order) signed by NMED, DOE, and the Regents of the University of California on March 1, 2005. The Consent Order specifies the conditions and requirements for the investigation and cleanup activities at the Laboratory performed by ENV-ERS. In accordance with the Consent Order, the nature and extent of releases of hazardous waste or hazardous constituents are investigated through the Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) process.

AOC 00-008 was a former surface disposal area containing building debris that came from a demolished weather hutment called "Point Weather." The hutment was located on Kwage Mesa and was used in connection with shots fired in Bayo Canyon. No laboratory testing activities were conducted on North or Kwage Mesa (LANL 1992, 07668, p. 6-2). This site was proposed for no further action (NFA) in the Operational Unit (OU) 1071 RFI work plan in 1992 (LANL 1992, 07668). The work plan, including the NFA proposal, was approved by the U.S. Environmental Protection Agency (EPA) in January 1994 (Davis 1993, 15113). This NFA decision was later reviewed and confirmed by EPA (King 2005, 88464). AOC 00-008 is now considered "administratively complete" and will not be discussed further in this plan.

AOC 00-026 is known as the "Gun Mount Landfill" because it may contain a buried gun mount, radio poles, and hutments located on North Mesa (LANL 1992, 07668, p. 6-5). This site was proposed for NFA in the OU 1071 RFI work plan in 1992 (LANL 1992, 07668). The work plan, including the NFA proposal, was approved by EPA in January 1994 (Davis 1993, 15113). This NFA decision was later reviewed and confirmed by EPA (King 2005, 88464). AOC 00-026 is now considered "administratively complete" and will not be discussed further in this plan.

Solid Waste Management Unit (SWMU) 00-011(d) was a firing range in a small north-trending tributary of Bayo Canyon. The site operated from 1944 to 1948 and was recommended for NFA on March 1, 1994. It will be addressed in the Guaje/Barrancas/Rendija Aggregate Area work plan, and there is no further discussion of this site in this document.

SWMU 10-006 may consist of various locations where burning operations at Technical Area (TA) 10 were conducted, primarily in the 1950s and early 1960s. Uranium-238 solutions were deposited on plywood and burned in 1955; the fate of the resultant ash is unknown. As decommissioning of TA-10 progressed, many structures were burned in place or in other locations within TA-10. Open-burning records are incomplete and details about location, type of materials, and ash disposition are unknown. Because of the possibility of elevated radioactivity in the ash, the ash likely was transported either to MDA C at TA-50 or to MDA G at TA-54. Contaminants associated with open burning could have included uranium, strontium-90, and high explosives (HE). Because the location of the burn pits is unknown, the Laboratory has not developed a specific sampling plan for SWMU 10-006. However, if observations made during field work (e.g., geophysical and radiological surveys) at Consolidated Unit 10-001(a)-99 identify the location of SWMU 10-006 or indicate the possibility of a release associated with this SWMU, additional samples specifically targeting SWMU 10-006 will be collected.

1.1 General Site Information

The Bayo Canyon Aggregate Area consists of the lower central portion of Bayo Canyon at TA-10 and three mesa-top sites as described in section 1.0. The rationale for the consolidation of Consolidated Units 10-001(a)-99 and 10-002(a)-99 was based on the operational history, waste streams, geographical proximity, transport mechanisms, and on the investigation required to assess contamination (LANL 1999, 63175). Two of the mesa-top sites (AOCs 00-008 and 00-026) are administratively complete and the third [00-011(d)] is being addressed in another work plan (Guaje/Barrancas/Rendija Aggregate Area). The remainder of this document deals specifically with the investigation of the TA-10 sites within Bayo Canyon. All further discussion in this work plan will refer to TA-10.

1.2 Objectives

This investigation work plan has the following two primary objectives: (1) to prescribe additional investigation activities necessary to complete the characterization of contamination associated with the TA-10 consolidated units, SWMUs, and AOCs, and (2) to prescribe the collection of additional data necessary to support the selection of a corrective action.

2.0 BACKGROUND

2.1 Site Description and Operational History

TA-10 is located in the bottom of the central portion of Bayo Canyon, between Kwage Mesa to the south and Otowi Mesa to the north, approximately 0.5 mi. west of the Los Alamos County Sewage Treatment Plant (Figure 2.1-1). Bayo Canyon is located at an elevation of approximately 6000 to 6740 ft above sea level and slopes to the southeast at an approximate 3% grade. The TA-10 area is at an elevation of approximately 6600 to 6700 ft above sea level; the elevations of adjacent mesa tops range from about 7000 to 7100 ft above sea level. The upper portions of the canyon walls are vertical or near-vertical cliffs cut into the upper Tshirege Member of Bandelier Tuff. The canyon floor is mainly cut into the lower Otowi Member of Bandelier Tuff and is overlain with 1 to 6 ft of colluvium on which a sandy soil has developed. A narrow, braided stream channel with low banks runs through the center of the canyon and is underlain

with Quaternary stream alluvium (LANL 1996, 54491, p. 3). According to findings during a 1994 drilling operation in Bayo Canyon, the alluvium ranges from approximately 30 to 45 ft below ground surface (bgs). In many areas, the upper 5 to 15 ft of alluvium has been reworked, displaced, backfilled, and mixed with construction debris during the construction, decontamination, and decommissioning activities that took place while the site was operational (LANL 1996, 54491, p. 36). Vegetation is a mix of grass, sagebrush, chamisa, and pine trees.

TA-10 was used as a firing test site from 1943 through 1961, and the area and all related structures were constructed to test assemblies that contained conventional HE, including components made from depleted or natural uranium. The principal structures associated with TA-10 were a radiochemistry laboratory (TA-10-1), two assembly buildings (TA-10-10 and TA-10-12), an inspection building (TA-10-8), a personnel building (TA-10-21), and structures at two detonation control complexes (TA-10-13 and TA-10-15) and adjacent firing pads (Figures 2.1-2 and 2.1-3). Formerly, TA-10 also included various ancillary facilities associated with waste disposal, particularly for the radiochemistry laboratory. Associated facilities included sanitary and radioactive liquid waste sewage lines, manholes, septic tanks, seepage pits, and solid radioactive waste disposal pits (Mayfield 1979, 11717, p. 12).

TA-10 now consists of 27 SWMUs and 2 AOCs (Figures 2.1-4 and 2.1-5). The area underwent extensive decontamination and decommissioning (D&D), including razing all structures. D&D activities began in 1960 and were completed in 1963; all explosive testing ceased in 1961. After D&D, the site was released to Los Alamos County in 1967 but has remained under DOE administrative control. An RFI was conducted in 1994, followed by a voluntary corrective action (VCA) in 1995. Interim actions (IAs) were conducted in 1994 and 1997. These actions included further remediation and the establishment of stormwater and site-access controls. The IA results indicated that any remaining metal (from shrapnel) posed a low level of risk to human health (LANL 1996, 54491, p. 36).

Consolidated Unit 10-001(a)-99 represents the consolidation of SWMUs 10-001(a–e), 10-005, and AOCs 10-001(e) and 10-008. AOC 10-008 was not discovered until a 1994 IA to address shrapnel in Bayo Canyon (LANL 1997, 56660, p. 1). Samples from this site were included in the 1994 RFI (LANL 1996, 54332). In accordance with the RFI results, all the SWMUs that made up the TA-10 firing sites (including SWMU 10-005) were recommended for NFA.

Consolidated Unit 10-002(a)-99 consists of SWMUs 10-002(a, b), 10-003(a–o), 10-004(b), and 10-007 that were once part of a liquid disposal complex. This complex served the radiochemistry laboratory at TA-10, and waste was discharged to leach fields and pits. The entire area underwent D&D in 1963 (Blackwell 1963, 04751), and SWMU 10-007 was created as a building debris landfill where any remaining materials from the D&D activity were placed. This SWMU was in the footprint created by the excavation of solid waste disposal pits (containing radioactive, inorganic, and organic chemicals) used by the radiochemistry laboratory from 1945 to 1950. The wastes were removed and the pits backfilled with the uncontaminated shot pad building debris and site soil during the 1963 D&D activities. SWMUs 10-003(a–o) consisted of the bulk of the liquid disposal complex, including liquid disposal pits, industrial waste manholes and septic tanks, industrial waste lines, and a leach field that served the radiochemistry laboratory. SWMU 10-004(b) was a reinforced-concrete sanitary septic tank that served the radiochemistry laboratory between 1944 and 1963 and may have received liquid waste from radiochemistry laboratory operations as well. The tank was removed during D&D activities in 1963. The 1996 RFI report for TA-10 recommended NFA for SWMUs 10-002(a) and (b). However, for SWMUs 10-003(a) and 10-007, the RFI results generated an IA. The IA was conducted in February 1997 and included sample collection, installation of stormwater control measures, and the construction of an exclusion zone to minimize the potential for exposure to humans and other animals.

SWMU 10-004(a) was a former 1060-gal. septic tank (structure TA-10-40) that discharged to a pit with associated lines to an outfall located in a stream channel northeast of SWMU 10-002(a). The tank served the personnel building (TA-10-21) from 1949 through 1963 and was removed during the 1963 D&D activities. It is not known whether the 4-in.-diameter tile drain and the soil surrounding the outfall were removed as well. A 1994 RFI recommended this SWMU for NFA.

AOC C-10-001 is within the area associated with SWMU 10-001(a)-99, and consisted of two radioactive (strontium-90) soil contamination areas. These areas were bulldozed during 1963 D&D activities and were rediscovered during shrapnel-removal operations in 1994. A VCA was conducted in 1995 to excavate the radioactive soil and restore the site with clean fill material.

AOC 10-009 is a former landfill that contained materials such as asbestos siding, heavy-gauge and coaxial cable, glass laboratory equipment, and other debris. The EPA was notified of a new SWMU in May 1995, and the site was fenced off until further investigation.

A more detailed description of the sites and their histories is presented in the historical investigation report (HIR) for TA-10 (LANL 2005, 89658).

2.2 Land Use

TA-10 was transferred to Los Alamos County in 1967 but remains under DOE administrative control. Bayo Canyon is currently open to the public and used for recreational activities. However, the area encompassing the central liquid disposal complex [SWMUs 10-003 (a–o)] has been posted with monuments to prohibit excavation before the year 2142. Chainlink fences exist around the two debris landfills (SWMU 10-007 and AOC 10-009). The fence around 10-003(a–o) is also posted as a soil contamination area. The current and reasonably foreseeable future land use is recreational.

2.3 Relationship to Other SWMUs and AOCs

Bayo Canyon is geographically isolated from the current Laboratory. No other SWMUs are located near the TA-10 portion of Bayo Canyon. The upper portions of Bayo Canyon may be impacted by the northern portion of the Los Alamos townsite. These potential impacts will be addressed in the North Canyons investigation report. The work plan for North Canyons (LANL 2001, 71060) was submitted to NMED on September 21, 2001, and approved on July 19, 2005.

2.4 Conceptual Model

A conceptual model for TA-10 has been developed to focus site characterization efforts. The sampling prescribed in this work plan is based principally on the conceptual model and should ensure complete characterization of the site's nature and extent of contamination. The conceptual exposure model includes potential contaminant source areas, contaminant transport mechanisms, and potential human receptors of contaminant exposures. The conceptual model for the consolidated units, SWMUs, and AOCs at TA-10 is summarized graphically in Figure 2.4-1.

2.4.1 Potential Contaminant Sources

The conceptual site model includes both surface and subsurface potential sources of contamination, as follows:

- Surface—widely dispersed contamination associated with explosives testing at the firing sites and detonation pile, the septic system outfall, and the exposed portions of the debris landfills.
- Subsurface—residual contamination remaining after the D&D of multiple site structures, the debris landfills, releases from the radiological laboratory's acid waste handling system (including planned discharges from infiltration pits and leaks from lines and tanks), and releases from site septic systems (including planned releases from leach fields and leaks from lines and tanks).

2.4.2 Potential Contaminant Transport Mechanisms

Potential transport mechanisms that may lead to the exposure of potential receptors include

- dissolution and/or particulate transport of surface contaminants from precipitation and runoff,
- airborne transport of contaminated surface soils or particulates,
- continued dissolution and advective/dispersive transport of chemical and radiological contaminants contained in subsurface soil and bedrock, and
- biotic perturbation and/or translocation of contaminants in subsurface contaminated media.

2.4.3 Potential Contaminant Receptors

Current potential receptors of surface contamination include site remediation workers at former TA-10 and recreational users in Bayo Canyon. Potential receptors for subsurface contamination include potential groundwater users; however, no perched water has been encountered in the area of TA-10 and current unsaturated conditions limit vertical migration. If subsurface materials are excavated and brought to the surface, potential receptors of subsurface contamination will be the same as those listed for surface contamination.

2.5 Previous Investigation and Remediation Activities

The following sections provide a summary of previous environmental investigations and remediation activities conducted by the Laboratory at the individual SWMUs and AOCs within the aggregate area. The TA-10 HIR (LANL 2005, 89658) presents a detailed description of past activities at the sites, including operational and pre-RFI sampling, which are not covered in the following summary.

2.5.1 Previous Investigation Activities

Figures 2.5-1 through 2.5-4 show the locations of RFI sampling conducted within TA-10. The TA-10 HIR (LANL 2005, 89658) provides a summary of RFI sampling results. The RFIs, VCAs, and IAs performed at TA-10 are discussed below.

2.5.1.1 Consolidated Unit 10-001(a)-99

Two RFIs were conducted at SWMUs in this consolidated unit, one in June 1994 and the other in October and November 1994. The June 1994 RFI was conducted at SWMUs 10-001(a–d) to determine if residual

hazardous constituents existed in surface deposits near the firing pads and to confirm that no human health or ecological risk was attributable to the radiological constituents identified in previous investigations (Ford, Bacon & Davis Utah, Inc. 1981, 08032). The activities included collecting 145 surface soil and stream sediment samples at 93 locations (Figure 2.5-1). These samples were collected in the portions of the canyon floor that were possibly impacted by testing activities. In October and November 1994, RFI sampling was conducted at SWMU 10-005 (Figure 2.5-2). AOCs 10-008 and 10-001(e) were characterized using data collected from the surface sampling for SWMUs 10-001 (a–d). All the investigations targeted possible subsurface releases of strontium-90, total uranium, lead, beryllium, barium, inorganic chemicals, and HE. The RFIs included geodetic, radiological, and geophysical surveys. In accordance with the RFI results, NFA was recommended for SWMUs 10-001(a), 10-001(b), 10-001(c), 10-001(d), 10-001(e) (LANL 1995, 49974, p. v), 10-005 (LANL 1996, 54332, p. 103), and AOC 10-008 (LANL 1997, 56660, p. 27).

2.5.1.2 Consolidated Unit 10-002(a)-99

This consolidated unit consists of SWMUs 10-002(a), 10-002(b), 10-003 (a–o), 10-004(b), and 10-007. The Laboratory conducted an RFI from May through November 1994, which targeted possible subsurface contamination at these SWMUs. Investigation activities included geodetic surveys, radiological surveys, geophysical surveys, drilling, and subsurface sampling. In all, 269 samples were collected from 67 locations (see HIR Figure 3.2-1 [LANL 2005, 89658]). In accordance with the RFI results, the Laboratory recommended NFA for SWMUs 10-002(a), 10-002(b), and 10-004(b) (LANL 1996, 54332, p. ii). The NFA recommendation was based on investigation data indicating that the sites were adequately characterized in accordance with applicable state and federal regulations and that the sites posed no unacceptable risk under current and projected land use. At SWMU 10-003(a–o), the Laboratory identified the potential for an unacceptable risk because of the concentrations of strontium-90 present. The Laboratory planned and implemented an IA (discussed below) in accordance with this finding. SWMU 10-007 has not been investigated.

2.5.1.3 SWMU 10-004(a)

The Laboratory conducted an RFI at SWMU 10-004(a) in September and October 1994. A total of 31 subsurface samples were collected at 8 locations (see HIR Figure 3.2-3 [LANL 2005, 89658]). Samples were analyzed for inorganic chemicals, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), total uranium, HE, and strontium-90. In accordance with the RFI results, NFA was recommended (LANL 1996, 54332, p. 90).

2.5.1.4 AOC C-10-001

AOC C-10-001 consists of two areas in Bayo Canyon where the Laboratory discovered elevated radiation levels during routine shrapnel-removal operations in 1994 (see HIR Figure 3.2-5 [LANL 2005, 89658]). At one area, the elevated radiation levels were associated with a single piece of shrapnel, which was removed from the site (LANL 1996, 54491, p. 5). At the other area, soil contaminated with strontium-90, possibly bulldozed onto the location during D&D operations, was found. In response, the Laboratory planned and implemented a VCA (discussed below).

2.5.1.5 AOC 10-009

AOC 10-009 is a debris landfill discovered during routine surface shrapnel characterization activities in Bayo Canyon. The Laboratory notified EPA of the new SWMU in May 1995 and fenced the site, pending further investigation.

2.5.2 Previous Remediation Activities

2.5.2.1 Consolidated Unit 10-001(a)-99

In addition to the structural removals conducted during D&D operations in the early 1960s, the Laboratory removed contaminated soils associated with structures and the shot pads. The Laboratory also removed shrapnel from the site by hand.

2.5.2.2 Consolidated Unit 10-002(a)-99

This area underwent D&D from 1960 through 1963. All above-ground and subsurface structures were removed or excavated. The Laboratory conducted the IA at Consolidated Unit 10-002(a)-99 in February 1997. The IA objectives were to minimize the exposure of receptors to strontium-90 contamination until the implementation of a final remedy and to reduce the potential for the migration of contaminants in soil and plant litter by stormwater runoff.

A soil contamination area was established around the site to limit access; the area is defined by a locked chainlink fence with signs declaring “Soil Contamination Area” posted every 30 ft along the fence (LANL 1997, 55889, p. 12). Stormwater control measures include a silt fence constructed inside the exclusion zone fence along the northern and eastern parts of the site to trap soil or debris that might be transported by sheet flow. In addition, straw bales were placed along the edge of a channel that emerges from a culvert along the western part of the site to prevent a potential high-discharge storm event from flowing onto the site. The last best management practice inspection was in 2001 when the site was declared stable (Veenis 2005, 88799).

2.5.2.3 SWMU 10-004(a)

The SWMU 10-004(a) septic tank was removed during D&D activities in 1963. The resulting excavation was backfilled and the tank was disposed of at TA-54. It is unknown if the associated 4-in.-diameter tile drain and the soil around the outfall were removed during D&D.

2.5.2.4 AOC C-10-001

The Laboratory conducted a VCA in August 1995 at AOC C-10-001 to address strontium-90 contaminated soil at two sites within the AOC. The VCA included site radiological surveys to delineate the contaminated areas, hand augering within and around the areas of surface contamination to determine the extent of subsurface contamination, and removal of soil containing strontium-90 at activities above 97 pCi/g in accordance with calculations performed in residual radioactivity (RESRAD) (LANL 1995, 49833, p. 2). The Laboratory containerized the contaminated soil and disposed of it at TA-54. The site was restored by filling the excavated area with clean fill material and covering the surface with pine needles. Confirmatory samples were collected from the area where the contaminated soil had been found and removed (Figure 2.5-5).

2.6 Data Evaluation

The existing TA-10 site data are evaluated in the following sections to establish the adequacy of site characterization and to identify additional data needed to fully define the nature and extent of contamination across TA-10. The data assessments are performed specifically for Consolidated Units 10-001(a)-99 and 10-002(a)-99, SWMU 10-004(a), and AOCs C-10-001 and 10-009. The evaluation of the nature and extent of contamination is based only on the fixed-laboratory data collected for the RFI and the later IA and VCA sampling; these data are evaluated and presented in their entirety in the TA-10 HIR (Plates 1 through 4 [LANL 2005, 89658]). The quality of the data are also discussed in the HIR, and the data forming the basis of this evaluation are of good quality and sufficient to support site decisions.

The data requirements specified in the Consent Order are also explicitly identified as necessary additional investigation data in the discussions for each consolidated unit, SWMU, or AOC. Section IV.C.5 of the Consent Order requires analysis of VOCs, SVOCs, explosive compounds, target analyte list (TAL) metals, perchlorate, and cyanide for all TA-10 sites. This work plan proposes this full suite of analyses for all investigation samples, along with an analysis for strontium-90. These analyses were selected in accordance with the prescribed analytical suite, historic processes, and known contamination at TA-10 (see the HIR [LANL 2005, 89658]).

2.6.1 Consolidated Unit 10-001(a)-99

Grid sampling over the entire Consolidated Unit 10-001(a)-99 area identified isolated surface sampling (0 to 0.33 ft bgs) locations containing inorganic chemicals above background value (BV) and strontium-90 above the fallout value (FV), and detected organic chemicals.

Cadmium, copper, lead, mercury, and zinc were reported at concentrations above BV in one or more surface samples collected from 14 locations. Nitrobenzene was detected in three surface samples; high-melting explosive (HMX [1,3,5,7-teranitro-1,3,5,7-tetrazacyclo-octane]) was detected in one surface sample. Two surface samples contained strontium-90 at concentrations above FV. Grid samples were only collected from the surface. As a result, the vertical extent of contamination for these chemicals is not defined.

In addition to the grid samples, four boreholes (10-01281 through 10-01284) were drilled to a depth of 50 ft and sampled at Consolidated Unit 10-001(a)-99, specifically targeting SWMU 10-005. Samples from two boreholes (10-01281 and 10-01282) contained cadmium at concentrations above BV; however, cadmium was not observed at depths greater than 28.5 ft. Trichlorofluoromethane was also detected in one sample at borehole 10-01284. Strontium-90 was detected at 10-01281 at a depth of 2.5 ft.

Surface radiological data were not collected with adequate spatial density or areal coverage to effectively support a complete assessment of the potential exposure to site users. Further, shrapnel is known to remain on the site, particularly within the TA-10 fenced area; however, it is not known what percentage of the remaining shrapnel is radioactively contaminated, to what degree shrapnel correlates with elevated surface radiation levels, or if it presents a physical hazard.

Finally, perchlorate data have not been collected at Consolidated Unit 10-001(a)-99.

The review of the existing site data for Consolidated Unit 10-001(a)-99 revealed additional data requirements, as follows:

1. the vertical extent of cadmium, copper, lead, mercury, and zinc contamination at surface locations containing these inorganic chemicals at concentrations above BV;

2. the vertical extent of nitrobenzene and HMX contamination at surface locations containing these organic chemicals at concentrations above detection limits;
3. the vertical extent of strontium-90 contamination at surface locations containing this radionuclide at concentrations above FV;
4. the lateral extent of strontium-90 north and south of borehole 10-01281;
5. the lateral extent of cadmium north and south of boreholes 10-01281 and 10-01282;
6. current radiological conditions for the canyon-bottom areas of TA-10 to identify previously unidentified areas of elevated radioactivity at the surface and to assess the co-location of radiation levels with remaining surface shrapnel;
7. the distribution of remaining shrapnel within the fenced portion of TA-10 to evaluate the physical threat posed by large pieces of shrapnel and the radiological threat posed by contaminated shrapnel at the surface; and
8. the presence and distribution of perchlorate and cyanide across the site.

2.6.2 Consolidated Unit 10-002(a)-99

Consolidated Unit 10-002(a)-99 covers a large geographic region and consists of multiple sites, many of which are only indirectly related by historical process. Therefore, to facilitate the evaluation of contaminant distributions across the consolidated unit and to focus the identification of additional data required to complete site characterization, Consolidated Unit 10-002(a)-99's central area (the Central Area) is considered separately from the remainder of Consolidated Unit 10-002(a)-99.

Data for Consolidated Unit 10-002(a)-99 (originally presented in the 1994 RFI report [LANL 1996, 54332]) were collected from cross-shaped arrays (HIR Figure 3.2-3 and Plates 1 through 4 [LANL 2005, 89658]) of boreholes distributed throughout the area. The location of the central borehole in each array targeted either areas of subsurface contamination identified during the 1976 Formerly Utilized Sites Remedial Action Program (FUSRAP) investigations (Mayfield 1979, 11717) or was centered on the approximate location of a former structure (LANL 1995, 49073, p. 3-1). For SWMUs 10-002(a), 10-003(a–d), and 10-003(f–m), a borehole was drilled and sampled in the center of the former structure or within approximately 10 ft of the former structure location. The remaining borehole locations in the sample arrays extend beyond the former structure locations. This sampling approach has ensured that possible contaminant sources were effectively targeted and has provided good coverage for the identification of residual contamination remaining at Consolidated Unit 10-002(a)-99.

2.6.2.1 Consolidated Unit 10-002(a)-99 Central Area

The Central Area (see HIR Figure 3.2-3 [LANL 2005, 89658]) consists of multiple, now-removed liquid disposal pits and lines and the extant SWMU 10-007 debris landfill. Four arrays of boreholes were installed within the Central Area. A crossed array of nine boreholes was centered on liquid disposal pit 10-41 [SWMU 10-003(a)]. Similarly, a five-borehole array was centered on manhole 10-50 [SWMU 10-003(g)]. In addition, a 10-borehole and an 8-borehole array were centered on known contaminant locations identified during the FUSRAP investigation.

Antimony, beryllium, cadmium, mercury, and zinc are present at concentrations above BV in one or more boreholes. Samples collected from borehole 10-01213 between 19.2 and 39.2 ft bgs contained antimony and zinc at concentrations above BV; samples collected from greater depths did not contain these chemicals at concentrations above BV. Samples collected throughout borehole 10-01205 contained

cadmium at concentrations above BV; the sample from a depth of 26.5 ft in borehole 10-01294 contained mercury at a concentration above BV. Beryllium was detected at concentrations above BV in samples collected from boreholes 10-01209 (48.4 to 49.2 ft) and 10-02220 (49.4 to 50.0 ft). Some of the inorganic chemical analyses yielded elevated mercury detection limits above the BV. No perchlorate or cyanide data were collected at Consolidated Unit 10-002(a)-99.

Ethylbenzene and xylene were both detected in the two deepest samples (36.6 to 37.4 ft bgs and 49.4 to 50 ft bgs) at borehole 10-01294. In addition, a sample collected from a depth of 17.5 ft bgs in borehole 10-01201 and another sample collected from a depth of 36 ft bgs in borehole 10-02221 contained detected concentrations of naphthalene; naphthalene was not detected in deeper samples in either borehole.

Strontium-90 is present at activities greater than 100 pCi/g in multiple samples collected throughout the Consolidated Unit 10-002(a)-99 Central Area, with samples collected from borehole 10-02220 containing the highest activities of strontium-90 (up to approximately 40,000 pCi/g at 17.0 to 17.5 ft). Please refer to Plate 4 in the HIR (LANL 2005, 89658) for further details. However, clearly decreasing trends in strontium-90 activities contained in samples collected from boreholes 10-02220 to 10-02210 indicate that the nature and extent of strontium-90 contamination in the Central Area has been effectively defined (see Plate 4 in the HIR [LANL 2005, 89658]).

Total uranium is detected in the subsurface in all boreholes and nearly all surface soil samples at concentrations above BV. The Phase I RFI (LANL 1996, 54332, p. 19) attributed the uranium concentrations to a high percentage of pumice fragments in the samples. Uranium concentrations contained in samples collected from a depth of approximately 40 to 50 ft bgs yielded two to three times the concentration of uranium contained in samples collected from shallower depths. This depth corresponds to the approximate depth where the Qal stratum contacts the Qbo, Qbof, or Qbog strata, and indicates that the elevated uranium concentrations are representative of formation geochemistry and not a release.

The SWMU 10-007 debris landfill is co-located with the Central Area liquid waste disposal complex. Several of the RFI array boreholes planned for the Central Area were originally sited immediately over the landfill location. During the RFI, landfill debris repeatedly prevented the array boreholes from being advanced to the planned total depth; many of the boreholes required relocation to reach the planned sampling depths. The original borehole and relocated borehole locations provide some information on the size and location of the landfill. The area where landfill debris was encountered is defined by boreholes 10-02210 through 10-02212, 10-02216, 10-02219 through 10-02222, and 10-02224, which are shown in Figure 3.2-3 in the HIR (LANL 2005, 89658; LANL 1995, 49073, pp. 4-6–4-7), but the full extent of the landfill is not known.

The review of the existing site data for the Central Area of Consolidated Unit 10-002(a)-99 revealed additional data requirements, as follows:

1. lateral extent of antimony and zinc to the west of borehole 10-01213;
2. vertical extent of cadmium at borehole 10-01205 and the lateral extent of cadmium northwest of this location;
3. lateral extent of mercury to the north of borehole 10-01294;
4. additional mercury data from across the site to improve the mercury data set;
5. lateral extent of beryllium, particularly to the northwest of borehole 10-01209 and east of borehole 10-02220;

6. the presence and distribution of perchlorate and cyanide across the site;
7. vertical extent of ethylbenzene and xylene at borehole 10-01294;
8. lateral extent of naphthalene detected at boreholes 10-01201 and 10-02221;
9. confirmation of the highest strontium-90 concentrations at borehole 10-2220 as a result of the significance and age of the existing data;
10. confirmation of the lateral extent of strontium-90 contamination to the west and north of Array 1;
11. geophysical and test pit and physical inspection data to confirm the physical extent of the SWMU 10-007 debris landfill; and
12. the depth to the top of the debris and the physical makeup of the debris to finalize any future remedial designs (discussed in section 4.3).

2.6.2.2 Consolidated Unit 10-002(a)-99 Excluding the Central Area

The remainder of Consolidated Unit 10-002(a)-99 includes the liquid waste disposal system and septic system SWMUs north-northeast of the former radiochemistry building location as well as the SWMU 10-002(a) and 10-002(b) waste disposal pits. Seven additional borehole arrays were drilled within Consolidated Unit 10-002(a)-99 outside of the Central Area. Borehole arrays drilled in 1994 are shown in Figure 3.2-3 of the HIR (LANL 2005, 89658).

Inorganic chemicals were reported at concentrations above BV in samples collected from the three borehole arrays that targeted the liquid waste disposal and septic system SWMUs. A single shallow sample collected at borehole 10-01244 and another single shallow sample collected at borehole 10-01266 contained beryllium and cadmium at concentrations above BV. A single shallow sample collected at borehole 10-01242 contained chromium, copper, lead, and mercury at concentrations above BV. A single sample collected at borehole 10-01266 from a depth of 16.2 to 16.8 ft contained arsenic at a concentration greater than BV. In addition, two samples collected at borehole 10-01228 from depths of 21.4 to 21.8 ft and 32.1 to 32.5 ft, and a sample at borehole 10-01232 (21.5 to 21.9 ft) in the northernmost array, contained beryllium at concentrations above BV. Decreasing trends in the existing site data (refer to the discussion in section 4.2 of the HIR as well as the HIR's Appendix B and Plates 1 and 2 [LANL 2005, 89658]) demonstrate that the vertical extent of inorganic chemicals has been adequately defined.

Three samples collected from borehole 10-01271 contained detected concentrations of di-n-butylphthalate. Decreasing trends in the existing site data demonstrate that the vertical extent of organic chemicals has been adequately defined.

In the area of SWMU 10-002(a), one array consisting of five boreholes was drilled. Samples collected from boreholes 10-01251 (44.0 to 44.6 ft) and 10-01254 (28.4 to 29.3 ft) contained beryllium at concentrations above BV; samples collected from borehole 10-01253 (37.5 to 38.1 ft) contained cadmium at concentrations above BV. In addition, the sample collected from 49.4 to 50.0 ft in borehole 10-01251 contained a detected concentration of bis(2-ethylhexyl)phthalate.

In the area of SWMU 10-002(b), two arrays consisting of nine boreholes each were drilled as shown in Figure 3.2-3 in the HIR (LANL 2005, 89658). Four boreholes fall within the currently defined footprint of the SWMU; an additional eight boreholes were drilled and sampled within 15 ft of the SWMU.

Samples collected at SWMU 10-002(b) boreholes 10-01259 and 10-01262 from depths of 48.6–49.5 ft and 15.0 to 15.8 ft contained antimony at concentrations above BV. In addition, a sample collected from a depth of 2.5 to 3.9 ft from borehole 10-01293 contained copper at a concentration above BV. Single

samples collected at borehole 10-01288 contained detected concentrations of acetone (at a depth of 46.2 to 47.0 ft) and di-n-butylphthalate (at a depth of 4.2 to 5.0 ft), and pentachlorophenol and phenol were also detected once each in a single sample collected from a depth of 3.6 to 4.2 ft at borehole 10-01257. Existing site data adequately define the nature and extent of inorganic and organic chemicals.

Strontium-90 was detected above FV in several surface samples collected from the borehole arrays around SWMU 10-002(b). A sample collected from a depth of 3.6 ft bgs at borehole 10-01257 contained strontium-90 at an activity of 340 pCi/g. Decreasing concentration trends in the existing site data adequately define the extent of strontium-90 vertically and to the east, west, and south; no boreholes are located directly north of this location. Strontium-90 is present in borehole 10-01293 at an activity of 3.39 pCi/g at a depth of 10 ft bgs and at an activity of 3.19 pCi/g at 48.6 ft bgs. Decreasing concentration trends in the existing site data adequately define the extent of strontium-90 at this location vertically and to the north, east, and west. Finally, a sample collected from a depth of 11.4 to 12.1 ft at borehole 10-01289 contained strontium-90 at an activity of 158 pCi/g. Decreasing concentration trends in the existing site data also adequately define the extent of strontium-90 at this location vertically and to the east and west.

In addition, as identified in Section IV.C.5.iii of the Consent Order, the locations of SWMU 10-002(b) and the SWMU 10-003(n) leach field may not be known. Further, it is not known if the SWMU 10-004(b) drain line remains buried in place. The Consent Order requires verification of the SWMU locations and data derived from the footprints of these SWMUs (discussed further in section 4).

The review of the existing site data for Consolidated Unit 10-002(a)-99 outside of the Central Area revealed additional data requirements, as follows:

1. lateral extent of beryllium and cadmium northwest of borehole 10-01244 and northeast of borehole 10-01266;
2. lateral extent of chromium, copper, lead, and mercury north of borehole 10-01242;
3. lateral extent of arsenic north and east of borehole 10-01269;
4. lateral extent of di-n-butylphthalate south of borehole 10-01271;
5. lateral extent of beryllium north, west, and south of boreholes 10-01228 and 10-01232;
6. lateral extent of beryllium north of borehole 10-01251 and west of 10-01254;
7. lateral extent of cadmium south of borehole 10-01253;
8. vertical extent of bis(2-ethylhexy)phthalate at borehole 10-01251;
9. lateral extent of antimony north and south of borehole 10-01259 and south of 10-01262;
10. lateral extent of copper south of borehole 10-01293;
11. lateral extent of strontium-90 north of borehole 10-01257;
12. lateral extent of strontium-90 north and south of borehole 10-01289;
13. lateral extent of strontium-90 south of borehole 10-01293;
14. the presence and distribution of perchlorate and cyanide across the site;

15. geophysical and pothole data to confirm the physical location of the SWMU 10-003(n) leach field, the SMWU 10-002(b) pit, and the presence of the SWMU 10-004(b) drain line; and
16. data from the footprints of the SWMU 10-003(n) leach field, the SWMU 10-002(b) pit, and the SWMU 10-004(b) drain line.

2.6.3 SWMU 10-004(a)

A single array consisting of eight boreholes was drilled at SWMU 10-004(a) near structure 10-40 (HIR Figure 3.2-3 [LANL 2005, 89658]). A single sample contained antimony at a concentration above BV; the remaining site data adequately define the lateral and vertical extent of this chemical. A single sample from the bottom of borehole 10-01277 contained beryllium at a concentration above BV at a depth of 61.5 to 62.5 ft. Two samples in borehole 10-01278 collected from depths of 2.5 to 3.7 ft and 19.2 to 20 ft, as well as a single sample from borehole 10-01279 collected from a depth of 14.0 to 15.0 ft, contained cadmium at concentrations above BV. A sample collected from the bottom of borehole 10-01277 at a depth of 61.5 to 62.5 ft contained lead at a concentration above BV. Boreholes 10-01273 and 10-01276 both had several samples collected from depths ranging from 2.5 to 50 ft that contained mercury at concentrations above BV. Boreholes 10-01272 and 10-01277 each had one sample that contained zinc at concentrations above BV. In addition, boreholes 10-01274 and 10-01275 each had one sample that contained detected concentrations of bis(2-ethylhexyl)phthalate.

The review of the existing site data for SWMU 10-004(a) revealed additional data requirements, as follows:

1. vertical extent of beryllium at borehole 10-01277;
2. lateral extent of cadmium west of boreholes 10-01278 and 10-01279;
3. vertical extent of lead at borehole 10-01277;
4. lateral extent of mercury north of borehole 10-01273 and east of 10-01274;
5. vertical extent of zinc at borehole 10-01277;
6. lateral extent of bis(2-ethylhexyl)phthalate east of borehole 10-01274 and south of borehole 10-01275; and
7. the presence and distribution of perchlorate and cyanide across the site.

2.6.4 AOC C-10-001

Strontium-90 activities up to 3518 pCi/g were previously identified at AOC C-10-001 before the VCA implementation at the site. The maximum activity of strontium-90 in the samples collected after the excavation activities was 12.8 pCi/g (LANL 1995, 53782, p. 1-2). The existing site data collected during the VCA adequately define the nature and extent of residual strontium-90 remaining on-site. Historically, no data have been collected from the site for hazardous constituents; the proposed collection of site data is designed to document the presence and distribution of hazardous constituents and perchlorate and cyanide.

2.6.5 AOC 10-009

No data are available for AOC 10-009. The presence and distribution of inorganic chemicals (including perchlorate and cyanide), organic chemicals, and radioisotopes will be evaluated. The physical extent and location of the debris landfill also require characterization using geophysical surveys and/or the

excavation of test pits, and the surface radiation levels require characterization. Data necessary to support corrective action decisions are discussed in section 4.

3.0 SITE CONDITIONS

The following sections present the current surface features and the existing subsurface geologic characteristics beneath Bayo Canyon in general and TA-10 in particular. Known surface and subsurface traits and their potential effects on the occurrence and concentration of contaminants include

- canyon terrain, which affects meteorological conditions and ecological habitats at the surface;
- a semiarid climate with low precipitation and a high evapotranspiration rate, which limits the extent of subsurface moisture percolation and the amount of moisture available to leach radionuclides or other hazardous waste constituents; and
- a thick, relatively dry unsaturated (vadose) zone, which greatly restricts or prevents downward migration of contaminants through the vadose zone to the regional aquifer.

3.1 Surface Conditions

3.1.1 Surface Water

Surface water (stream) flow in the canyon is intermittent, with runoff occurring during the summer months (July through August) from heavy thunderstorms. The runoff is generally of short duration over a period of several hours. Streamflow can also occur as a result of spring snowmelt runoff. Individual flooding events may cause realignment of the main channel. No perched or alluvial aquifers were encountered to depths of 89.43 ft during subsurface investigations at TA-10. The elevation of the regional aquifer is about 6000 ft above sea level or approximately 600 ft below the surface of Bayo Canyon (LANL 1997, 56660, p. 6).

Historical sedimentation on the floor of Bayo Canyon is minimal. The channel is discontinuous, and precipitation runoff generally spreads out over the grassy valley bottom. These areas of unchanneled flow are potential areas of sediment deposition (Broxton and Eller, 1995, 58207, pp. 67–68).

3.1.2 Soils

Surface soils in Bayo Canyon consist of poorly developed, well-drained soils of the Totavi series on Bandelier Tuff and alluvium. These soils are generally 2 to 4 in. thick. In many parts of TA-10, the soil has been disturbed by operations and previous remediation activities.

3.2 Subsurface Conditions

This section describes the subsurface conditions in the Bayo Canyon area, including the area's stratigraphic and hydrogeologic conditions.

3.2.1 Stratigraphy

TA-10 is located on the floor of Bayo Canyon at an elevation ranging from 6600 to 6740 ft above sea level. The mesa tops range in approximate elevation from 7000 to 7100 ft above sea level. The upper portion of the canyon walls is vertical, cut into the upper (Tshirege) Member of Bandelier Tuff. From the base of the cliffs, steep slopes ranging from 10 to 30 degrees lead downward to a wide, gently sloping to flat canyon floor. The slopes and canyon floor are mainly cut into the lower (Otowi) Member of Bandelier

Tuff. The slopes are overlain by talus and colluvium from the cliffs above. The gentle side slopes of the canyon floor are covered with less than 1.5 ft to more than 6.5 ft of colluvium (Drake and Inoue 1993, 53456, p. 10). The canyon floor also includes a narrow inner canyon consisting of the modern braided stream channel with low banks ranging in height from 1.5 to 6 ft. Up to 40 ft of Quaternary stream alluvium underlie the canyon floor. Near the site of the former radiochemistry laboratory (TA-10-1), sediments of the Puye Formation underlie the Bandelier Tuff at a depth of approximately 62 ft bgs (LANL 1996, 54332).

3.2.2 Hydrogeology

3.2.2.1 Surface Water

Surface water flow on the canyon slopes and floor occurs predominantly by sheet flow during seasonal heavy rains. Several shallow tributary channels collect water that flows over the cliffs and across the ground surface. The only sediment sampling station in Bayo Canyon is located at its intersection with Los Alamos Canyon, approximately 2 mi. east of TA-10. A surface water gauging station is located just east of TA-10 (Figure 3.2-1).

The ephemeral stream in Bayo Canyon carries water only during periods of heavy rain. Anecdotal reports indicate that flooding has occurred on several occasions while TA-10 was in operation.

3.2.3.2 Perched Groundwater

Observations of perched intermediate groundwater in Laboratory wells are rare on the Pajarito Plateau. Perched waters are thought to form mainly at horizons where medium properties change dramatically, such as at paleosol horizons with clay or caliche found in basalt and volcanic sediment sequences. The Cerro Toledo interval, Guaje Pumice Bed, and Puye Formation are local examples.

No perched or alluvial aquifers are known to be present in Bayo Canyon, and none were encountered during the drilling of 93 boreholes in 1994. The boreholes were advanced to a minimum depth of 50 ft bgs (LANL 1996, 54332, pp. 7, 15). To date, no saturated conditions have been observed in the area.

3.2.3.3 Regional Aquifer

The regional aquifer in the Los Alamos area rises westward from the Rio Grande within the Santa Fe Group into the Puye Formation beneath the central and western portion of the Pajarito Plateau. The depth of the aquifer decreases from about 1200 ft bgs along the western margin of the plateau to about 600 ft bgs along the eastern margin. The regional aquifer is approximately 600 ft below the level of Bayo Canyon at the former TA-10 site.

4.0 SCOPE OF ACTIVITIES

The primary purpose of the activities prescribed in this investigation work plan is to achieve the objectives defined in section 1.2. Data collection activities for site characterization and for corrective action selection are specified. The site characterization activities are in accordance with the requirements outlined in the Consent Order and the additional data requirements identified in section 2.6 within the framework of the site conceptual model. The data necessary to support the selection of an appropriate corrective action for remaining contamination and shrapnel at TA-10 are based on the corrective action evaluation presented in section 4.4.

Table 4.0-1 presents a crosswalk between the Consent Order and the scope proposed in this section. The only significant deviation from the Consent Order is that no intermediate or deep regional groundwater monitoring wells are planned to be drilled because over 100 boreholes have been drilled in Bayo Canyon to various depths (maximum total depth [TD] of 88.9 ft [27.1 m] bgs) without encountering saturation. Regional well R-24 was drilled during the summer of 2005, just downgradient of TA-10, and no shallow perched or intermediate groundwater was encountered (report pending). Should shallow perched or intermediate water be encountered in any of the boreholes, monitoring wells will be added to the scope of activities in this work plan.

4.1 Surveys

Three surveys of the SWMUs and AOCs will be conducted before the start of characterization and remediation activities. A geodetic survey will be performed to locate former structures and predefined sampling locations. A site-wide radiological survey will be performed to identify areas of elevated radiation attributable to structure locations, releases, or radioactive shrapnel. Geophysical surveys to locate remaining buried structures, and indications of former structures, associated with the radiochemistry laboratory and the acid waste disposal complex will be performed across Consolidated Unit 10-002(a)-99. Additional geophysical surveys will be conducted across all of TA-10 to identify buried shrapnel. In conjunction with these surveys, visual reconnaissance will be conducted to identify undocumented areas of potential contamination, including the location of SWMU 10-006.

4.1.1 Geodetic Survey

Geodetic surveys will be conducted during the implementation of this work plan to re-establish previous sampling locations planned for resampling; these locations are principally within Consolidated Unit 10-001(a)-99. The survey results will allow the verification of previously identified contaminant concentrations and the collection of data at greater depth beneath locations with known concentrations of contaminants requiring further characterization. In addition, locations of important former structures, also critical to ensure adequate characterization of the nature and extent of contaminant releases and residual contamination, will be re-established. Targeted structures are principally within Consolidated Unit 10-002(a)-99 and include former septic tanks, septic lines, acid waste lines, and disposal pits. All new sampling locations will be surveyed by a New Mexico-licensed land surveyor as specified in Section IX.B.2.f of the Consent Order.

4.1.2 Radiological Survey

A walkover radiological survey of the areas where radiological contamination is expected to occur will be performed with Geiger-Mueller detectors (or equivalent) to locate areas of elevated radiation. The surveys will quantify and bound the extent of surface radiological contamination. The surveys will be conducted at a line spacing of approximately 10 ft between detectors, with additional focused surveys to better define areas of elevated count rates. In accordance with observations in the field, this configuration may be modified to improve the quality of the data collection. The results will be presented in contour maps of count rates that will guide surface sampling activities.

4.1.3 Geophysical Survey

Geophysical surveys targeting buried shrapnel will be conducted over the same area as covered by the radiological survey. Focused electromagnetic geophysical surveys to identify buried structures and buried debris will be conducted at Consolidated Unit 10-002(a)-99 and AOC 10-009. The focused surveys, using

EM-31 and EM-61 equipment, will produce anomaly maps that will be compared to existing information about the site, including engineering drawings where available. In accordance with this review, areas will be selected for further definition using ground-penetrating radar (GPR). The features to be identified in the geophysical survey include

- the physical limits of the landfills to define the extent of the debris;
- the former location of structures, such as the SWMU 10-002(b) disposal pits south of the radiochemistry building, to guide the placement of surface samples and boreholes for further characterization;
- the presence or location of buried pipes, such as the drain line associated with the SWMU 10-004(b) septic system, to confirm whether they were removed, and to guide the placement of surface samples and boreholes for further characterization; and
- the areas with the highest density of remaining shrapnel pieces.

Data from the radiological and geophysical surveys will be used to refine the sampling locations proposed below.

4.2 Sampling Activities

Both drilling and surface and shallow subsurface sampling activities are prescribed by this work plan. In addition to the primary environmental samples, quality assurance/quality control (QA/QC) samples will be collected at frequencies specified in the Consent Order and in accordance with the applicable standard operating procedures (SOPs) listed in section 5. At a minimum, QA/QC samples will include field duplicate samples to evaluate sample variability and rinsate blanks to confirm decontamination procedures. A summary of samples to be collected during the implementation of this work plan and the specific data requirements addressed by the borehole and surface samples is presented in Table 4.2-1.

4.2.1 Borehole Sampling

Borehole sampling is proposed to characterize SWMU 10-005, the Central Area of Consolidated Unit 10-002(a)-99, the remainder of Consolidated Unit 10-002(a)-99 (exclusive of the Central Area), SWMU 10-004(a), and AOC 10-009. A total of 53 boreholes are planned to characterize these sites within TA-10.

Boreholes will extend to the minimum depths required by the Consent Order (25 to 30 ft bgs) and as deep as is required to bound the vertical extent of contamination. The boreholes will be continuously cored, logged, and sampled on 5-ft intervals. All recovered cores will be field screened for VOCs and gross alpha, beta, and gamma activity. A minimum of two fixed laboratory analytical samples will be collected from each borehole. As specified in the Consent Order, samples will be submitted from the depth correlating to the maximum observed radioactivity screening or headspace VOC concentration and from the bottom of the borehole. Additional samples may also be collected from intervals where contamination is suspected as a result of elevated field-screening results and/or if visual inspection reveals fractures or staining. Borehole samples will be submitted for the full suite of analyses specified in the Consent Order and section 2.6 of this document.

Two boreholes will be advanced and sampled at SWMU 10-005, which is part of Consolidated Unit 10-001(a)-99. The borehole locations specified for this area were selected to define the lateral extent of strontium-90 and vertical extent of cadmium. The specified locations of the boreholes for this area are shown in Figure 4.2-1.

Eleven boreholes will be completed within the Central Area of Consolidated Unit 10-002(a)-99 (Figure 4.2-2). These borehole locations were selected principally to define the lateral and vertical extent of a small number of inorganic and organic chemicals, and to verify the extent of strontium-90 at depth beneath the Central Area. In addition, two core samples will be collected for the analysis of saturated and unsaturated hydraulic conductivity, porosity, and bulk density from borehole 10-02220 because it is the area of highest contamination.

Thirty boreholes will be completed within Consolidated Unit 10-002(a)-99, outside of the Central Area (Figure 4.2-2). These borehole locations were selected principally to define the lateral and vertical extent of a small number of inorganic and organic chemicals and to define the lateral and vertical extent of strontium-90 in the area of SWMU 10-002(b). They will be based on the results of geophysical surveys.

Five boreholes will be completed in the area of SWMU 10-004(a) (Figure 4.2-2). The specified borehole locations for this site are intended to define the vertical and lateral extent of a small number of inorganic chemicals and the lateral extent of bis(2-ethylhexyl)phthalate.

Five boreholes will be completed in the area of AOC 10-009. The borehole locations defined in this work plan were selected principally to establish the presence and distribution of chemicals and radionuclides. The boreholes will also support the evaluation of the physical dimensions of the debris landfill. The specified locations of the boreholes for this site are depicted in Figure 4.2-3.

4.2.2 Surface and Shallow Subsurface Sampling

Surface and shallow subsurface sampling is prescribed across Consolidated Unit 10-001(a)-99 and at AOC C-10-001. All specified locations will be sampled at two depth intervals, from 0 to 0.5 ft bgs and from 1.5 to 2.0 ft bgs. Samples may be collected, if practical, from greater depths if field-screening data indicate the possibility of contamination.

Samples will be collected from 22 locations across Consolidated Unit 10-001(a)-99; all locations were previously sampled during the 1994 RFI. The specified sampling locations were selected principally to define the vertical extent of a small number of inorganic and organic chemicals and strontium-90. The specified sampling locations for Consolidated Unit 10-001(a)-99 are shown in Figure 4.2-4.

Samples will be collected from five locations at AOC C-10-001. The sampling strategy specified for AOC C-10-001 is designed to characterize the area and establish the extent of contamination. The specified sampling locations for AOC C-10-001 are shown in Figure 4.2-3.

4.3 Preliminary Corrective Action Evaluation for TA-10

The following is a preliminary evaluation of the corrective action that is appropriate for Bayo Canyon. This preliminary evaluation is included to help identify the additional data requirements needed to finalize the corrective action selection for the site.

4.3.1 Primary Concerns

The presence of the following substances and/or materials may indicate that the site is unsuitable for an unrestricted release of the property (the materials in their current locations and concentrations/activities may require corrective action):

- strontium-90 in the TA-10 Central Area subsurface

- near-surface debris that could injure trail users through direct contact;
- chamisa contaminated with strontium-90; and
- potentially contaminated shrapnel.

The portion of the Central Area of TA-10 (SWMU 10-007) where elevated levels of strontium-90 were detected may exceed DOE 5400.5 guidelines for residual radioactive material. However, there is no viable exposure pathway to recreational users because the area of elevated activity is too deep to impact recreational users. This contamination could leach from the source area into the surrounding tuff formation and may be the source of radionuclides in some of the chamisa (LANL 1996, 54617, p. 62)

Near-surface debris presenting a physical and/or a radiological hazard to recreational users is located in two areas of TA-10—SWMU10-007 and AOC 10-009. SWMU 10-007 contains the location of the disposal pits and a landfill created during the removal of those disposal pits, which were used to handle the waste and building debris generated during D&D activities. AOC 10-009 has a variety of surface and buried debris of unknown origin.

Chamisa plant samples collected from the Central Area have exhibited elevated beta radiation above BV (LANL 1997, 55889, p. 3). These chamisa plants, decomposition products (litter), and pollen could be contacted by recreational users or foraging animals; decomposition products and pollen could be transported by wind and water.

Despite the previous shrapnel removal action, some shrapnel may be encountered by a trail user, and a small percentage of the shrapnel may be radioactive.

4.3.2 Requirements and Preliminary Corrective Action Goals and Objectives

Table 4.3-1 contains applicable requirements that will help select the corrective action. Groundwater has no applicable requirement because groundwater quality standards have not been exceeded. Surface water requirements are not included because Bayo Canyon is an ephemeral drainage and there is no evidence of contaminant transport by surface water. Future potential for surface water and groundwater impacts will be addressed as part of the preliminary evaluation of the corrective action.

The following preliminary corrective action goals were developed for the Bayo Canyon property:

- prevent strontium-90 from impacting groundwater;
- prevent direct contact with strontium-90;
- prevent direct contact with debris and radioactive shrapnel;
- limit exposure to shrapnel; and
- prevent inhalation and incidental ingestion of radioactive chamisa.

The following preliminary corrective action objectives are intended to meet the goals described above:

- prevent formation or movement of leachate from strontium-90 in the Central Area of TA-10;
- prevent direct contact with potentially contaminated debris in the TA-10 Central Area;
- isolate trail users from the debris in two shallow debris areas;
- isolate trail users from shrapnel;

- isolate trail users from radioactive chamisa; and
- control radioactive chamisa pollen and dust.

4.3.3 Comparison of Preliminary Corrective Action Alternatives

A value analysis of corrective action technologies was conducted to identify those that would be most appropriate for corrective action. Presumptive remedies were considered; containment is the most applicable since it is the EPA's presumptive remedy for municipal waste landfills (EPA 1993, 88001). As the debris landfills in Bayo Canyon are relatively small and the Consent Order mandated the evaluation of removal for SWMU 10-007, removal was also considered.

Preliminary corrective action alternatives were formulated to represent a range of cost and effectiveness at meeting the requirements and objectives described above. The following are the preliminary alternatives:

- Preliminary Alternative 1: no action;
- Preliminary Alternative 2: extensive institutional controls (maintain fences, cut vegetation, and monitor frequently); land use restricted to recreational;
- Preliminary Alternative 3: extensive institutional controls plus subsurface, low-permeability grout barrier; application of herbicide above barrier; land use restricted to recreational;
- Preliminary Alternative 4: moderate institutional controls (maintain fences and monitor periodically) plus excavation and disposal to remove strontium-90 in the Central Area; land use restricted to recreational;
- Preliminary Alternative 5: simple institutional controls (monitor occasionally) plus the excavation and disposal of debris and strontium-90 in the TA-10 Central Area; land use restricted to industrial; and
- Preliminary Alternative 6: extensive institutional controls plus engineered simple cap over both debris areas; divert surface water with low barrier; land use restricted to recreational.

The following criteria for comparing the preliminary alternatives are in accordance with the Consent Order (Section VII.D.4) and with DOE Order 5400.5:

- protect human health and the environment;
- meet standards (including as-low-as-reasonably-achievable [ALARA] and worker exposure);
- control source term (reduce or eliminate future releases);
- attain standards for the management of waste removed as part of corrective action;
- ensure long-term reliability and effectiveness;
- reduce toxicity and mobility;
- ensure short-term effectiveness;
- ensure implementability; and
- minimize cost (capital and maintenance).

The preliminary alternatives were compared to each other with respect to their ability to satisfy the comparison criteria. The ranking of preliminary alternatives considered the relative importance of each of

the comparison criteria, with protectiveness of human health and the environment the most important criterion and reduction of toxicity and mobility the least important. Reduction of toxicity and mobility was judged to be less important because the most significant concern, the elevated strontium, is too deep to affect receptors directly and too small to result in a significant plume.

The preferred preliminary alternative for corrective action at SWMU 10-007 is Preliminary Alternative 6—an engineered cap over the debris area. Although Preliminary Alternative 6 was not ranked the best preliminary alternative to meet any one single comparison criteria, it consistently ranked high for each of the comparison criteria and did rank first when all comparison criteria were considered. Furthermore, adjusting the relative importance of comparison criteria (sensitivity analysis) to reflect different stakeholder perspectives resulted in Preliminary Alternative 6 still being the best or nearly the best preliminary alternative. Because of its limited size, the preliminary preferred alternative proposed for the debris area identified as AOC 10-009 is removal and site restoration. Details on the evaluation of alternatives are presented in Appendix C.

Preliminary Alternative 6 would likely be a one- or two-layer cap designed to reduce infiltration of surface water and isolate the debris from recreational users. Because SWMU 10-007 is on the canyon floor, a berm/ditch system would be constructed to divert storm flows. Extensive institutional controls would be employed to maintain the integrity of the cap.

The following additional data searches are needed to refine the comparison of preliminary alternatives:

1. test pits in the debris areas extending to the top of debris or a maximum of 5 ft deep on a 100-ft grid to estimate the horizontal limits of debris in accordance with the visual classification of the test pit material;
2. two test pits at each debris area extending to 12 ft bgs to characterize the physical, chemical, and radiological characteristics of the debris that could possibly impact a recreational or industrial user; samples will be collected where significant changes in material type are observed (but no more than 5 ft apart vertically) for analytical testing of the hazardous and radiological chemicals of potential concern (COPCs); and
3. material availability study to identify potential sources of material for cover construction and backfill; note that this study does not require direct coordination with the sampling campaign prescribed by this work plan and may be conducted independently.

4.4 Site Restoration Activities

Site restoration will be conducted if needed in areas disturbed by drilling and sampling activities at TA-10. Best management practices installed during field activities will be inspected, maintained, and restructured where necessary to control surface runoff and impede erosion processes. Disturbed areas will be regraded as close to original grade as possible; reseeding, along with the addition of soil amendments and fertilizer, will follow using Laboratory-approved seed mixtures.

4.5 Waste Management

The waste streams generated during the implementation of this work plan will be characterized as a result of the direct sampling of waste, analytical data generated as a result of sampling described in this plan, and other acceptable knowledge. All wastes will be managed in accordance with applicable federal, state, DOE, and Laboratory requirements. Anticipated waste streams, regulatory classification, amounts, and disposal pathways are presented in the management plan for investigation-derived waste (Appendix B).

5.0 INVESTIGATION METHODS

The principal investigation methods that will be used during the implementation of this work plan are various site surveys, including geodetic, geophysical, and radiation surveys; drilling; hand sampling of surface and shallow subsurface media; and mechanized potholing. Potential monitoring well installation, borehole abandonment, and equipment decontamination are also discussed in this section. Investigation methods are summarized in Table 5.0-1.

The following ENV-Environmental Remediation and Characterization (ECR) SOPs are applicable to the investigation methods proposed in this plan:

- SOP-1.02 Sample Containers and Preservation
- SOP-1.03 Handling, Packaging, and Transporting Field Samples
- SOP-1.04 Sample Control and Field Documentation
- SOP-1.05 Field Quality Control Samples
- SOP-1.08 Field Decontamination of Drilling and Sampling Equipment
- SOP-3.11 Geodetic Surveys
- SOP-6.03 Sampling for Volatile Organic Compounds in Groundwater
- SOP-6.09 Spade and Scoop Method for Collection of Soil Samples
- SOP-6.10 Hand Auger and Thin-Wall Tube Sampler
- SOP-6.24 Sample Collection from Split-Spoon Samplers and Shelby-Tube Sampler
- SOP-6.26 Core Barrel Sampling for Subsurface Earth Materials
- SOP-06.33 Headspace Vapor Screening with a Photo Ionization Detector
- SOP-7.05 Subsurface Moisture Measurements Using a Neutron Probe
- SOP-10.14 Performing and Documenting Gross Gamma Radiation Scoping Surveys
- SOP-12.01 Field Logging, Handling, and Documentation of Borehole Materials

Complete SOP descriptions can be found at http://erinternal.lanl.gov/procedures.shtml. Additional procedures may be added as necessary to describe and document quality-affecting activities.

5.1 Site Surveys

Geodetic, geophysical, and radiological surveys will be conducted to meet the data requirements specified in this work plan.

5.1.1 Geodetic Surveys

Geodetic surveying will be conducted in accordance with SOP-3.11, Geodetic Surveys. Horizontal coordinates and elevations will be determined by a professional, registered New Mexico land surveyor using the New Mexico State Plane Coordinate System. The survey results will be presented as part of the investigation report. Sample coordinates will be incorporated into the Laboratory's Environmental Restoration Database.

5.1.2 Geophysical Surveys

The principal geophysical methods to be used during the investigation prescribed by this work plan are EM-31, EM-61, and GPR. A focused geophysical survey will also be conducted to locate shrapnel remaining at TA-10. All surveys will be conducted in accordance with the vendor's specifications. All results will be presented in the investigation report.

For this investigation, EM-31 and EM-61 data will be recorded at approximately 2-ft intervals along lines spaced approximately 20 ft apart. Higher resolution coverage (as needed) will be completed in selected target areas using 5-ft line spacing. Line and station separation may sometimes vary depending upon surface obstructions, such as the presence of cultural interference (e.g., aboveground metal objects and overhead power lines) and dense vegetation. Geodetic coordinates will be recorded at 1-second intervals using an integrated global positioning system (GPS). A base station free from cultural interference will be occupied at the beginning and end of each survey day to calibrate the instrument and perform system functional tests. During these tests, battery, phasing, and sensitivity checks will be performed.

The GPR survey will be performed using a digital SIR-2 subsurface interface radar system (or equivalent). After initial field tests will be conducted to determine maximum penetration and sufficient resolution, an appropriate transducer will be selected to perform the survey. Different transducers may be used in an attempt to provide greater penetration depths. Data will be digitally recorded, displayed, and analyzed during acquisition to allow real-time interpretation. Line locations will be selected based on electro-magnetic (EM) anomaly location and surface obstructions.

Electromagnetic induction is anticipated to be the geophysical technology best suited to identify and locate nonferrous metallic fragments such as shrapnel. The two most appropriate systems are the Geonics Mark II EM-61 and the G-tek TM-5EMU. Both are widely used to map small buried metallic targets in surveys for unexploded ordinance surveys. The TM-5EMU is better suited to identifying small near-surface targets than the EM-61 and is therefore likely the best instrument to locate shrapnel at TA-10. Instrument configuration and survey parameters, such as traverse spacing and sampling frequency, will be optimized during field implementation in accordance with site-specific conditions. The results will be used to produce digital survey maps.

5.1.3 Radiological Surveys

The walkover beta/gamma surveys will be performed to identify any areas with potentially elevated radiation emission rates. An integrated GPS-radiological survey system will be used. The system will consist of a Ludlum Model 2221 rate meter/scaler with a Geiger-Mueller detector coupled to a Trimble Pro XRS mapping-grade GPS instrument. The Ludlum Model 2221 will be operated in rate meter mode allowing for a beta/gamma count rate tagged with its corresponding coordinates to be collected at timed (approximately 2-second) intervals. The detectors will be carried at a height determined by the radiological contractor either in backpacks worn by field personnel or mounted on a "baby jogger" pushcart. High-and-low density surveys may be conducted. High-density surveys will be performed at the discretion of the survey team to better define anomalies using a detector spacing of approximately 2.5 ft and a survey speed of 1 ft per second (ft/s); low-density surveys will be performed with a detector spacing of 5 ft and a survey speed of 2.5 ft/s. All surveys will be conducted in accordance with the vendor's specifications. All results will be presented in the investigation report.

At the end of each survey day, the field data will be downloaded into a laptop computer and processed on-site using a combination of Trimble Pathfinder Office and ESRI ArcView GIS computer applications. Team personnel will review the daily data to ensure completeness of coverage.

5.2 Drilling and Deep Subsurface Sampling Methods

All drilling activities will be conducted in accordance with the appropriate SOPs (refer to Table 5.0-1), the site-specific health and safety plan, and radiation work permits to ensure health and safety issues are reviewed and addressed during field operations.

All boreholes will be drilled using hollow-stem auger drilling methods with 4.25-in.-inside-diameter auger flights. Each borehole will be continuously cored and sampled using a split barrel sampler. Core will be radiologically screened, field-analyzed for VOCs (using head-space analysis techniques), visually inspected, and geologically logged. Field screening, with the exception of x-ray defraction (XRF), which does not have sufficient sensitivity to detect background levels of inorganic chemicals, will be conducted in accordance with the requirements specified in the Consent Order. Screening for gross alpha activity will be conducted using an air proportional probe and a Ludlum Model 139 rate meter (or equivalent); screening for gross beta/gamma radiation will be conducted using and ESP-1 rate meter and HP-260 Geiger-Mueller detector (or equivalent). VOC screening will be performed using a photoionization detector equipped with an 11.7-eV bulb.

Borehole locations have been proposed (presented in section 4) in accordance with the data evaluation discussed in section 2.6, the Consent Order, and the NMED Notice of Disapproval (NOD) comments dated October 20, 2005. One borehole will be drilled at the previously sampled borehole 10-02220 within Array 3 in the Central Area. The state-planar coordinates for this borehole location will be established at the field using geodetic survey methods and the existing survey data for this point. Other borehole locations will be established in the field using geodetic survey methods and approximate state-planer coordinates derived from the borehole sampling location maps referenced in section 4. In addition, boreholes planned to target the footprints of SWMUs, such as at SWMUs 10-002(b), 10-003(n), 10-003(h), and 10-004(b), will be located in accordance with geophysical survey results. Each proposed borehole location will be thoroughly examined to identify potential hazards for subsurface drilling; the exact location of some boreholes may require adjustment in accordance with utility surveys conducted as part of the excavation permitting process or the identification of other hazards.

Continuous core subsurface tuff samples will be inspected, in accordance with SOP-6.26, for lithologic and structural features and removed from the split-barrel sampler for sample collection. Samples will be collected at the depths specified in section 4.

Sample jars and/or ziplock bags will be filled with discrete segments of the core and will be shipped through the Sample Management Office (SMO) to off-site laboratories for analysis. Sample analyses will be performed using methods specified by contract requirements of the Laboratory's SMO (LANL 2000, 71233).

In addition, all geotechnical analyses will be performed using methods specified by contract requirements of the Laboratory's SMO (LANL 2000, 71233).

5.3 Hand and Shallow Subsurface Sampling Methods

The most common method for surface and shallow subsurface sampling will be the spade and scoop method (SOP-6.09). In accordance with this method, a sample is collected by digging a hole to the target depth (as specified in this work plan), and collecting a discrete grab of sample material. Stainless steel shovels, spades, scoops, and bowls are used to ease decontamination. Disposable tools made of polystyrene or Teflon may also be used, if necessary. In some cases, hand-augering tools will be used to collect shallow subsurface samples if geologic material conditions permit. Acceptable tools and their use

are covered in SOP-6.10. If the surface location is at bedrock, an axe or hammer and chisel may be necessary to produce sufficient material for a full-suite analytical sample.

All surface and shallow subsurface sampling locations prescribed by this work plan were sampled during previous sampling campaigns. These locations will be re-established in the field using geodetic survey methods and the existing survey data for these locations. Samples will be collected at the proposed depths; however, if field-screening data indicate the possibility of contamination at deeper sample depths, additional samples will be collected either using hand-sampling methods or, if appropriate, drilling.

Surface and shallow subsurface samples will be radiologically screened and field-analyzed for VOCs (using head-space analysis techniques) prior to collection and placed in ziplock bags and/or sample jars as grabs derived from hand augers, scoops, or chiseling devices in accordance with appropriate SOPs (see section 5.0). Field screening will be conducted in accordance with the requirements specified in the Consent Order. Screening for gross alpha activity will be conducted using an air proportional probe and a Ludlum Model 139 rate meter (or equivalent); screening for gross beta/gamma radiation will be conducted using and ESP-1 rate meter and HP-260 Geiger-Mueller detector (or equivalent). VOC screening will be performed using a photoionization detector equipped with an 11.7-eV bulb. Samples will be shipped through the SMO to off-site laboratories for analysis. Sample analyses will be performed using methods specified by contract requirements of the Laboratory's SMO (LANL 2000, 71233). See Table 4.2-1 for a summary of the screening and analytical requirements.

5.4 Excavation of Test Pits

A backhoe or track-mounted excavator will be used to install all test pits as part of the investigations at the landfill and debris pits to evaluate the physical extent and type of material disposed at TA-10. Test pit locations will be in accordance with field observations, requirements specified in section 4.0, and the current understanding of the site. The approximate dimensions of test pits will be in accordance with field observations and conditions encountered during excavation. Screening of the excavated materials will be conducted as necessary, and samples of excavated test pit materials may be collected for laboratory analyses if conditions warrant a higher level of characterization.

5.5 Potential Perched Saturation Zone Monitoring Well Installation

If saturation is encountered as a borehole is advanced, drilling will be stopped to determine whether sufficient water volume is available to analyze the water quality. Generally, the total volume required is approximately 0.5 to 1.0 L. If the minimum volume of groundwater cannot be collected, the borehole will be continued to the planned TD or until saturation is again encountered and the process is repeated. Insufficient water sample volumes from discrete depths will not be composited to make the required volume for screening analysis.

If sufficient volume exists, a groundwater sample will be collected and analyzed for cations and anions, alkalinity, total organic carbon, total inorganic carbon, and total dissolved solids on a rapid-turnaround basis. Typically, results of groundwater screening samples are available within 48 hr. While awaiting screening, the borehole will be advanced to the base of saturation, or the perching horizon, and halted. If possible, the perching horizon will be identified and not penetrated. This activity will determine the thickness of the zone of saturation and the characteristics of the perching horizon. Borehole drilling will cease, a monitoring well will be designed, and the design will be submitted to NMED for approval. After the design has been approved, the well will be installed. A borehole will be drilled adjacent to the well and the saturated zone isolated with a double-wall casing-advancement drilling method to isolate the known

saturated zone. The additional borehole will then be completed to the planned depth and the process repeated.

If perched groundwater monitoring wells are installed, a regular monitoring program will be implemented for data collection and analysis (see section 6.0).

5.6 Borehole Abandonment

All boreholes will be abandoned by pressure grouting, using tremie pipe in accordance with the procedures outlined in SOP-5.03. The procedure takes into account any subsurface characteristics (such as perched zones) that would require isolation if the decision to abandon versus well installation had been made. The placement of backfill materials (such as bentonite and cement), the volume (calculated and actual), intervals of placement, and additives used to enhance backfilling will be documented.

5.7 Equipment Decontamination

After the investigation activities, equipment will be decontaminated. Residual material adhering to equipment will be removed using dry decontamination methods, including the use of wire brushes and scrapers followed with a spray detergent and wiping with clean paper towels (SOP-1.08). High concentrations of organic chemicals are not present in the areas to be sampled, so the use of methanol as a rinse is not necessary. Nitric acid rinses will only be implemented if stainless steel or disposable sampling supplies are not used. Field QA/QC suites will include the collection of rinsate samples, which will document the effectiveness of the decontamination process.

Prior to demobilization, all sampling equipment will be screened and radiological swipes counted to confirm that the equipment can be removed from the site. If equipment cannot be free-released after dry decontamination, a high-pressure sprayer along with long-handled brushes and rods will be used to more effectively remove contaminated material from equipment. Pressure washing of equipment will be performed on a temporary wash pad with a high-density polyethylene liner. Cleaning solutions and wash water will be collected and contained for proper disposal as discussed in Appendix B. Decontamination solutions will be sampled to determine final disposition. Air filters on equipment operating in the exclusion zone will be considered contaminated and will be removed and replaced before equipment leaves the site. Equipment ready for demobilization will be surveyed by a Health, Safety, and Radiation (HSR-1) Radiation Control Technician before being released from the site, if necessary.

6.0 MONITORING AND SAMPLING PROGRAM

Currently, no monitoring is being conducted at TA-10 after the implementation of this work plan. However, intermediate groundwater-monitoring wells will be installed if the presence of shallow perched water is indicated. If any monitoring wells are necessary, a monitoring plan will be developed and submitted for review and approval from NMED. The monitoring plan will detail the parameters to be monitored, monitoring frequency, and procedures to be followed.

7.0 SCHEDULE

After the approval of this work plan by NMED, readiness review and site-preparation activities can begin. Preparation activities and implementation of the fieldwork is anticipated to require 4 to 6 months through demobilization from the site. Sample submittals to the SMO should be completed by this time. Receipt of analytical data are anticipated within 30 days of demobilization. After receiving data, a preliminary review

of the investigation results will be carried out by Laboratory and NMED personnel. An investigation report will be written and is currently due to NMED by January 31, 2008.

8.0 REFERENCES

The following list includes all documents cited in this report. Parenthetical information following each reference provides the author, publication date, and ER ID number. This information is also included in text citations. ER ID numbers are assigned by the ENV-ERS Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the ENV-ERS reference set titled "Reference Set for OU 1079."

Copies of the reference sets are maintained at NMED Hazardous Waste Bureau; DOE Los Alamos Site Office; the U.S. Environmental Protection Agency, Region 6; and at ENV-ERS. The sets were developed to ensure the administrative authority has all material needed to review this document, and they are updated periodically as needed. Documents previously submitted to the administrative authority are not included.

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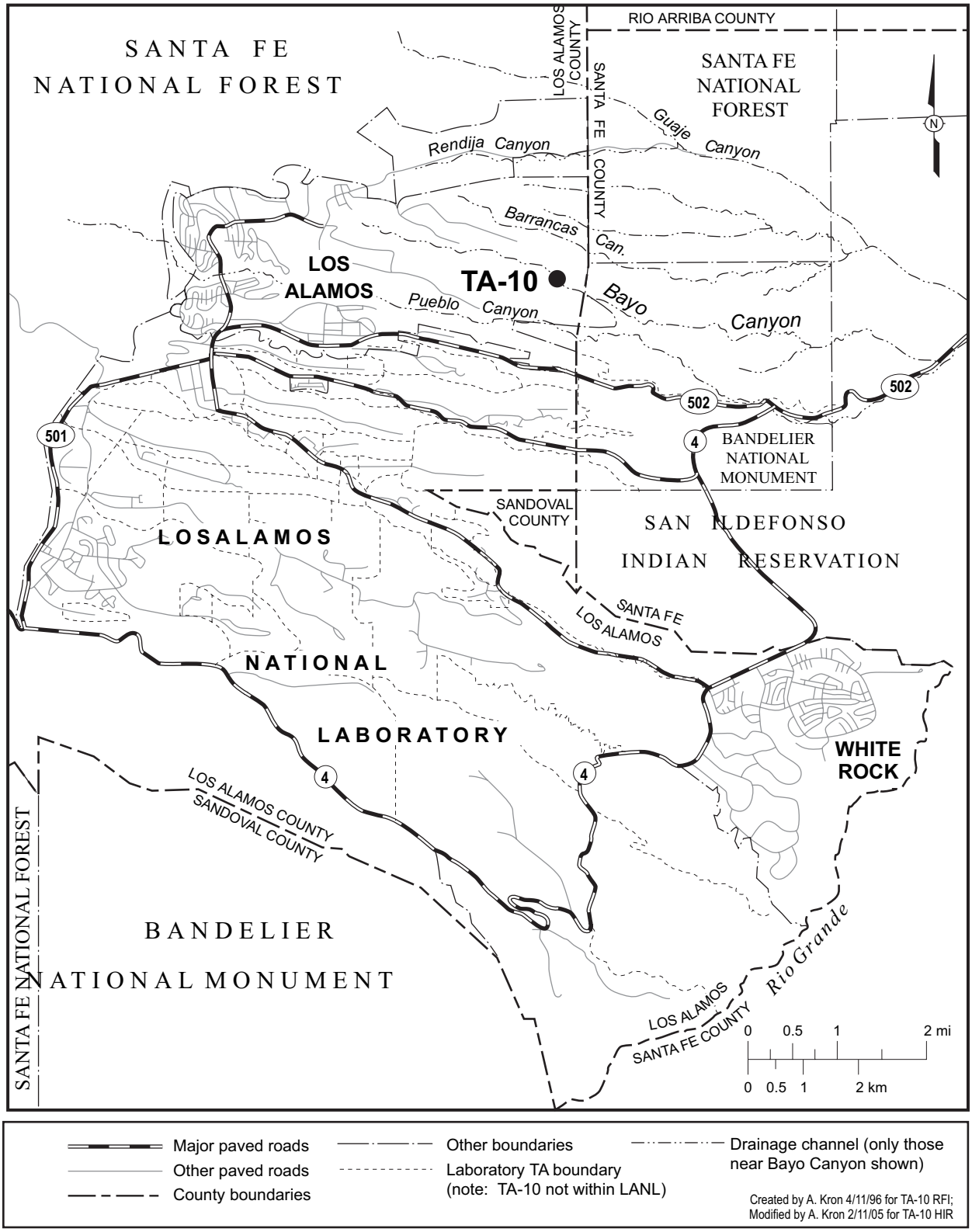

Figure 2.1-1. Locations of Bayo Canyon and TA-10 with respect to Laboratory TAs and surrounding landholdings

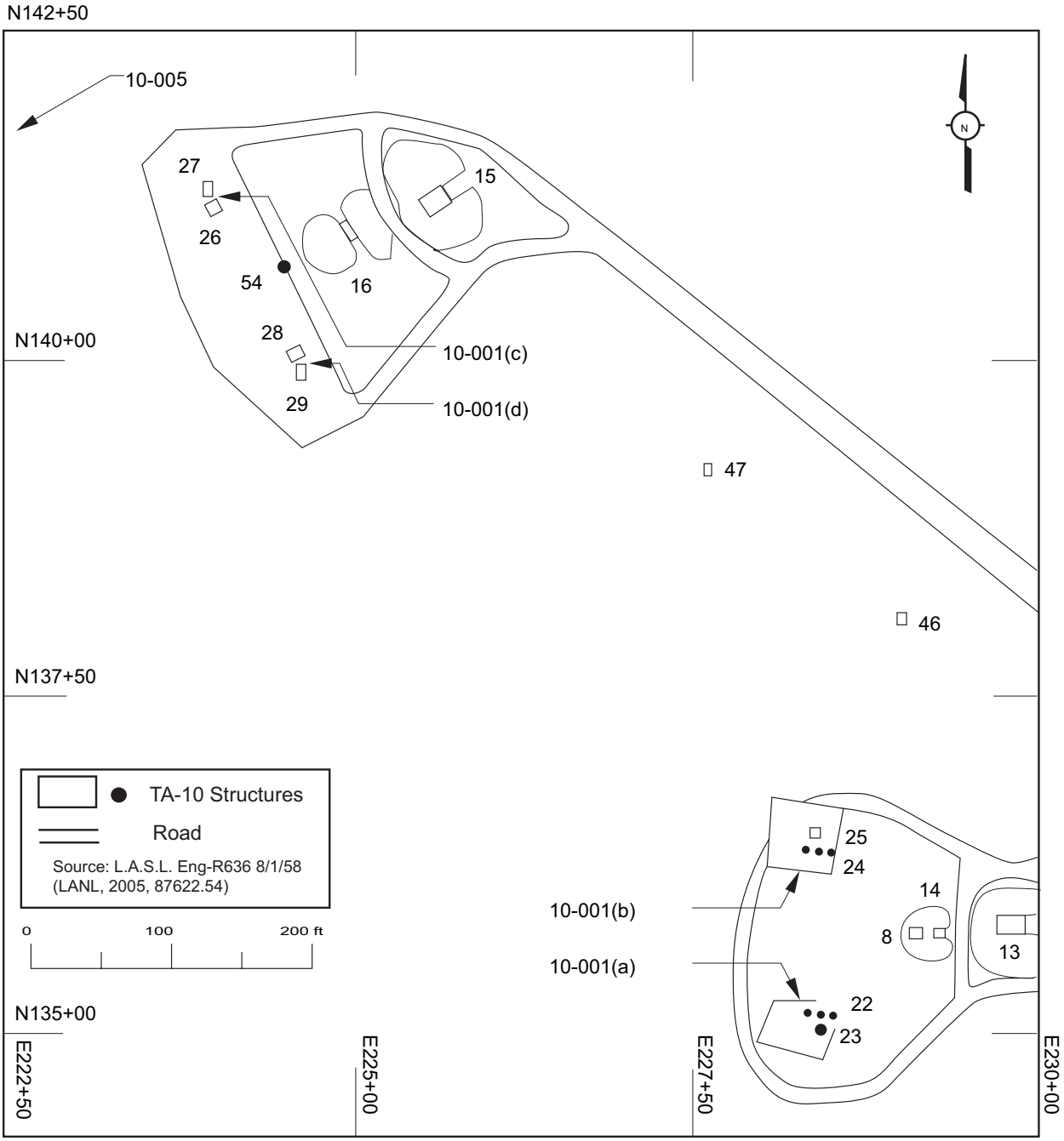

Figure 2.1-2. TA-10 firing sites with associated SWMUs

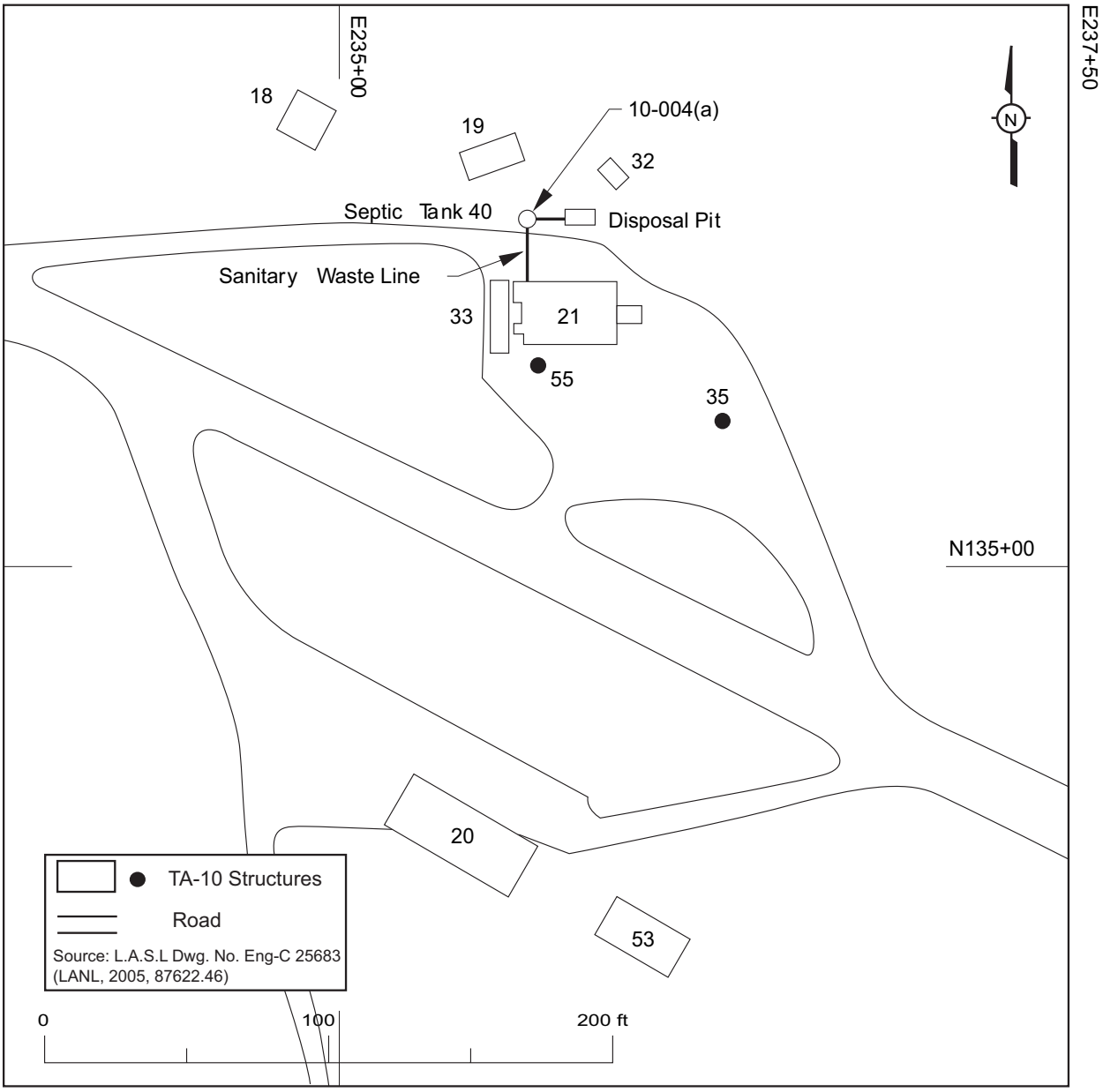

Figure 2.1-3. SWMU 10-004(a) and associated structures

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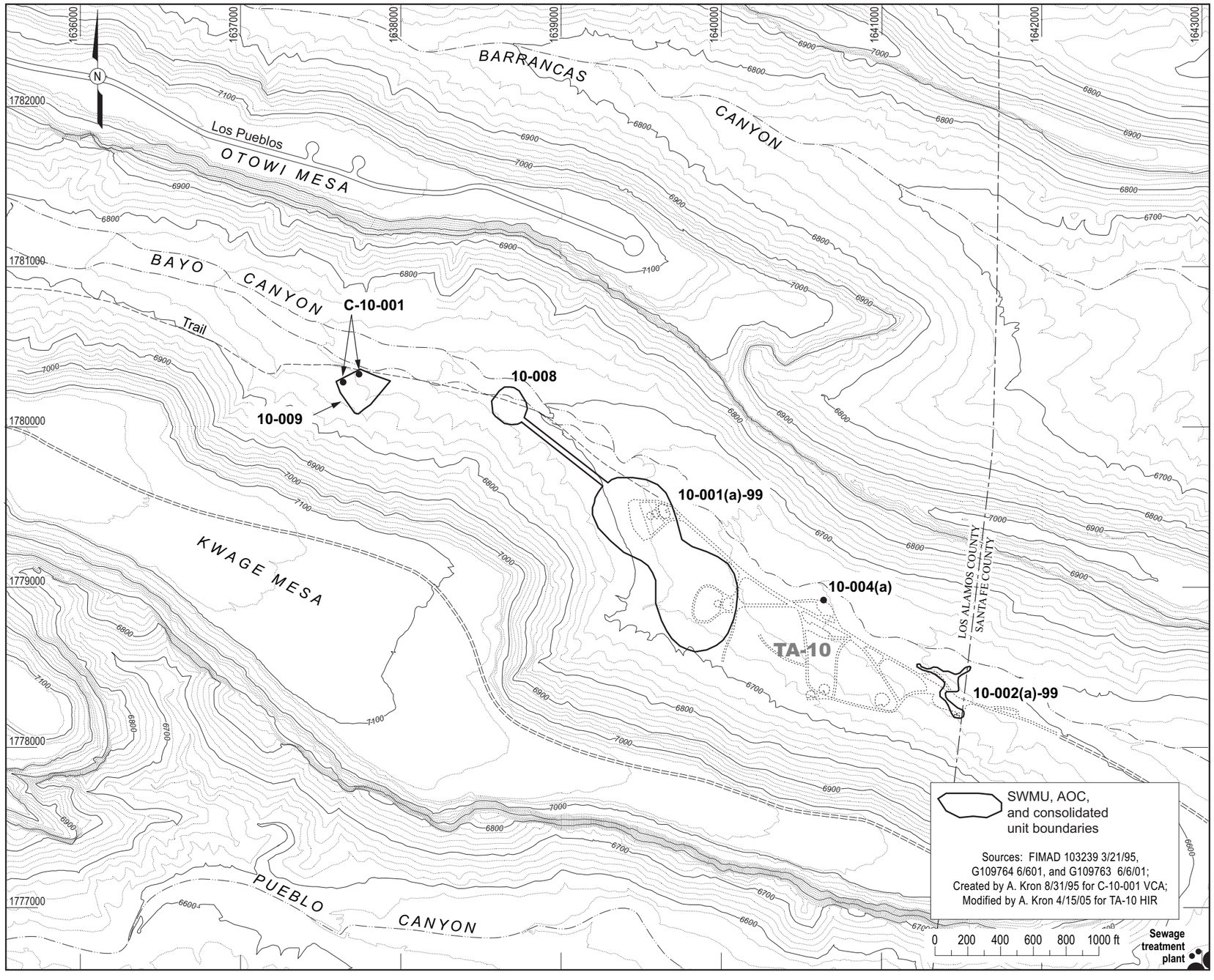

Figure 2.1-4. Locations of consolidated units, SWMUs, and AOCs

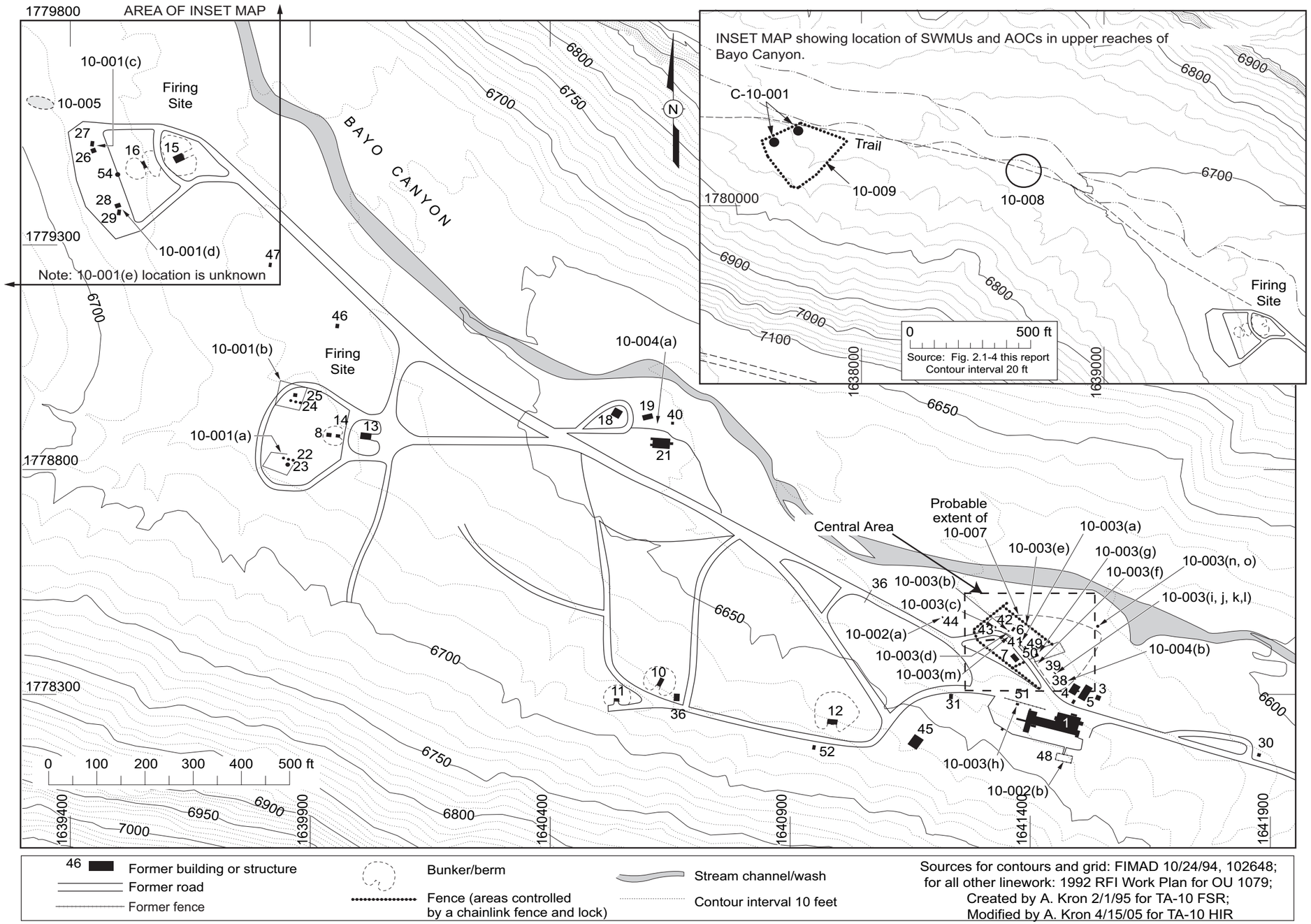

Figure 2.1-5. Locations of all SWMUs and AOCs at TA-10

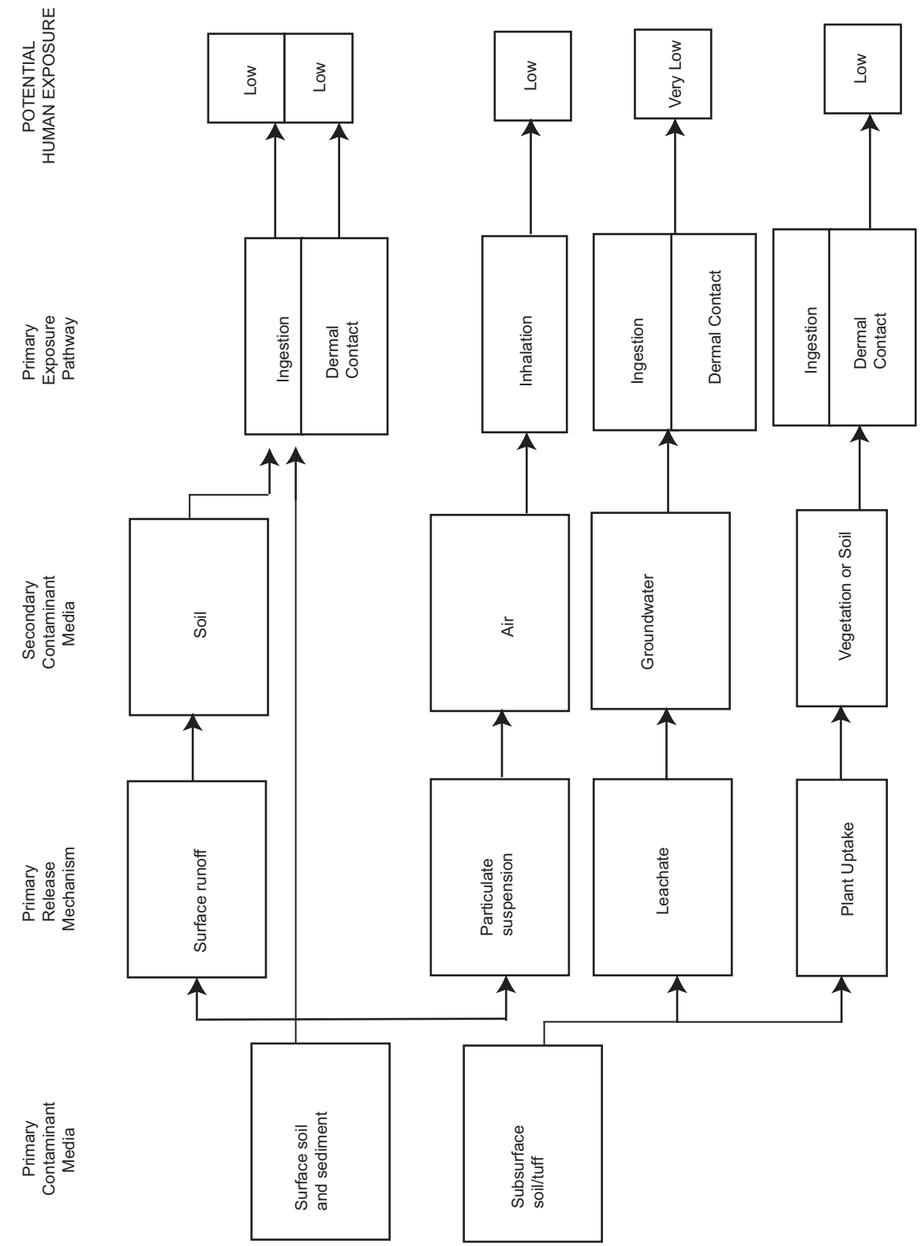

Figure 2.4-1. Conceptual model for human health exposure pathways at TA-10, Bayo Canyon

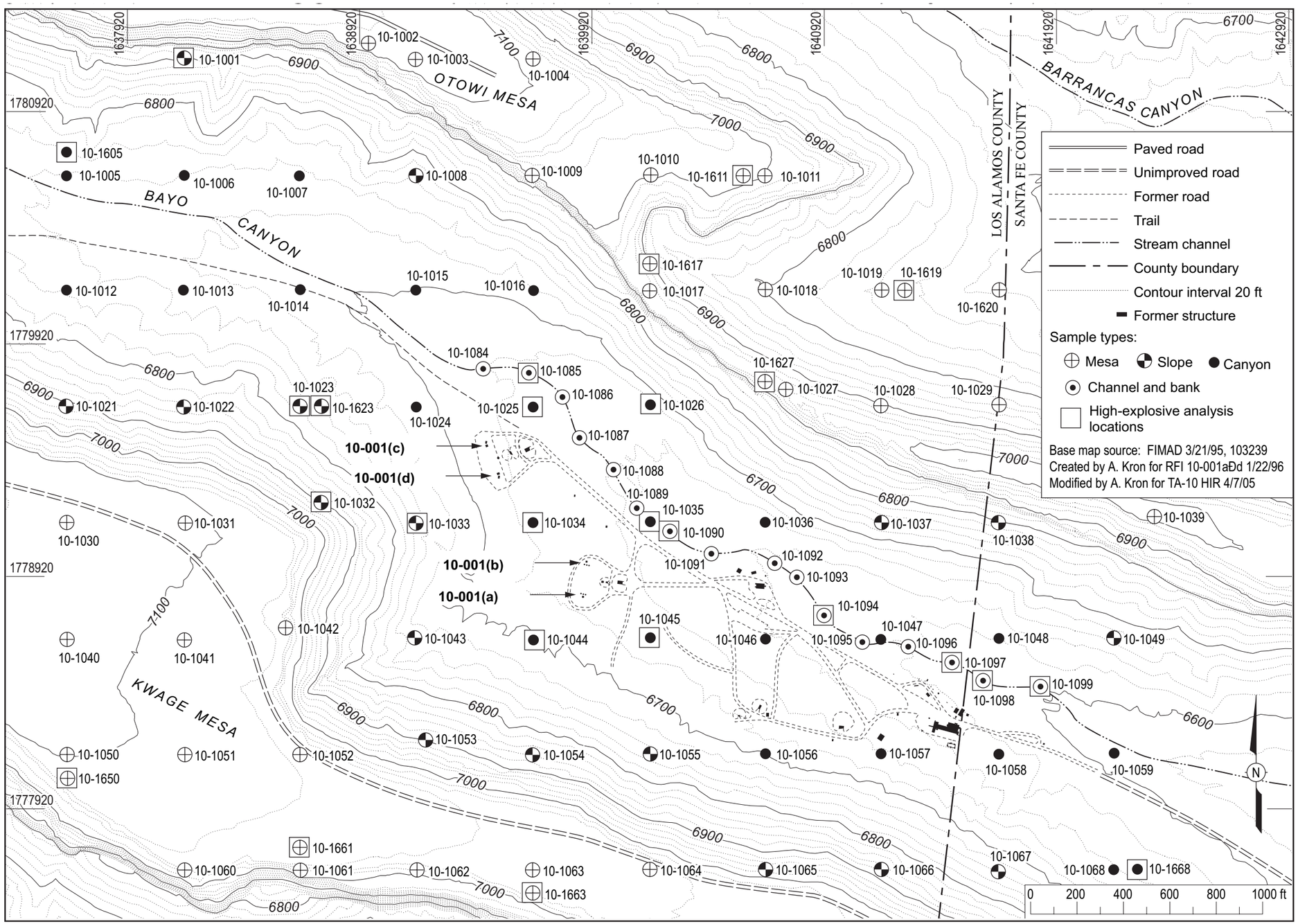

Figure 2.5-1. 1994 RFI surface samples collected for SWMU 10-001(a–d)

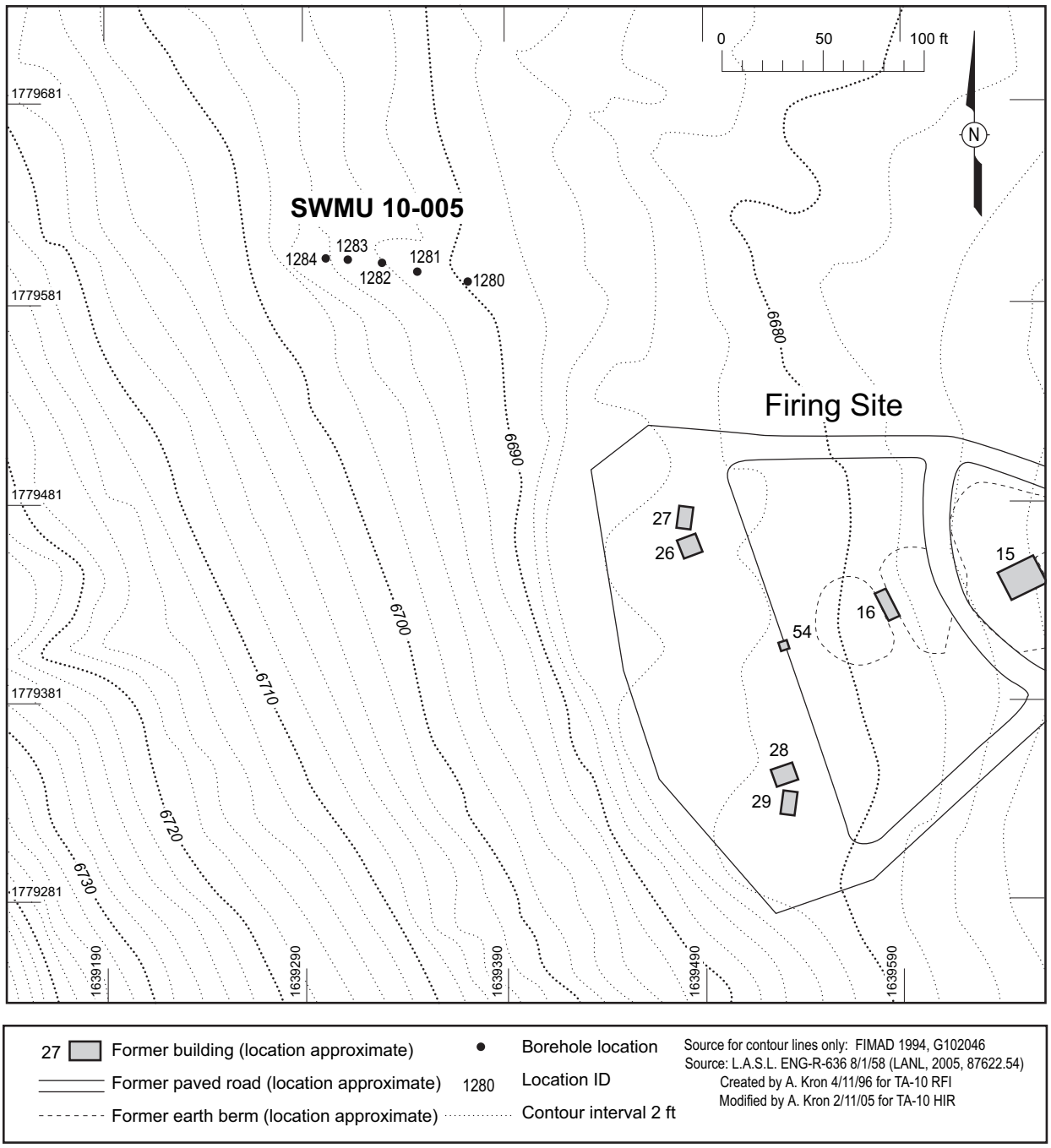

Figure 2.5-2. 1994 borehole locations at SWMU 10-005

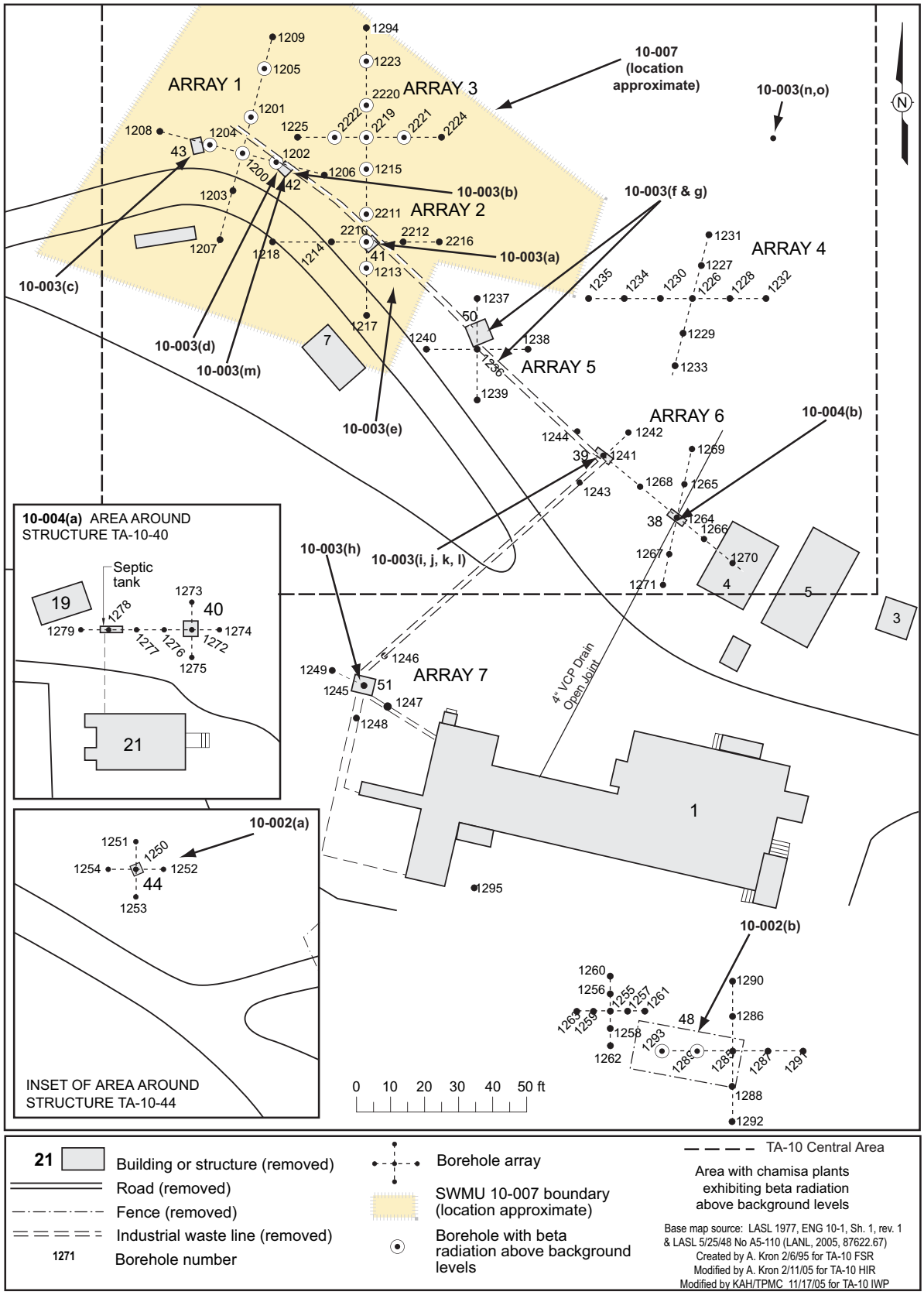

Figure 2.5-3. 1994 RFI borehole locations, Central Area

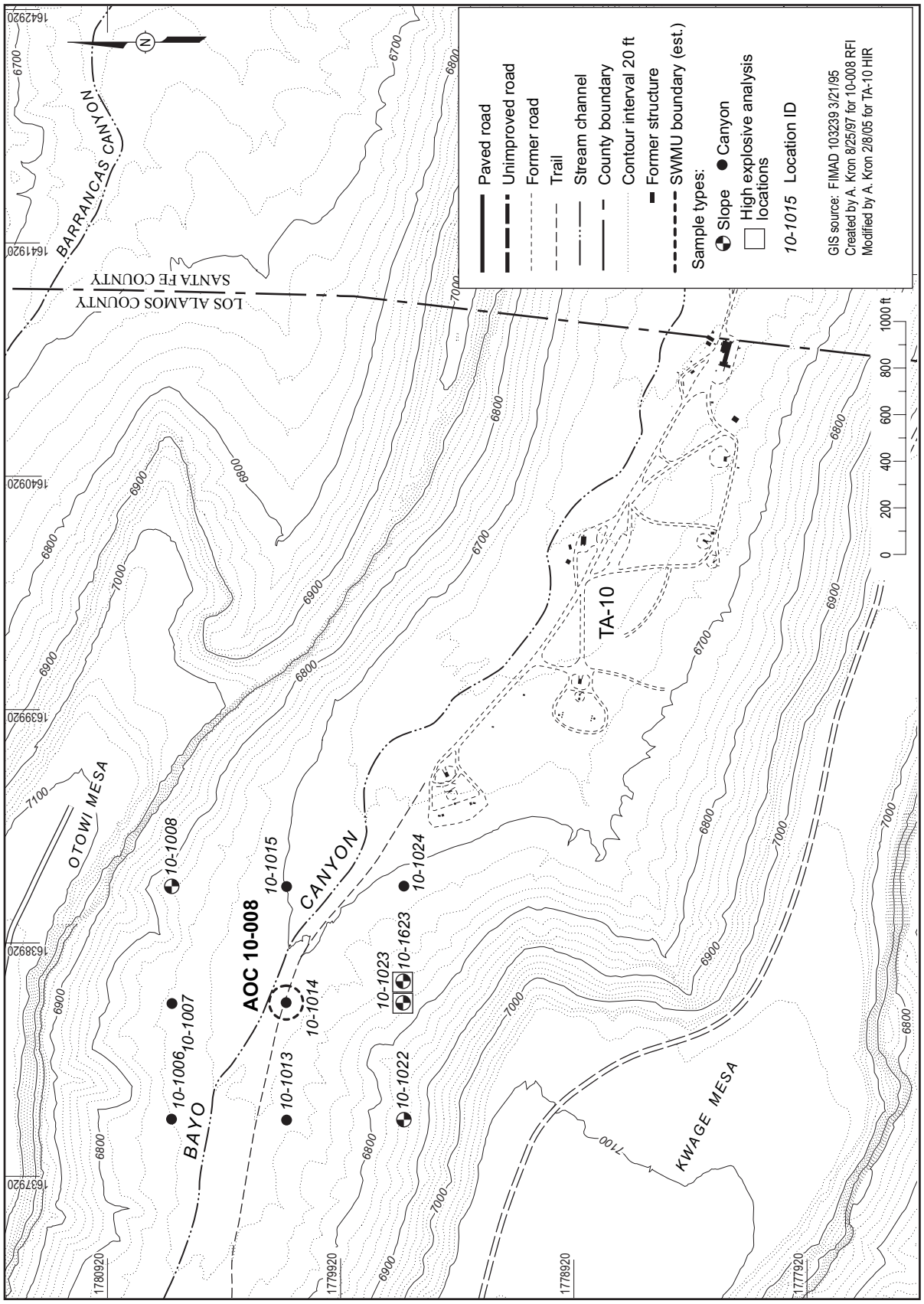

Figure 2.5-4. 1994 RFI sampling locations at AOC 10-008

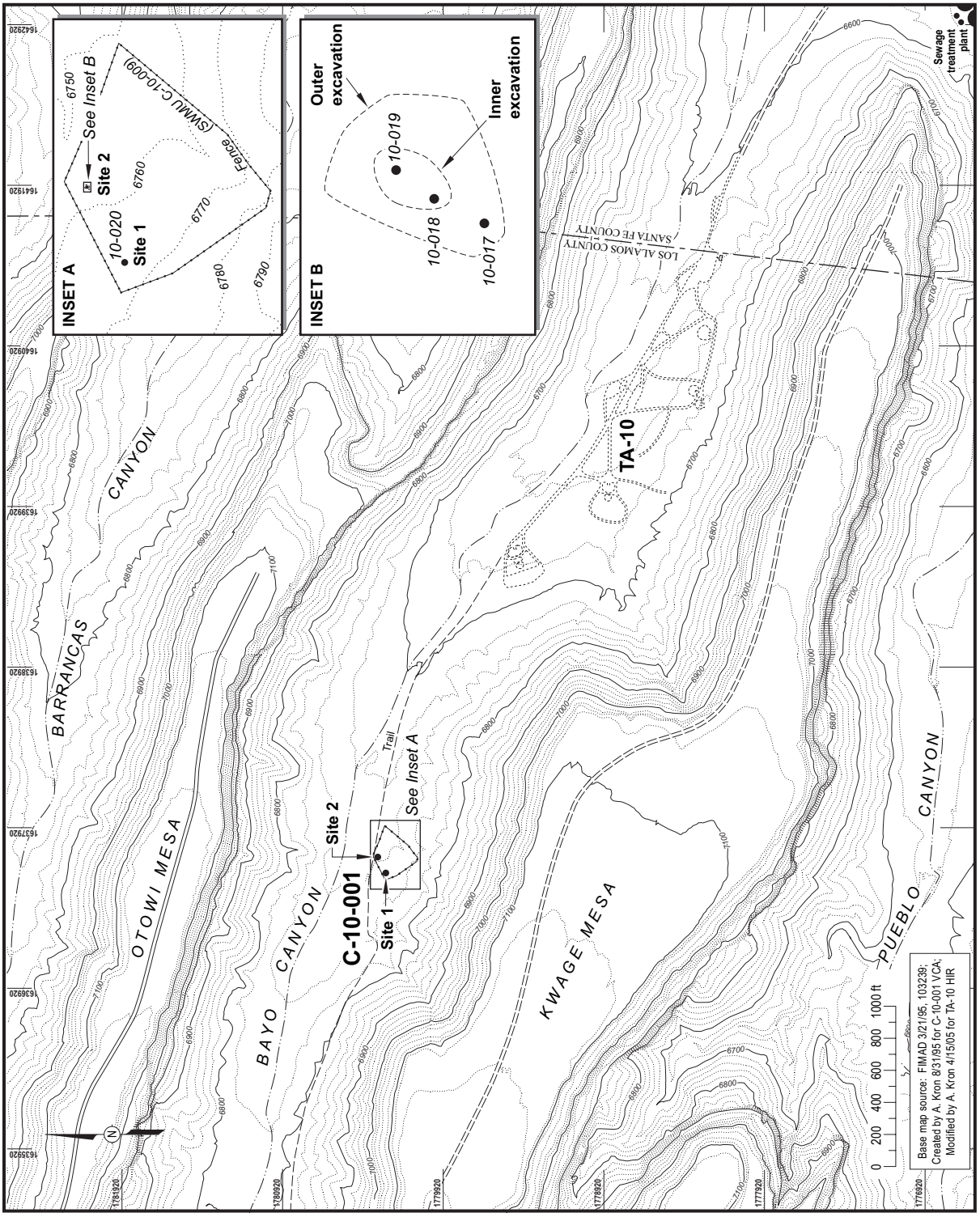

Figure 2.5-5. Locations of confirmation samples at AOC C-10-001

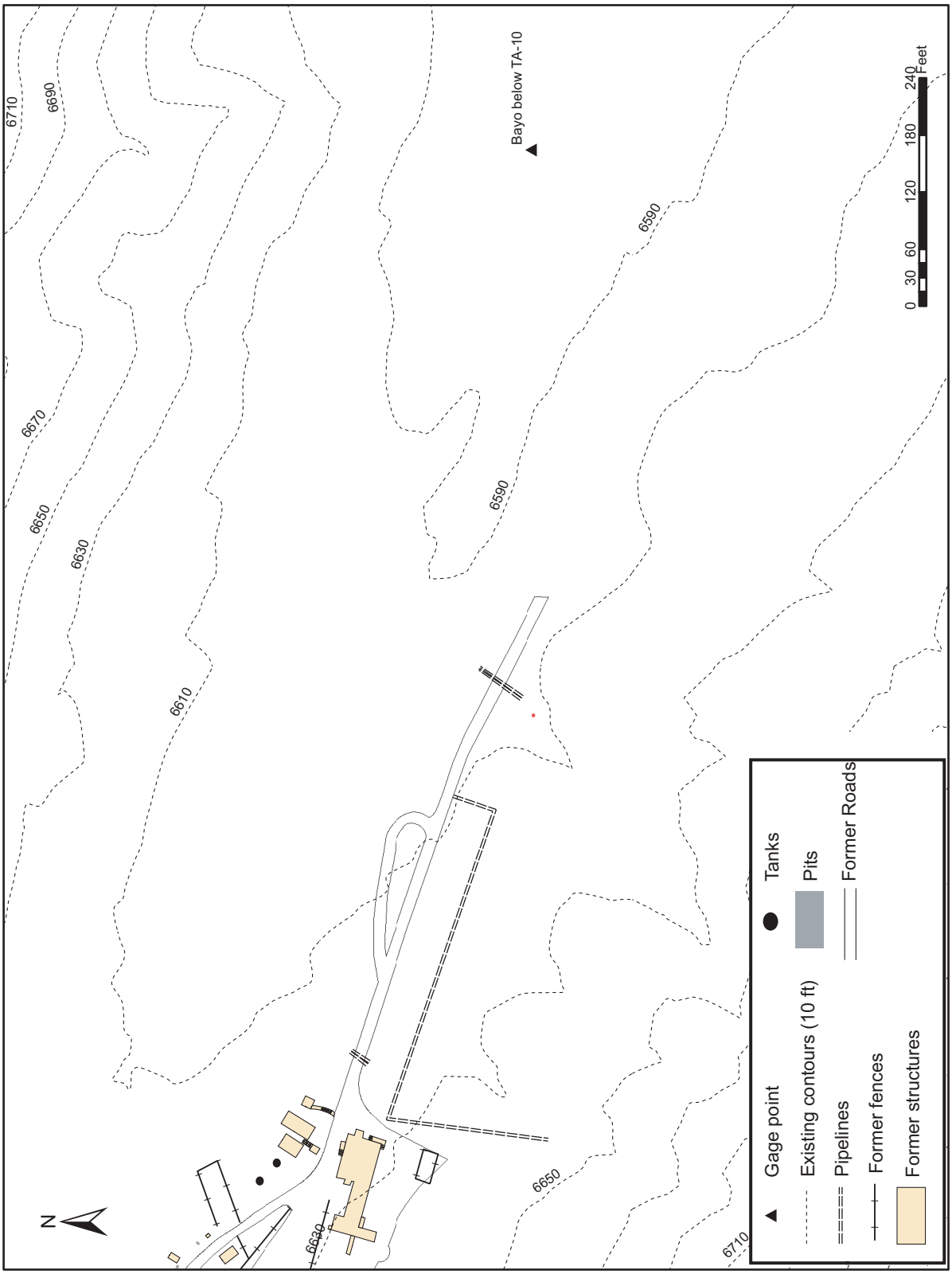

Figure 3.2-1. Location of stream gaging station east of TA-10

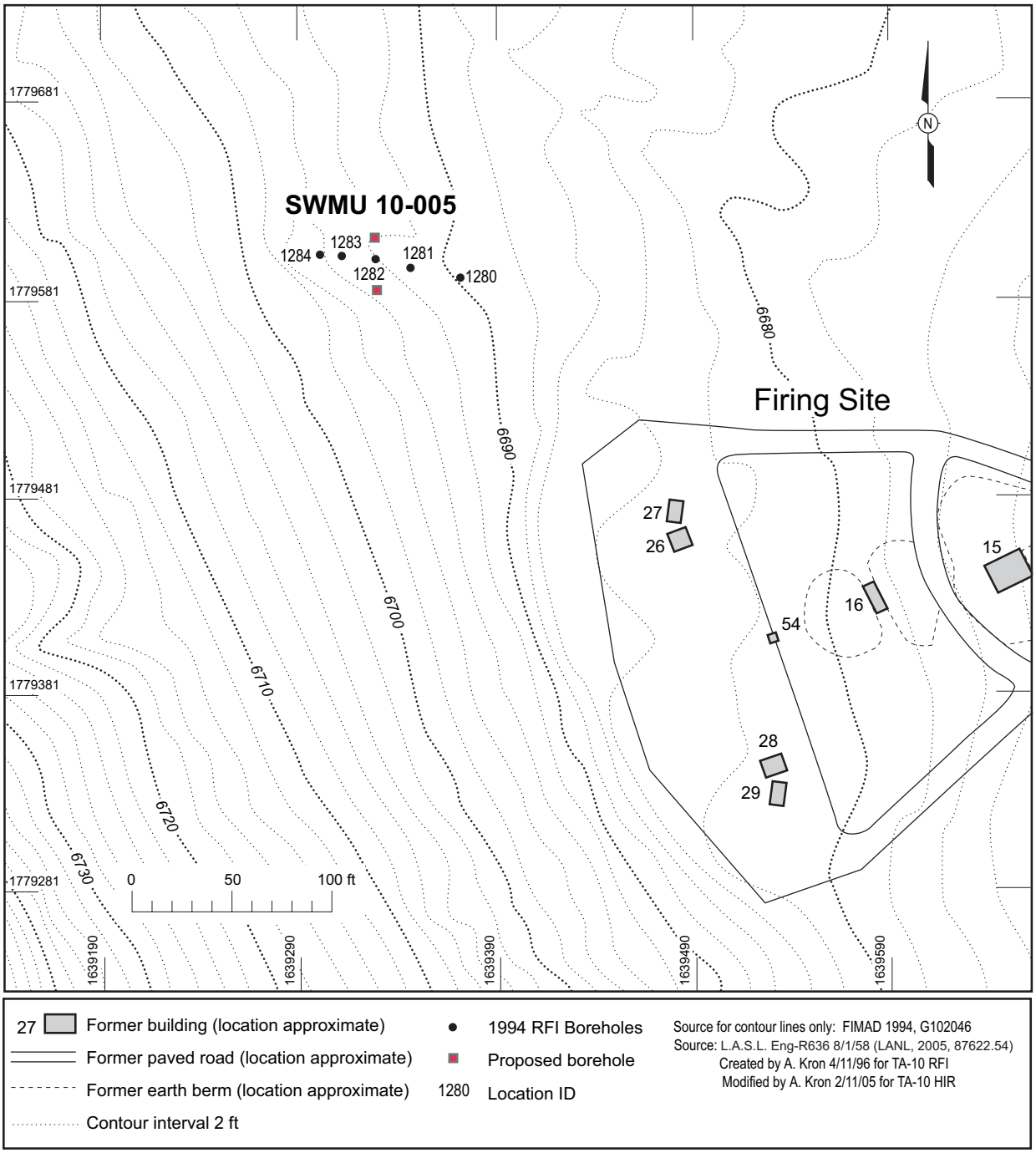

Figure 4.2-1. 1994 borehole locations at SWMU 10-005 and proposed borehole locations

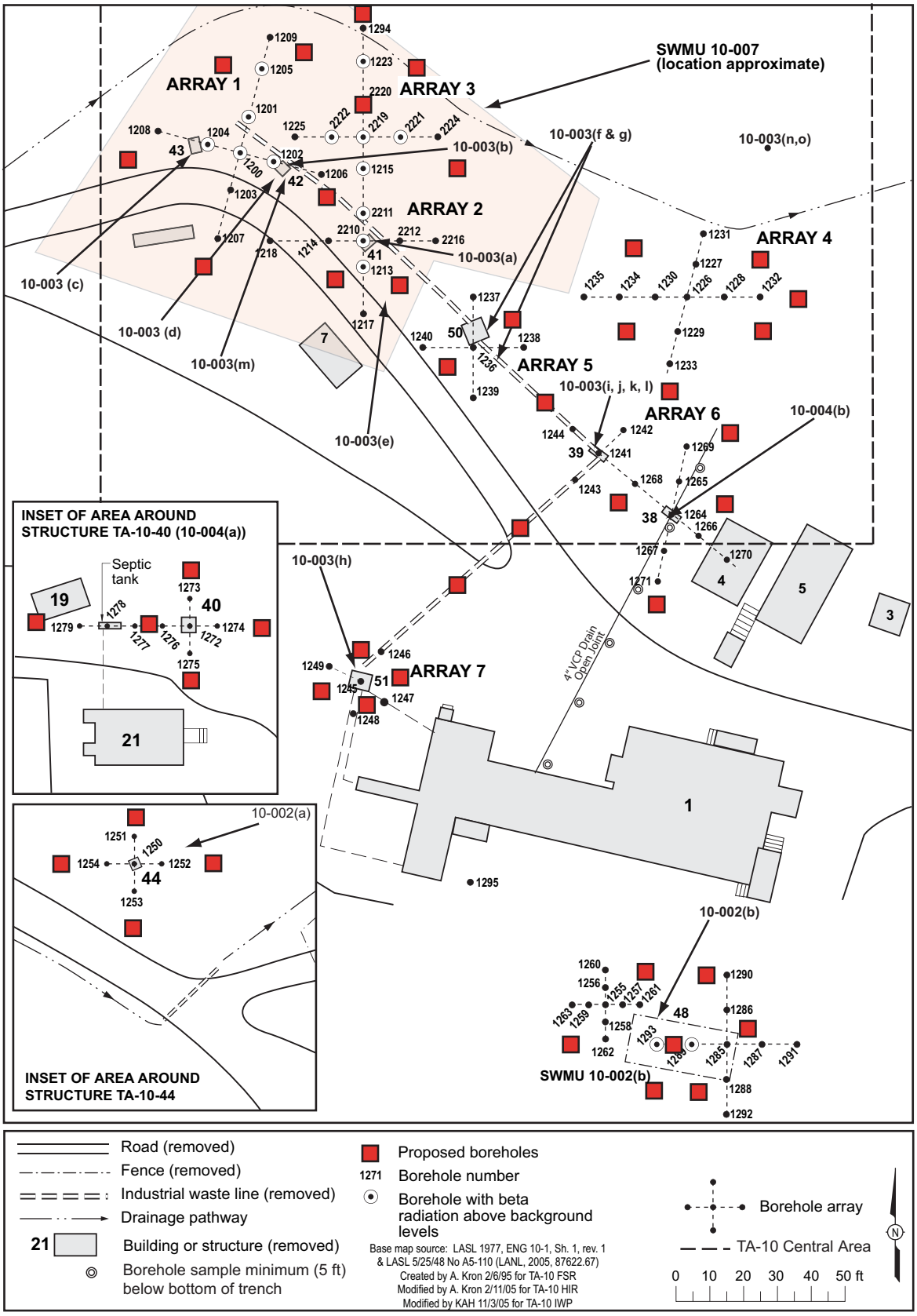

Figure 4.2-2. 1994 RFI boreholes and proposed boreholes in the Central Area

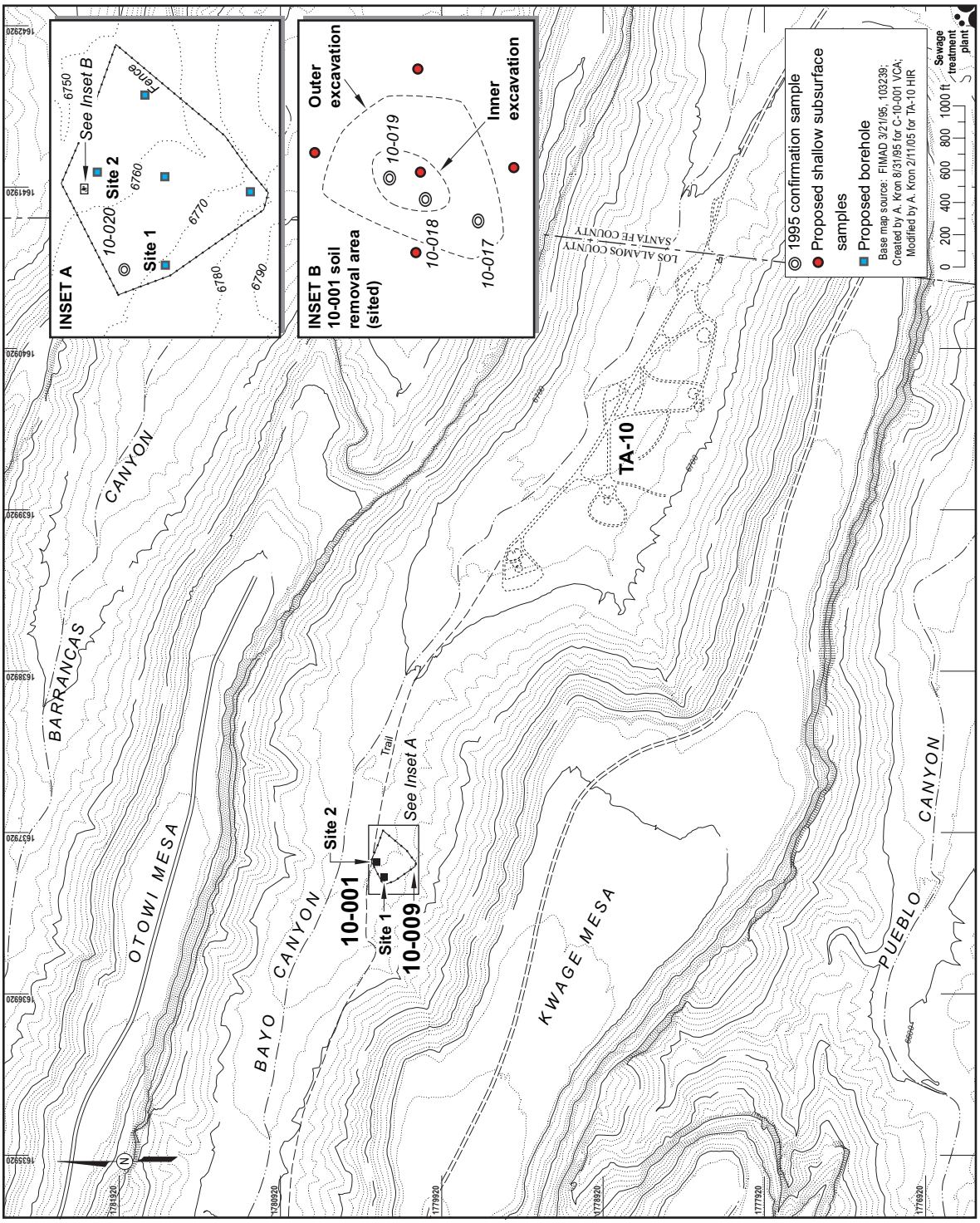

Figure 4.2-3. 1995 VCA confirmation sampling locations and proposed shallow sampling and borehole locations at AOCs C-10-001 and 10-009

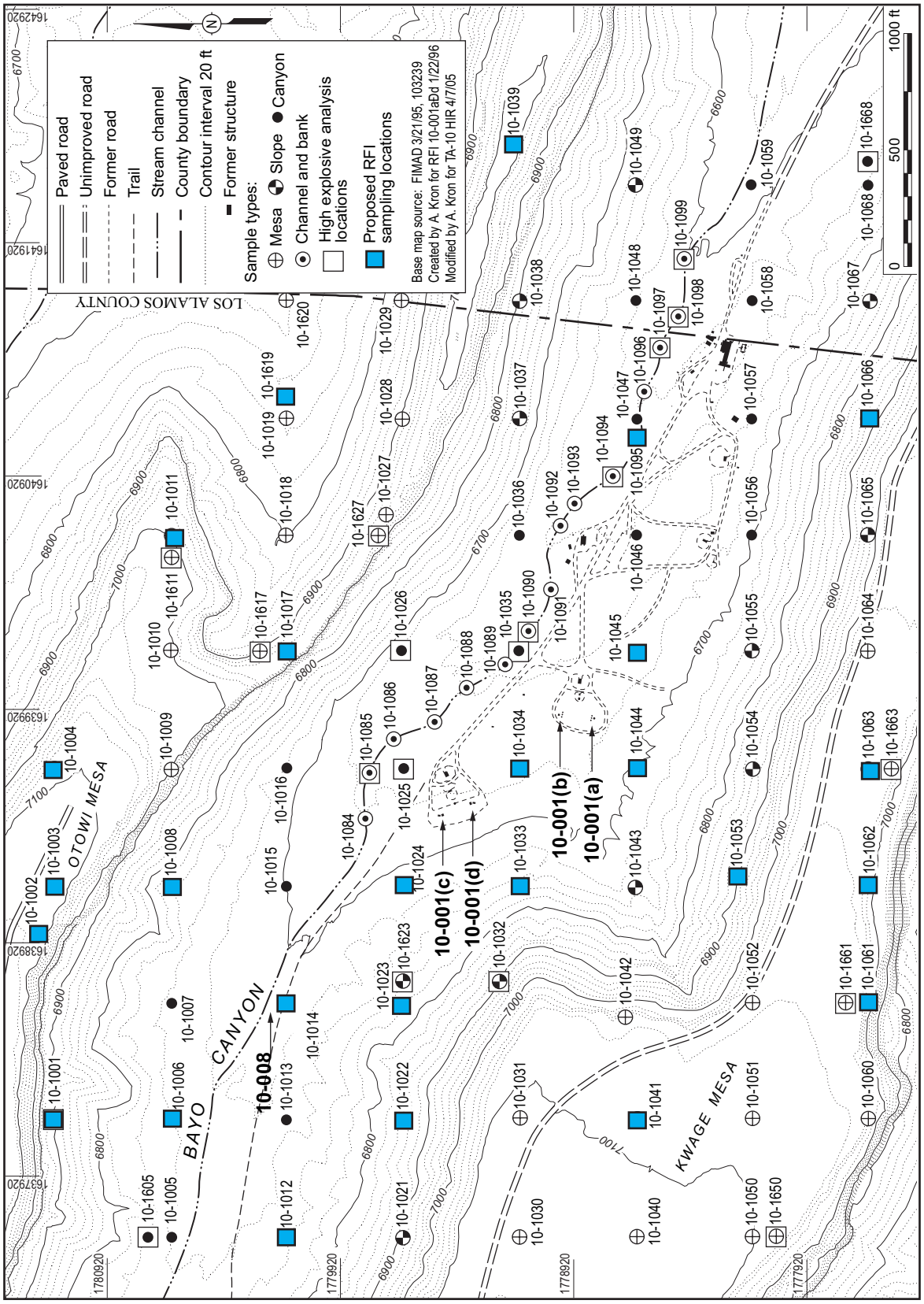

Figure 4.2-4. 1994 RFI shallow sampling locations and proposed sampling locations for surface and shallow subsurface site-wide nature and extent

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Table 4.0-1
Crosswalk between Consent Order and Investigation Work Plan

Consent Order	LANL Proposed Alternative Scope	Consent Order Requirements Met?
IV.C.5.c.ii Technical Area 10 Survey of Disposal Units The Respondents shall conduct a survey of the disposal units at TA-10. The Respondents shall determine the dimensions and total depth of each disposal shaft, pit, and other unit into which contaminants were disposed, and the base profile, topography, low elevation point, and down-slope end of the base of each disposal shaft, pit, and other unit into which waste was disposed.		
1. The dimensions and base elevations of each pit, shaft, and other unit shall be determined using as-built construction drawings and boring logs.	1. The engineering drawings are listed in HIR Appendix C (LANL 2005, 89658).	**Yes**
2. If unavailable, ground penetrating radar, magnetic surveys, or other methods shall be used.	2. None. (See section 4.1).	**Yes**
3. The methods used to evaluate the disposal units shall be approved by the Department prior to implementation.	3. None. Work will be performed in accordance with the approved investigation work plan.	**Yes**
4. The survey shall be completed prior to implementation of the drilling explorations under Section IV.C.5.c.iii. *(Numbering added to facilitate discussion)*	4. None. The survey will be completed prior to implementation of drilling.	**Yes**
IV.C.5.c.iii Technical Area 10 Drilling Explorations The Respondents shall submit to the Department for the review and approval a work plan at TA-10. The work shall be conducted in accordance with Section IX.B. The work plan shall meet the following requirements:		
1. The type and concentrations of contaminants present at, and off-site from, each SWMU and/or AOC.	1. None. Historical data are presented in the HIR (LANL 2005, 89658).	**Yes**
2. The presence of subsurface moisture and the extent of any zones of saturation in the canyon alluvium or bedrock above the regional aquifer.	2. None. Moisture will be noted during borehole logging.	**Yes**
3. Prior to the implementation of drilling explorations, the respondents shall determine the locations, dimensions, remaining structures, and the total depths of facility related features at each SWMU and AOC, and the types of contaminants released from each SWMU and AOC.	3. None. Locations and dimensions of structures and types of contaminants are described in the engineering drawings listed in the HIR (LANL 2005, 89658). Geophysical investigations will be performed as noted in number 2 above.	**Yes**

Table 4.0-1 (continued)

Consent Order	LANL Proposed Alternative Scope	Consent Order Requirements Met?
The characterization shall be completed utilizing data acquired from samples, drill cuttings, cores, and downhole geophysical data. The subsurface conditions shall be characterized by evaluating samples of soil, rock, sediments, and groundwater for field screening and laboratory chemical analysis. The following are requirements for completing subsurface explorations:	Discussions of former structures and past releases are presented in the HIR.	
1.The exact location of former SWMU 10-002(b) shall be identified and a minimum of ten borings shall be advanced to depths of 25 ft bgs in the vicinity of the former disposal pit.	1. None. Four boreholes were drilled within the footprint of SWMU 10-002(b) during the 1994 RFI. Based on direction provided by NMED, seven additional boreholes will be drilled and sampled for a total of 11 boreholes at SWMU 10-002(b).	**Yes**
2. Ten borings shall be advanced to depths of 30 ft bgs in the vicinity of the leach field.	2. None. Array 4 targets the vicinity of the leach field; ten borings were advanced at Array 4 to a minimum depth of 50 ft bgs. Based on direction provided by NMED, six additional boreholes will be drilled and sampled around Array 4 for a total of 16 boreholes in the vicinity of the leach field.	**Yes**
3. The presence or absence of drain lines at former SWMU 10-004(b) shall be determined. If present, the drain lines shall be removed, and samples shall be collected from the excavation at 20-ft intervals for field screening and laboratory analyses. If the drain line is not excavated, borings shall be advanced to depths at 25-ft intervals along the entire length of the drain line to depths of five ft below the base of the drain line trench.	3. None. Site will be checked with geophysical surveys to determine if the drain line remains in place. LANL will collect samples in accordance with the results of the surveys and as required.	**Yes**
4. The drilling activities shall be conducted in accordance with Section X of this Consent Order.	4. None.	**Yes**
5. The boring locations shall be approved by the Department prior to the start of drilling activities. The borings shall be advanced using hollow-stem auger drilling methods, where practicable, or other drilling methods approved by the Department.	5. None.	**Yes**
6. Two borings shall be advanced to first water to evaluate for fractures in rock beneath the alluvium and the presence of perched groundwater at depth beneath the site.	6. No borehole is planned to a depth of first water since no shallow or intermediate water has been encountered at TA-10. Regional well R-24 will be drilled as soon as July 2005 to the east of the TA-10 site. Based on the findings at R-24, additional borings and wells will be planned if intermediate water is discovered.	**No**

Table 4.0-1 (continued)

Consent Order	LANL Proposed Alternative Scope	Consent Order Requirements Met?
IV. C.5.c.iv Technical Area 10 Soil and Rock Sampling		
The Respondents shall, at a minimum, conduct soil and rock sampling during subsurface explorations activities at TA-10 in accordance with the following requirements:	See investigation work plan section 5.2	
1. Soil samples shall be collected from each boring at five-ft intervals and from the native material directly below the base of each SWMU or AOC structure or excavation. A sample also shall be obtained at the maximum depth of each boring.	1. None.	**Yes**
2. Samples shall be collected and screened in accordance with the methods described in Section IX.B of this Consent Order.	2. Field-screening methods conform to the requirements of section IX.B with the exception of XRF screening. XRF screening does not provide adequate detection limits to be useful in guiding sample collection at TA-10.	**No**
3. Two cores, or the number specified in the Department approved work plan, shall be obtained from selected borings, at depths approved by the Department, for permeability testing in accordance with Section IX. B of this Consent Order.	3. None.	**Yes**
4. Two samples, or the number specified in the Department-approved work plan shall be selected from each boring for submittal to a laboratory for analysis of VOCs, SVOCs, explosive compounds, perchlorate, TAL metals, and cyanide.	4. None.	**Yes**
5. The sample displaying the greatest field-screening evidence of VOC concentrations shall be selected for submittal to the analytical laboratory for chemical analysis.	5. None.	**Yes**
6. If field-screening evidence of contamination is not observed in a boring, the sample obtained from the native material located directly below the limits of the original construction excavation shall be submitted for the chemical analyses.	6. None.	**Yes**
7. The sample obtained from the maximum depth of each boring also shall be submitted to an analytical laboratory for the analyses.	7. None.	**Yes**
8. All borings not completed as monitoring wells shall be properly plugged and abandoned in accordance with Section X.D of this Consent Order. The Respondents shall provide a status report describing the details of borehole abandonment to the Department as an appendix to the investigation report.	8. None. See investigation work plan section 5.6	**Yes**

Table 4.0-1 (continued)

Consent Order	LANL Proposed Alternative Scope	Consent Order Requirements Met?
9. Evaluate the need for removal of the landfill material at SWMU 10-007 for disposal at an approved landfill. Collect samples from the limits of the excavation at locations specified by the Department.	9. Remedial alternatives are evaluated in section 4. Boreholes are proposed beyond the inferred limits of SWMU 10-007.	**Yes**
IV. C.5.c.v Technical Area 10 Groundwater Well Installation The Respondents shall submit to the Department for review and approval a work plan for groundwater well installation at TA-10. The work shall be conducted in accordance with Section IX.B. Implementation of the approved work plan shall meet the following requirements, subject to the procedures of Section III.M of this Consent Order:		
1. Two borings shall be advanced to depths intersecting the first significant presence of intermediate zone perched groundwater downgradient of the former liquid waste treatment facility at locations approved by the Department. The respondents shall construct monitoring wells in the borings in accordance with section X of the Consent Order if groundwater is observed in zones above the regional aquifer.	1. Water zones above the regional aquifer are not anticipated at TA-10 and no boreholes deeper than 55 ft are proposed. If intermediate saturated horizons are encountered during drilling of R-24, just downgradient from TA-10, additional boreholes targeting these horizons beneath TA-10 will be proposed.	**No**
2. One well shall be installed intersecting the regional aquifer at a location approved by the Department.	2. Regional groundwater monitoring well R-24 is located immediately down canyon from TA-10 and will provide the required data. R-24 is being installed as part of the interim site-wide groundwater monitoring program, independently of the investigation prescribed by this work plan.	**Yes**
3. Core and groundwater samples shall be collected from the boring prior to well construction. The core samples shall be collected to evaluate hydraulic parameters, Kd, and for potential contaminants.	3. None. Groundwater monitoring will be performed in accordance with the interim site-wide groundwater monitoring plan required by Section IV.A.3 of the Consent Order.	**Yes**

Table 4.0-1 (continued)

Consent Order	LANL Proposed Alternative Scope	Consent Order Requirements Met?
IV. C.5.c.vi Technical Area 10 Groundwater Monitoring The respondents shall monitor and sample all wells specified below containing alluvial, intermediate, and regional groundwater in accordance with the Interim Plan approved by the Department under Section IV.A.3.b that meets the requirements listed below, subject to the procedures in Section III.M of this Consent Order. Such monitoring and sampling shall also be conducted in accordance with Section IX of this Consent Order. After completing the installation of all additional monitoring wells in the Los Alamos Canyon watershed as described in Section IV.B and subject to the procedures in Section III.M of this Consent Order, the Respondents shall submit to the Department for review and written approval a watershed-specific long-term groundwater monitoring plan for Los Alamos Canyon. Upon Department approval of the long-term monitoring plan for Los Alamos Canyon watershed, the requirements of the long-term monitoring plan shall apply and shall supersede the requirements of the Los Alamos Canyon watershed section of the Interim Plan.		

Table 4.2-1
Sampling Activities

Consolidated Unit / SWMU / AOC	Figure Number	Number of Sampling Locations	Number of Samples*	Screening Frequency	Sample Media	Issue Addressed
Consolidated Unit 10-001(a)-99	4.2-1	2 boreholes	Minimum 4 samples + 1 QA/QC suite	Every 5 ft	Qal, Qbo, Qbof, Qbog	Inorganic chemical and strontium-90 detections in borehole sampling locations See section 2.6.1; data requirements 4 and 5
Consolidated Unit 10-002(a)-99 Central Area	4.2-2	11 boreholes	Minimum 22 samples + 2 QA/QC suite	Every 5 ft	Qal, Qbo, Qbof, Qbog	Inorganic chemical and organic chemical detections in borehole sampling locations See section 2.6.2.1; data requirements 1–8
Consolidated Unit 10-002(a)-99 Excluding Central Area	4.2-2	30 boreholes	Minimum 60 samples + 6 QA/QC suite	Every 5 ft	Qal, Qbo, Qbof, Qbog	Determine lateral extent of inorganic, organic and strontium-90 detections outside the Central Area See section 2.6.2.2; data requirements 1–14
SWMU 10-004(a)	4.2-2	5 boreholes	Minimum 10 samples + 1 QA/QC	Every 5 ft	Qal, Qbo, Qbof, Qbog	Determine lateral extent of inorganic and organic detections See section 2.6.3; data requirements 1–7
AOC C-10-009	4.2-3	5 boreholes	Minimum 10 samples + 1 QA/QC	Every 5 ft	Qal, Qbo, Qbof, Qbog	No characterization data exists See section 2.6.5
Consolidated Unit 10-001(a)-99	4.2-4	26 shallow sampling locations	52 samples + 6 QA/QC suite	Each sample	ALLH, SED	Inorganic, organic and strontium-90 detections in surface sampling locations See section 2.6.1; data requirements 1–5 and 8.
AOC C-10-001	4.2-3	3 shallow sampling locations	6 samples + 1 QA/QC suite	Each sample	ALLH	RCRA samples not previously collected See section 2.6.4
SWMU 10-006	NA	To be determined based on field evidence	To be determined based on field evidence	Each sample	ALLH	No characterization data exists, location is unknown.

* From each borehole, a minimum of two samples will be collected for fixed laboratory analysis, one from the highest field VOC field-screening result, and one from the maximum depth of the borehole (minimum depth of 30 ft bgs). In the absence of elevated field-screening results a sample will be collected from the first native material below the target structure. Shallow samples will collected at 0.0 to 0.5 ft bgs and 1.5 to 2.0 ft bgs and will continue to depths greater than 2 ft bgs if indicated by field screening or previous sampling.

Table 4.3-1
Corrective Action Requirements

Citation	Action	Basic Requirements
DOE 5400.5 II (5) (a)	Release of property having residual radioactive material	Release of real property shall be in accordance with the guidelines and requirements for residual radioactive material presented in Chapter IV. These guidelines and requirements apply to both DOE-owned facilities and to private properties that are being prepared by DOE for release.
DOE 5400.5 IV (2) (e)	Implement ALARA	The monitoring, cleanup, and control of residual radioactive material are subject to the ALARA policy of this DOE Order. Applications of ALARA policy shall be documented and filed as a permanent record.
DOE 5400.5 II (2) (b)	Evaluations under the As Low As Reasonably Achievable (ALARA) Process	"Therefore, except for meeting requirements of the National Environmental Policy Act, qualitative analyses are acceptable, in most instances, for ALARA judgments, especially where potential doses are well below the dose limit."
DOE 5400.5 IV (3)	Limit radiation exposures to public	The basic public dose limits for exposure to residual radioactive material, in addition to natural occurring "background" exposures, are 100 mrem (1 mSv) effective dose equivalent in a year.
DOE Albuquerque memo dated June 13, 2000 (DOE 2000, 67153)	Limit radiation exposures to public	Limit dose to 15 mrem per year over background.
DOE 5400.5 IV (4) (a)	Residual concentrations of other radionuclides	Guidelines for residual concentrations of radionuclides other than radium and thorium shall be derived from the basic dose limits by means of an environmental pathway analysis using specific property data where available. Residual concentrations of radioactive material in soil are defined as those in excess of background concentrations averaged over an area of 100 m^2.
DOE 5400.5 IV (4) (a) (1)	Elevated local concentrations	If the average concentration in any surface or below-surface area less than or equal to 25 m^2, exceeds the limit or guideline by a factor of $(100/A)^{0.5}$, (where A is the area [in square meters] of the region in which concentrations are elevated), limits for "hot spots" shall also be developed and applied. Reasonable efforts shall be made to remove any source of radionuclide that exceeds 30 times the appropriate limit for soil, irrespective of the average concentration in the soil.
NESHAPS 40 CFR §61.92, 61.93 Subpart H	Limit doses because of emissions of radionuclides to the air	Emissions of radionuclides to the ambient air from DOE facilities shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 10 mrem/yr (0.1 mSv/yr).
Consent Order	Protection of human health and the environment Nonradionuclides only	Corrective measures will be required if NMED determines that there has been a release of contaminants into the environment at a SWMU or AOC and that corrective action is necessary to protect human health or the environment from such a release.
DOE 5400.5 IV (7)	Supplemental limits and exceptions	If special specific property circumstances indicate that the guidelines or authorized limits established for a given property are not appropriate for any portion of that property, then DOE-Field Office Manager may request, through the Program Office, that supplemental limits or an exception be applied.

Table 5.0-1
Summary of Field Investigation Methods

Method	Summary
Sample Containers and Preservation	Specific requirements/processes for sample containers, preservation techniques, and holding times are based on Environmental Protection Agency guidance for environmental sampling, preservation, and quality assurance. Specific requirements for each sample are printed on the sample collection logs provided by the SMO. All samples are preserved by placing them in insulated containers with ice to maintain a temperature of 4˚C. Additional preservation requirements, such as adding nitric acid or other preservatives, may apply to different media or analytical methods.
Handling, Packaging and Transporting Field Samples	Field team members seal and label samples before packing and ensure that the sample and transport containers are free of external contamination. Field team members package all samples so as to minimize the possibility of breakage during transportation.After all environmental samples are collected, packaged, and preserved, a field team member transports them to either the SMO or an SMO approved radiation screening laboratory under chain-of-custody. The SMO arranges to ship samples to analytical laboratories. The field team member must inform the SMO and/or the radiation screening laboratory coordinator when levels of radioactivity are in the action-level or limited-quantity ranges.
Sample Control and Field Documentation	The collection, screening, and transport of samples is documented on standard forms generated by the SMO. These include sample-collection logs, chain-of-custody forms, and sample-container labels. Collection logs are completed at the time of sample collection and are signed by the sampler and a reviewer who verifies the logs for completeness and accuracy. The corresponding labels are initialed and applied to each sample container, and custody seals are placed around container lids or openings. Chain-of-custody forms are completed and assigned to verify that the samples are not left unattended.
Field Quality Control Samples	Field quality-control samples are collected in accordance with Consent Order requirements as follows: • Field Duplicates at a frequency of 10%, collected at the same time as a regular sample and submitted for the same analyses. • Equipment Rinsate Blanks at a frequency of 10%, collected by rinsing decontaminated sampling equipment with deionized water, which is captured in a sample container and submitted for laboratory analysis. • Trip Blanks required for all field events that include the collection of samples for volatile organic compounds (VOCs) analysis. Trip blank containers of certified clean sand are opened and kept with the other sample containers during the sampling process.
Field Decontamination of Drilling and Sampling Equipment	Dry decontamination is the preferred method to minimize the generation of liquid waste. Dry decontamination may include using a wire brush or other tool to remove soil or other material adhering to the sampling equipment, followed by using a commercial cleaning agent (nonacid, waxless cleaners) and paper wipes. Dry decontamination may be followed by wet decontamination, if necessary. Wet decontamination may include washing with a nonphosphate detergent and water, followed by a water rinse and a second rinse with deionized water. Alternatively, steam cleaning may be used.

Table 5.0-1 (continued)

Method	Summary
Geodetic Surveys	Geodetic surveys will be conducted using a Trimble 5700 differential global positioning system (DGPS). The survey data will conform to Laboratory Information Architecture (IA) project standards IA-CB02, "GIS Horizontal Spatial Reference System," and IA-D802, "Geospatial Positioning Accuracy Standard for A/E/C/ and Facility Management." All coordinates will be expressed as SPCS 83, NM Central, U.S. ft coordinates. All elevation data will be reported relative to the National Geodetic Vertical Datum of 1929.
Sampling for Volatile Organic Compounds in Groundwater	States the responsibilities and describes the process for sampling for volatile organic compounds in groundwater. This SOP also describes the selection of equipment and materials used in the sampling process. The objectives are to collect valid samples for volatile organic analysis and to subject samples to the least amount of turbulence and subsequent possible aeration. Procedure covers conducting preoperation activities, sampling, preparing documentation, and conducting postoperation activities.
Spade and Scoop Method for the Collection of Soil Samples	This method is typically used for collection of shallow (i.e., typically 0 to 12 inches) soil samples. The "spade-and-scoop" method involves digging a hole to the desired depth, as prescribed in the sampling and analysis plan, and collecting a discrete grab or portion of a composite sample. Procedure covers presampling activities, sampling activities, and post sampling activities.
Hand Auger and Thin-Wall Tube Sampler	This method is typically used for sampling soil or sediment at depths of less than 10–15 ft but may, in some cases, be used for collecting samples of weathered or nonwelded tuff. The method involves hand-turning a stainless-steel bucket auger (typically with a 3–4-in. inner diameter), creating a vertical hole that is advanced to the desired sample depth. When a depth just above the target interval is reached, the auger is first decontaminated and then advanced through the sample interval. The sample material is transferred from the auger bucket to a stainless-steel sampling bowl before filling the various required sample containers.
Sample Collection from Split-Spoon Samplers and Shelby Tube Samplers	In the split-spoon sampling method, a stainless-steel core barrel (typically with a 4-in. inner diameter and 2.5 ft long) is advanced using a powered drilling rig. The core barrel extracts a continuous length of soil and/or rock that can be examined as a unit. The split-spoon core barrel is a cylindrical barrel split lengthwise so the two halves can be separated to expose the core sample. Once extracted, the section of core is typically screened for radioactivity and organic vapors, photographed, and described in a geologic log. A portion of the core may then be collected as a discrete sample from the desired depth. The Shelby tube is a similar type of sampling apparatus. The split spoon is a multi-piece sampler; the Shelby tube is a single-piece metal tube of thinner gauge.
Headspace Vapor Screening with a Photo Ionization Detector	Individual soil, rock, or sediment samples may be field-screened for volatile organic compounds by placing a portion of the sample in a plastic sample bag or in a glass container with a foil-sealed cover. The container is sealed and gently shaken, and allowed to equilibrate for 5 minutes. The sample is then screened by inserting a detector probe into the container and measuring and recording any detected vapors.
Subsurface Moisture Measurements Using a Neutron Probe	This method is used for collecting subsurface moisture measurements using a neutron probe. A daily field standard count will be taken to ensure that the instrument source, detector, and electronics are operating within the manufacturer's specifications. The probe will be lowered into the borehole and field measurements will be collected and data recorded on a laptop computer connected to the probe.

Table 5.0-1 (continued)

Method	Summary
Field Sampling of Core and Cuttings for Geological Analysis (Core Barrel Sampling for Subsurface Earth Materials)	Describes the process for subsampling core or cuttings in the field for geological analysis on the ENV-ERS Program. Specifically, this procedure covers the activity and associated documentation for collection and transport of core or cuttings subsamples from a drill site directly to EES-1 sample preparation or analysis sites at LANL. The examination or subsampling of materials at the sample management facility is not covered under this procedure; for such activities the appropriate governing SOP should be employed.
Field Logging, Handling, and Documentation of Borehole Materials	This method is limited to the activities necessary to take custody of core and cuttings from drill rig personnel; conduct field screening; remove time-sensitive analytical samples and subsamples for preliminary characterization; complete photographic documentation when necessary; perform field structural and lithologic description; and mark, package, and temporarily store the borehole materials at a drill-site borehole material storage trailer, if required.
Radiological Screening (Performing and Documenting Gross Gamma Radiation Scoping Surveys)	Samples may be field-screened continuously using an Eberline E-600/SHP380AB to detect both alpha and undifferentiated beta/gamma gross readings. Core samples are screened by holding the probe <1 in. away from the core. The core is screened immediately after it is removed from ground and before logging, sampling, etc. Measurements are determined by a quick scan to find the highest initial reading, After logging the core, a one-minute reading is performed to determine gross alpha and beta/gamma radiation levels. All screening data will be recorded in the Radiation Control Technician field log as well as in the lithologic boring logs.
Radiological Surveys (Performing and Documenting Gross Gamma Radiation Scoping Surveys)	Walkover beta/gamma surveys will be performed to identify any areas with potentially elevated radiation emission rates. An integrated GPS-radiological survey system will be used. The system will consist of a Ludlum Model 2221 ratemeter/scaler with a Geiger-Mueller detector coupled to a Trimble Pro XRS mapping-grade GPS instrument. High-density surveys will be performed at the discretion of the survey team to better define anomalies using a detector spacing of approximately 2.5 ft and a survey speed of 1 ft per second (ft/s); low-density surveys will be performed with a detector spacing of 5 ft and a survey speed of 2.5 ft/s.
Surface Geophysical Surveys	Surface geophysical surveys will be implemented using electromagnetic induction and ground-penetrating radar methods. All surveys will be conducted in accordance with the vendor's specifications. Electromagnetic induction data will be recorded at approximately 2-ft intervals along lines spaced approximately 20 ft apart. Higher resolution coverage (as needed) will be completed in selected target areas using 5-ft line spacing. Geodetic coordinates will be recorded at 1-second intervals using an integrated global positioning system (GPS). During these tests, battery, phasing, and sensitivity checks will be performed. The GPR survey will be performed using a digital SIR-2 subsurface interface radar system (or equivalent). Line locations will be selected based on EM anomaly location and surface obstructions.