354

RFI Work Plan
for
Operable Unit
1079

Environmental Restoration Program

May 1992

A Department of Energy
Environmental Cleanup Program

Los Alamos
NATIONAL LABORATORY

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Executive Summary

EXECUTIVE SUMMARY

The Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Work Plan for Operable Unit (OU) 1079 is a requirement of the Hazardous and Solid Waste Amendments (HSWA) Module VIII of Los Alamos National Laboratory's (the Laboratory's) RCRA Facility Permit (EPA 1990, 0306). The primary purpose of this work plan is to describe the site characterization activities and verification sampling that will address potential contaminant releases from the Solid Waste Management Units (SWMUs) comprising Operable Unit (OU) 1079. This work plan is being submitted to EPA Region VI on behalf of the Department of Energy (DOE) and the University of California (UC) which manages the Laboratory's Environmental Restoration (ER) Program for the DOE.

OU 1079 is situated in the Los Alamos townsite and is primarily under ownership of Los Alamos County with some private properties. The OU consists of four former Technical Areas (TAs) 10, 31, 32, and 45. All TAs in the OU were previously operated by the Laboratory, beginning operations as early as 1943 and continuing throughout the mid-1950s and 1960s. TA-10, located in Bayo Canyon, was used as a firing site to conduct experiments utilizing high explosives in conjunction with research on nuclear weapons. TA-31, known as the East Receiving Yard, was used for receipt and temporary storage of materials delivered by Navajo Van Lines. TA-32 was used as the first Laboratory medical research facility. TA-45, known as Waste Disposal (WD) Site, was located adjacent to Acid Canyon and was the site of the first radioactive waste water treatment plant at the Laboratory.

Most OU 1079 SWMUs have previously undergone decontamination and decommissioning (D&D). Historical D&D activities focused on removal of radioactive contamination to within DOE residual radioactivity guidelines in place at the time of the D&D activities. Many of these SWMUs were reevaluated for radiological hazards during DOE's Formerly Utilized Sites Remedial Action Program (FUSRAP) in the late 1970s. Following the FUSRAP studies, many of the SWMUs underwent additional remediation in the late 1970s and early 1980s to comply with more stringent DOE radiological guidelines.

OU 1079 currently contains 36 SWMUs, and three Areas of Concern (AOCs) as defined and listed in the 1990 SWMU Report (LANL 1990, 0145). SWMU types found in OU 1079 include firing sites, liquid waste disposal areas, solid waste landfills, an incinerator, untreated and treated waste outfalls, industrial waste lines, a vehicle decontamination facility, and a radioactive waste water treatment facility. Potential wastes from operations conducted at OU 1079 may include hazardous, explosive, and radioactive constituents. Two SWMUs and two AOCs within OU 1079 have been proposed for no further action based on archival data which indicate that the sites pose no current or future threat to human health or the environment.

The OU 1079 technical approach utilizes phased sampling to ensure that any environmental impacts associated with past and present activities are investigated in a manner that is both cost-effective and in compliance with the Laboratory's HSWA Module. The emphasis of this phased sampling approach is to determine if hazardous and radioactive constituents are present, and if present, to characterize the nature and extent of potential contamination. Data Quality Objectives (DQOs) and conceptual exposure models were developed to design a data collection program which will ensure that the right type, amount, and quality of data are collected. The proposed OU 1079 field investigations will be conducted such that data needs can be reevaluated after each phase to confirm the site conceptual model sufficiently to perform a baseline risk assessment or evaluate remedial alternatives.

The OU 1079 Phase I sampling strategy involves OU-wide surface and subsurface investigations that focus on determining the presence or absence of hazardous, radioactive, or explosive contaminants at OU 1079. Health-based risk assessments may be conducted for SWMUs for which sample results are above a trigger level, or a Voluntary Corrective Action (VCA) may be performed. If conducted, the risk assessment will be used to determine the need for possible remedial action through a VCA or through a Corrective Measures Study (CMS). If the data obtained in the Phase I sampling are insufficient to support a baseline risk assessment, the site will undergo additional sampling (Phase II) to provide the necessary data.

For purposes of implementing the sampling plans, the SWMUs are primarily arranged in SWMU Aggregates, with specific investigations of individual SWMUs included as necessary. All OU 1079 sampling plans were developed using the DQO Process. A total of 443 soil samples, including quality assurance (QA) samples, will be collected during implementation of the OU 1079 sampling plans. Table E-1 provides a summary of Phase I sampling plans proposed for OU 1079, including the total number of samples to be collected per SWMU or SWMU Aggregate, required laboratory analyses for the collected samples, and implementation dates for the field activities. Level I/II on-site field screening of samples will be conducted to assist in the selection of samples for laboratory analysis. A mobile or fixed analytical laboratory facility will provide Level III/IV data for use in baseline risk assessment.

In addition to sampling plans, the OU 1079 RFI work plan provides an overview of operational history and descriptions of each SWMU, the technical approach to the field investigations, and the development of the conceptual models. Five ancillary plans are included as annexes to this work plan: Project Management Plan (PMP); Quality Assurance Project Plan (QAPjP); Health and Safety Project Plan (HSPjP); Records Management Project Plan (RMPjP); and Community Relations Project Plan (CRPjP). Each of these annexes are tiered to ER Program Plans contained in the Installation Work Plan (LANL 1991, 0553). The Installation Work Plan is updated annually and submitted to EPA Region VI.

The baseline milestone schedule for the OU 1079 corrective action process is provided in Figure E-1. Sampling plans for surface SWMUs in TA-45 will be implemented in 1992. Sampling plans for the subsurface SWMUs in TA-45 and the SWMUS in TA-31, and TA-32 will be implemented in 1993. The surface and

TABLE E-1 SUMMARY OF PHASE I FIELD INVESTIGATION ACTIVITIES AT OU 1079.

TA	SWMU#	SWMU Aggregate / SWMU Description	No. Samples	Laboratory Analyses			Implementation Date(s)
				Chemical	Radiolog.	HE	
TA-10	10-001(a-d)	**Firing Sites Aggregate:**					
		Firing Sites 1-4/Sand Pile Detonation Area	115	x	x	x	FY-94
		Subsurf. Disp. Aggregate (Known):					
	10-002(a)	Disposal Pit	17	x	x		FY-94
	10-002(b)	Disposal Pit	19	x	x		FY-94
	10-003(a-o)	Liquid Waste Disposal Complex	92	x	x		FY-94
	10-004(b)	Septic Tank	17	x	x		FY-94
	10-007	Landfill	0				FY-94
		Subsurf. Disp. Aggregate (Unknown):					
	10-004(a)	Septic Tank	19	x	x		FY-94
	10-005	Surface Disposal/Open Burning Area	19	x	x	x	FY-94
TA-31		**TA-31 Aggregate:**					
	31-001	Septic Tank	4	x			FY-93
	•	Septic Tank Line	6	x			FY-93
	•	Septic Tank Outfall	8	x			FY-93
TA-32		**TA-32 Aggregate:**					
	32-001	Incinerator	1	x			FY-93
	32-002(a-b)	Septic Tank	5	x			FY-93
	•	Septic Tank Line	6	x			FY-93
	•	Septic Tank Outfall	13	x			FY-93
TA-45		**Treatment Plant Aggregate:**					
	1-002	Untreated Waste Outfall	23	x	x		FY-92
	45-001	Waste Treatment Facility & Outfalls	64	x	x		FY-92/-93
	45-003	Industrial Waste (Acid Waste) Lines	5	x	x		FY-92
		Vehicle Decontamination Aggregate					
	45-002	Decontamination Facility	7	x	x	x	FY-92
		Sanitary Sewer Outfall Aggregate:					
	45-004	Sanitary Sewer Outfall	3	x	x		FY-92
TOTAL			443				

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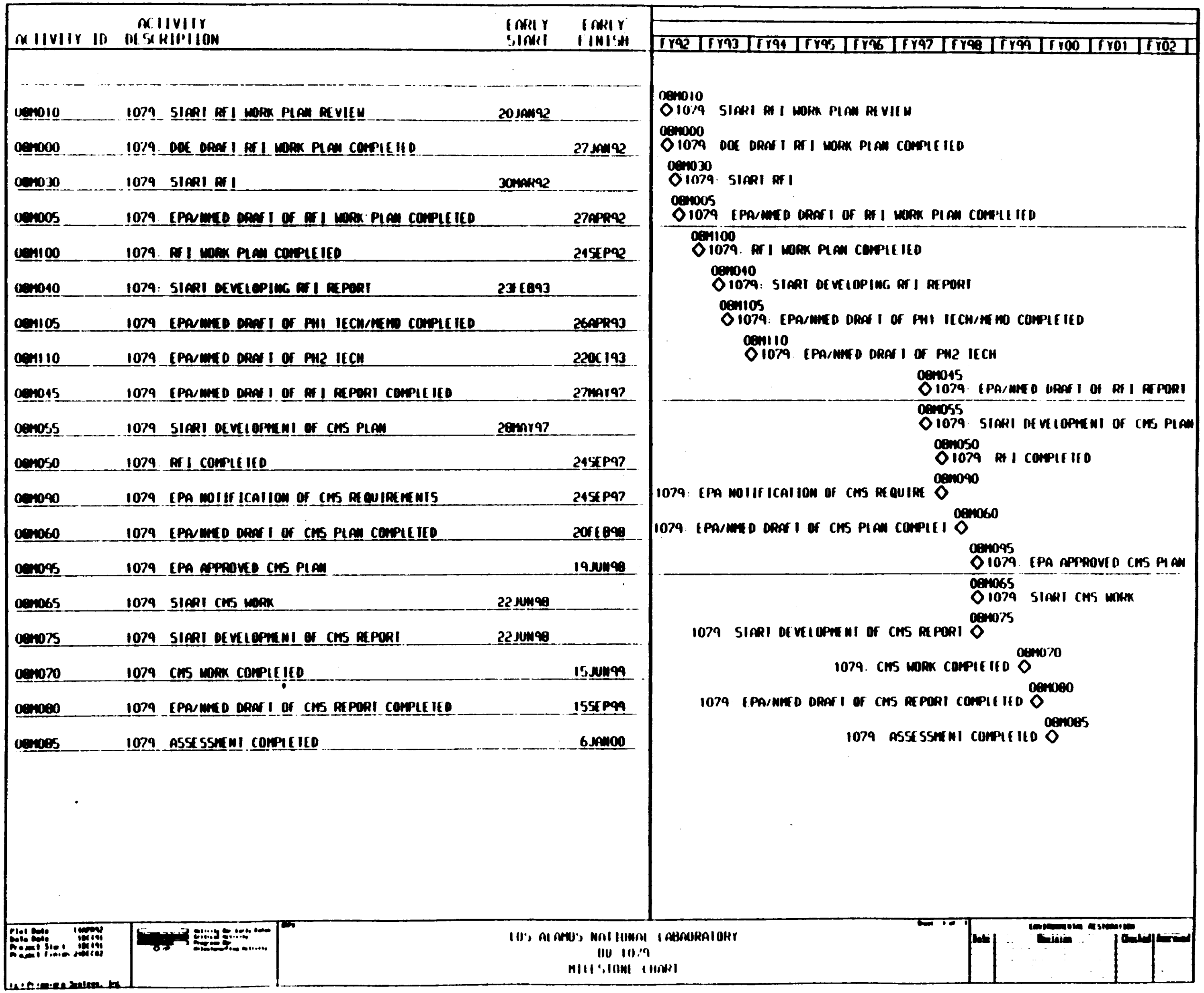

ACTIVITY ID	ACTIVITY DESCRIPTION	EARLY START	EARLY FINISH
08M010	1079 START RFI WORK PLAN REVIEW	20JAN92	
08M000	1079 DOE DRAFT RFI WORK PLAN COMPLETED		27JAN92
08M030	1079 START RFI	30MAR92	
08M005	1079 EPA/NMED DRAFT OF RFI WORK PLAN COMPLETED		27APR92
08M100	1079 RFI WORK PLAN COMPLETED		24SEP92
08M040	1079 START DEVELOPING RFI REPORT	23FEB93	
08M105	1079 EPA/NMED DRAFT OF PH1 TECH/MEMO COMPLETED		26APR93
08M110	1079 EPA/NMED DRAFT OF PH2 TECH		22OCT93
08M045	1079 EPA/NMED DRAFT OF RFI REPORT COMPLETED		27MAY97
08M055	1079 START DEVELOPMENT OF CMS PLAN	28MAY97	
08M050	1079 RFI COMPLETED		24SEP97
08M090	1079 EPA NOTIFICATION OF CMS REQUIREMENTS		24SEP97
08M060	1079 EPA/NMED DRAFT OF CMS PLAN COMPLETED		20FEB98
08M095	1079 EPA APPROVED CMS PLAN		19JUN98
08M065	1079 START CMS WORK	22JUN98	
08M075	1079 START DEVELOPMENT OF CMS REPORT	22JUN98	
08M070	1079 CMS WORK COMPLETED		15JUN99
08M080	1079 EPA/NMED DRAFT OF CMS REPORT COMPLETED		15SEP99
08M085	1079 ASSESSMENT COMPLETED		6JAN00

Figure E-1. OU 1079 RFI/CMS milestone chart.

subsurface SWMUs in TA-10 will be investigated in 1994. Cost estimates for OU 1079 baseline activities, including an estimate to completion, are provided in Figure E-2. Estimated cost for RFI implementation and reporting is $15.6 million. If required, the estimated cost for CMS implementation and reporting is $1.2 million. The total estimated cost for the corrective action process in OU 1079 is approximately $20.3 million.

Public participation is required by regulation during the OU 1079 RFI/CMS corrective action process. The Laboratory will provide various opportunities for public participation including public information meetings held as needed or when significant milestones are reached; solicitation of informal public review on the Draft OU 1079 RFI Work Plan; distribution of meeting notices and updates to the ER Program mailing list; preparation of informational fact sheets summarizing completed and future activities; and public access to reports or other documents generated during the implementation of this work plan in the ER Community Reading Room located at 2101 Trinity Drive in Los Alamos.

Task Description	Budget	Scheduled Start	Scheduled Finish
Assessment - RFI Work Plan	1,217,775	1 Oct 90	24 Sep 92
Assessment - RFI	13,251,932	30 Mar 92	24 Sep 97
Assessment - RFI Report	1,141,715	23 Feb 93	24 Sep 97
Assessment - CMS Plan	41,161	28 May 97	19 Jun 98
Assessment - CMS	913,130	22 Jun 98	6 Jun 00
Assessment CMS Report	211,910	22 Jun 98	15 Sep 99
Assessment - ADS Management	1,488,370	1 Oct 90	30 Sep 99
Assessment - VCA	828,633	1 Oct 92	30 Sept 98
Report Total	19,094,626		

	$ x 1,000
ESTIMATE TO COMPLETION	$19,095
ESCALATION	$209
PRIOR YEARS	$1,048
TOTAL AT COMPLETION	$20,352

Figure E-2. OU 1079 RFI/CMS schedule report and budget.

REFERENCES

EPA (U.S. Environmental Protection Agency), April 10, 1990. RCRA Permit No. NM0890010515, EPA Region VI, issued to Los Alamos National Laboratory, Los Alamos, New Mexico, effective May 23, 1990. **(EPA 1990, 0306)**

LANL (Los Alamos National Laboratory), November 1990. "Solid Waste Management Units Report," Volumes I through IV, Los Alamos National Laboratory Report No. LA-UR-90-3400, prepared by International Technology Corporation under Contract Number 9-XS8-0062R-1, Los Alamos, New Mexico. **(LANL 1990, 0145)**

LANL (Los Alamos National Laboratory), November 1991. "Installation Work Plan for Environmental Restoration," Revision 1, Los Alamos National Laboratory Report LA-UR-91-3310, Los Alamos, New Mexico. **(LANL 1991, 0553)**

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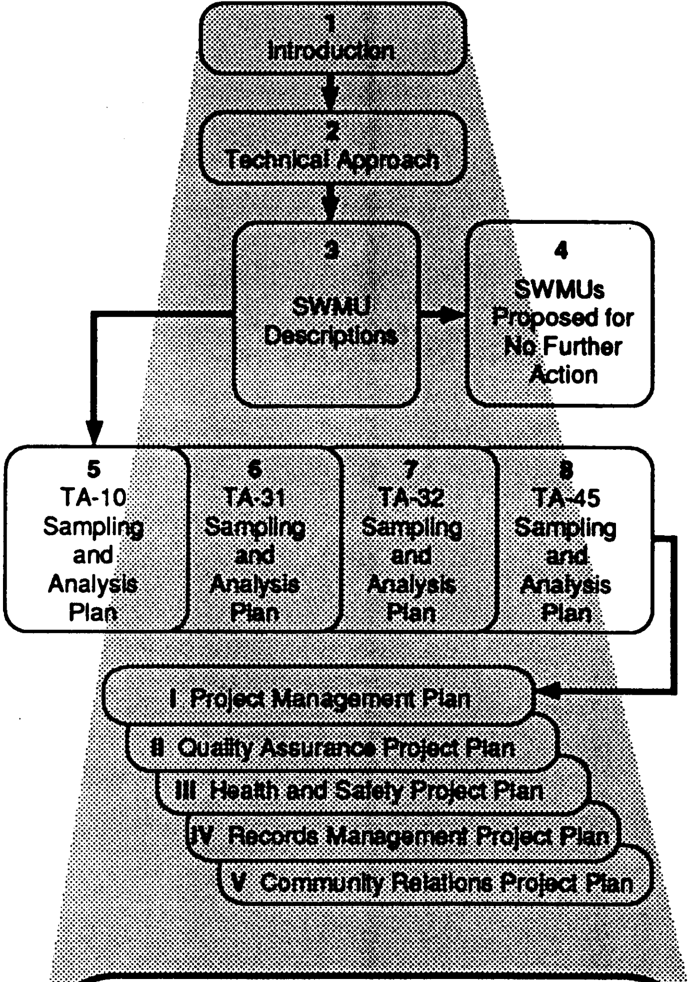
ACGIH	American Conference of Governmental Industrial Hygienists
AEC	US Atomic Energy Commission
ALARA	As Low as Reasonably Achievable
ANSI	American National Standards Institute
AOC	Area of Concern
AP	Administrative Procedure
AR	Administrative Requirement
ARAR	Applicable or Relevant and Appropriate Requirement
ASA	American Society of Agronomy, Inc.
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
CAR	Corrective Action Requirement
CEARP	Comprehensive Environmental Assessment and Response Program
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CGI	Combustible gas indicator
CMS	Corrective measures study
COC	Contaminant of Concern
CPR	Cardiopulmonary resuscitation
CRPjP	Community relations project plan
CRZ	Contamination reduction zone
D&D	Decontamination and Decommissioning
DCG	Derived Concentration Guidelines
DOE	U.S. Department of Energy
DQO	Data quality objectives
EM	Environmental Management
EP	Environmental Program
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
ERPG	Emergency response planning guideline
ES&H	Environmental Safety & Health
FID	Flame ionization detector
FIMAD	Facility for Information Management, Analysis and Display
FTL	Field Team Leader
FUSRAP	Formerly Utilized MED/AEC Sites Remedial Action Program
H&S	Health and Safety
H&S PL	Health and Safety Project Leader
HE	High explosive
HRD	Human Resources Development
HSPjP	Health and safety project plan
HSWA	Hazardous and Solid Waste Act Ammendments
IDLH	Immediately dangerous to life and health

IP	Ionization potential
IWP	Installation work plan
LA	Laboratory of Anthropology
LANL	Los Alamos National Laboratory
LASL	Los Alamos Scientific Laboratory
LEL	Lower explosive limit
LOQ	Limit of quantification
LTO	Laboratory Training Office
MCL	Maximum contaminant level
MDA	Material disposal area
MED	Manhattan Engineer District
MOS	Mixed oxide semiconductors
MSDS	Material safety data sheet
NEPA	National Environmental Policy Act
NFA	No further action
NIOSH	National Institute of Occupational Health and Safety
NRC	U.S. Nuclear Regulatory Commission
NQA	Nuclear quality assurance
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
OUPL	Operable Unit Project Leader
PCB	Polychlorinated biphenyl
PEL	Permissible exposure limit
PID	Photoionization detector
PL	Project Leader
PMP	Project management plan
PPE	Personal protective equipment
PVC	Polyvinyl chloride
QA	Quality assurance
QAPjP	Quality assurance project plan
QC	Quality control
QP	Quality Procedure
QPP	Quality program plan
QPPL	Quality Program Project Leader
RCRA	Resource Conservation and Recovery Act
REL	Recommended exposure limit
RFI	RCRA facility investigation
RMPjP	Records management project plan
RPF	Records processing facility
SAP	Sampling and analysis plan
SCBA	Self-contained breathing apparatus
SSO	Site Safety Officer
SHPO	State Historic Preservation Officer
SOP	Standard operating procedure
STEL	Short-term exposure limit
SVOC	Semivolatile organic compound
SWMU	Solid waste management unit
TA	Technical area
TAL	Target analyte list

TLD	Thermoluminescent dosimeter
TLV	Threshold limit value
TTL	Technical Team Leader
TWA	Time-weighted average
UC	University of California
UL	Underwriters Laboratory
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USGS	U.S. Geological Survey
VCA	Voluntary corrective action
VCP	Vitrified clay pipe
VMAX	Maximum volume to be remediated
VOA	Volatile organic analysis
VOC	Volatile organic compound

CHAPTER 1



Introduction

- Overview of ER Program
- Installation Work Plan
- HSWA Requirements
- Permit Modifications
- Operable Unit Description
- Document Organization

1.0 INTRODUCTION

1.1 Overview of Environmental Restoration Program

In March 1987, the Department of Energy (DOE) established an Environmental Restoration (ER) Program to address environmental cleanup requirements at its facilities nationwide. Los Alamos National Laboratory (the Laboratory) is operated for the DOE by the University of California (UC) and is subject to the DOE's ER Program.

The Laboratory's Resource Conservation and Recovery Act (RCRA) Facility Permit sets forth requirements that are implemented by the Laboratory's ER Program. In particular, the Hazardous and Solid Waste Amendments (HSWA) Module and schedules of the permit issued by the Environmental Protection Agency (EPA) give specific requirements affecting the conduct of the ER Program. The HSWA Module became effective on May 23, 1990 (EPA 1990, 0306). In addition to RCRA requirements, the ER Program is not inconsistent with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

1.1.1 Installation Work Plan

The HSWA Module requires the Laboratory to prepare an installation-wide work plan to contain the programmatic elements of a RCRA Facility Investigation (RFI) work plan. This requirement was satisfied by a Laboratory-wide Installation Work Plan (IWP) initially submitted to the EPA on November 19, 1990 and updated annually (LANL 1991, 0553). It serves as the plan by which DOE/UC will conduct the ER Program at the Laboratory. The IWP describes the ER Program and its history at the Laboratory, provides installation-wide descriptions of current conditions, identifies the Laboratory's solid waste management units (SWMUs) and their aggregation into a number of operable units (OUs), and presents the Laboratory's overall management and technical approach for meeting the requirements of the HSWA Module. The IWP is the document to which OU work plans are tiered. Relevant information presented in the IWP is not be repeated in OU work plans.

1.1.2 Operable Unit 1079 RFI Work Plan

The HSWA module also requires the Laboratory to submit RFI work plans for a specified percentage of listed SWMUs (Tables A and B) between May 1991 and May 1994. Each work plan must address all necessary actions to verify and determine the nature and extent of releases of hazardous waste or hazardous waste constituents from the SWMUs. The OU 1079 Work Plan is one of 23 OU work plans being prepared in response to that requirement.

Additional information regarding the ER Program, its implementation, and the guidance under which the OU 1079 Work Plan was prepared is given in Chapter 3 of the IWP.

1.2 Hazardous and Solid Waste Amendment Requirements

1.2.1 SWMUs Addressed In This Operable Unit

The HSWA Module VIII of the permit requires that all RFI work plans submitted to EPA by May 1992 address 35% of the SWMUs listed in Table A and 55% of the SWMUs listed in Table B. Tables A and B of the HSWA Module were developed by EPA based on a SWMU Report prepared in 1988 by the Laboratory (IT Corporation 1988, 0329). This OU 1079 Work Plan individually addresses 3% (22 of the 603 SWMUs) of the SWMUs listed in Table A and 4% (8 of the 182 SWMUs) of the SWMUs listed in Table B.

Subsequent research and investigative effort culminated in a revised SWMU Report submitted to EPA in November 1990 (LANL 1990, 0145). As discussed in greater detail in Subsection 3.4.2 of the IWP, no sites were eliminated in the revisions leading to the new SWMU Report, but some were combined or added. The result for OU 1079 is a current list of 36 SWMUs and three areas of concern (AOC). Two SWMUs and two AOCs have been recommended for no further action. The Laboratory's current SWMU list for OU 1079 is summarized in Table 1.2-1 and indicates the changes and additions since issuance of the HSWA Module list in 1990.

1.2.2 Permit Modification

Section 3.5 of the IWP states that each OU work plan may propose a HSWA Module Class III permit modification to adjust the SWMUs listed in Table A of the HSWA Module. Such adjustments may be necessary in order to remove those SWMUs which need no further investigation and add SWMUs to the current SWMU Report. The basis for such a permit modification for OU 1079 SWMUs is provided here as Table 1.2-1 with the current list of identified SWMUs. At this time, two SWMUs and two AOCs in OU 1079 have been identified as No Further Action (NFA) sites.

Additional NFA sites may be proposed in the OU 1079 phase reports and RFI report. Upon EPA approval of these reports, the ER Program may file a petition for no further action for the sites. The ER Program will file the installation-wide petition requesting a permit modification in conjunction with the annual update of the IWP.

1.2.3 Phase Reports and Work Plan Modification

Because the RFI is scheduled to take approximately five years at OU 1079, the Laboratory is prioritizing investigation activities for SWMUs. The Laboratory will submit phase reports on these prioritized site characterization activities to update the EPA on the RFI field work progress. These annual reports may also serve as work plan modifications to appropriately revise field sampling plans to reflect initial characterization results and Voluntary Corrective Actions (VCAs). During the

TABLE 1.2-1 OPERABLE UNIT 1079 SWMU LIST

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Original SWMU List in Tables A and B of HSWA Module(1)	Renumbered SWMUs(2)	Added SWMUs or Area of Concern (2)	SWMUs Recommended for No Further Action	Current SWMU List or Area of Concern (2) (5)	Current SWMU List Descriptions
Technical Area 10					
10-001 (a-d)				10-001 (a-d)	Firing Sites
		10-001 (e)	10-001 (e)		Sand Pile Detonation Area
10-002 (a-b)				10-002 (a-b)	Disposal Pits
10-003 (a-c)(3)				10-003 (a-c)	Liquid Disposal Pits
		10-003 (d-f)		10-003 (d-f)	Liquid Disposal Pits
10-003 (d-e)(3)	10-003 (g-h)			10-003 (g-h)	Manholes
10-003 (f)(3)	10-003 (i)			10-003 (i)	Industrial Waste (Acid Waste) Septic Tank
		10-003 (j-l)		10-003 (j-l)	Stainless Steel Tanks
		10-003 (m)		10-003 (m)	Clay Drain Pipe
		10-003 (n)		10-003 (n)	Leach Field
		10-003 (o)		10-003 (o)	Decontamination Holes
10-004 (a-b)				10-004 (a-b)	Septic Tanks
		10-005		10-005	Surface Disposal
10-006(3)			10-006		Open Burning Area
		10-007		10-007	Landfill
Technical Area 31					
31-001				31-001	Septic Tank
		C-31-001	C-31-001		Warehouses and Storage Yard
Technical Area 32					
		32-001		32-001	Incinerator
32-002 (a-b)				32-002 (a-b)	Septic Tanks
		C-32-001	C-32-001		Laboratories and Warehouses
Technical Area 45					
45-001				45-001	Waste Treatment Facility and Outfalls
45-002				45-002	Decontamination Facility
45-003				45-003	Industrial Waste (Acid Waste) Lines
		45-004		45-004	Sanitary Sewer Outfalls
1-002(3)(4)				1-002	Untreated Waste Outfall
		C-45-001		C-45-001	Treatment Facility Parking Lot

(1) From HSWA Module VIII of LANL Hazardous Waste Permit No. NM0890010515, effective May 23, 1990. (EPA 1990, 0306)

(2) From LANL, November 1990, "Solid Waste Management Units Report", Volumes I-IV, Los Alamos National Laboratory Report No. LA-UR-90-3400 (LANL 1990, 0145); Areas of concern are listed in Appendix C.

(3) From Table B (Priority SWMUs) of HSWA Module VIII of LANL Hazardous Waste Permit No. NM0890010515, effective May 23, 1990. (EPA 1990, 0306)

(4) Technical Area 1 untreated waste outfall into Acid Canyon will be included in Technical Area 45 field investigation.

(5) No voluntary corrective actions are identified at this time.

course of the RFI/Corrective Measures Study (CMS) phases of work at OU 1079, VCAs will be undertaken in three cases: when necessary to protect the health and safety of the public or laboratory personnel, when waste site conditions are such that a VCA is an appropriate response to stop further migration or dispersing of contaminants into the environment, or when cost effective. Therefore, phase reports are essentially Interim RFI reports and Interim RFI work plans. In particular, these reports will describe Phase II sampling investigations. The schedule for these annual phase reports/work plan modifications is presented in Annex I, the Project Management Plan, of this work plan.

1.3 Description of Operable Unit 1079 and Its Solid Waste Management Units

Operable Unit 1079 consists of SWMUs identified in the formerly utilized Technical Areas (TAs) 10, 31, 32, and 45 (Figure 1.3-1). The properties that comprise the former TAs are primarily under the ownership of Los Alamos County and some private properties, and serve as County maintenance and storage areas, private residences, and public recreation areas.

TA-10, located in Bayo Canyon (Figure 1.3-2), was used from 1943-1961 as a firing site to conduct experiments using high explosives. The site consisted of several firing pads, control buildings, battery buildings, a radiochemistry laboratory, subsurface disposal systems, and other associated structures. Bayo Canyon is currently undeveloped and is open to the public for recreational use.

TA-31, known as the East Receiving Yard (Figure 1.3-3), was used from 1945-1954 for receipt and temporary storage of materials delivered by Navajo Van Lines. The site consisted of warehouses, a receiving dock, a drum storage area, and a septic tank system. No documented spills occurred at the site. The former TA-31 is now occupied by the Eastern Area housing subdivision.

TA-32, used from 1944-1954, was the first Laboratory medical research facility (Figure 1.3-4). The site consisted of laboratories, an office building, several warehouses, an incinerator and several septic tank systems. No documented spills occurred at the site. The former TA-32 site is south of Trinity Drive and is used by the Los Alamos County Roads Division for storage and maintenance of equipment and materials.

TA-45, used from 1951-1964, was the site of the first radioactive wastewater treatment plant at the Laboratory (Figure 1.3-5). Radioactive industrial waste (acid waste) from TA-1 operations was discharged into Acid Canyon untreated from 1943 until the treatment plant was built in 1951. The site consisted of the treatment plant and associated industrial waste (acid waste) lines and outfalls, a vehicle decontamination facility, a sanitary sewer system, and a transformer station. The area formerly occupied by TA-45 is north of the intersection of Canyon Road and Central Avenue, and northeast of the Larry Walkup Aquatic Center. The site is currently utilized by Los Alamos County for equipment storage.

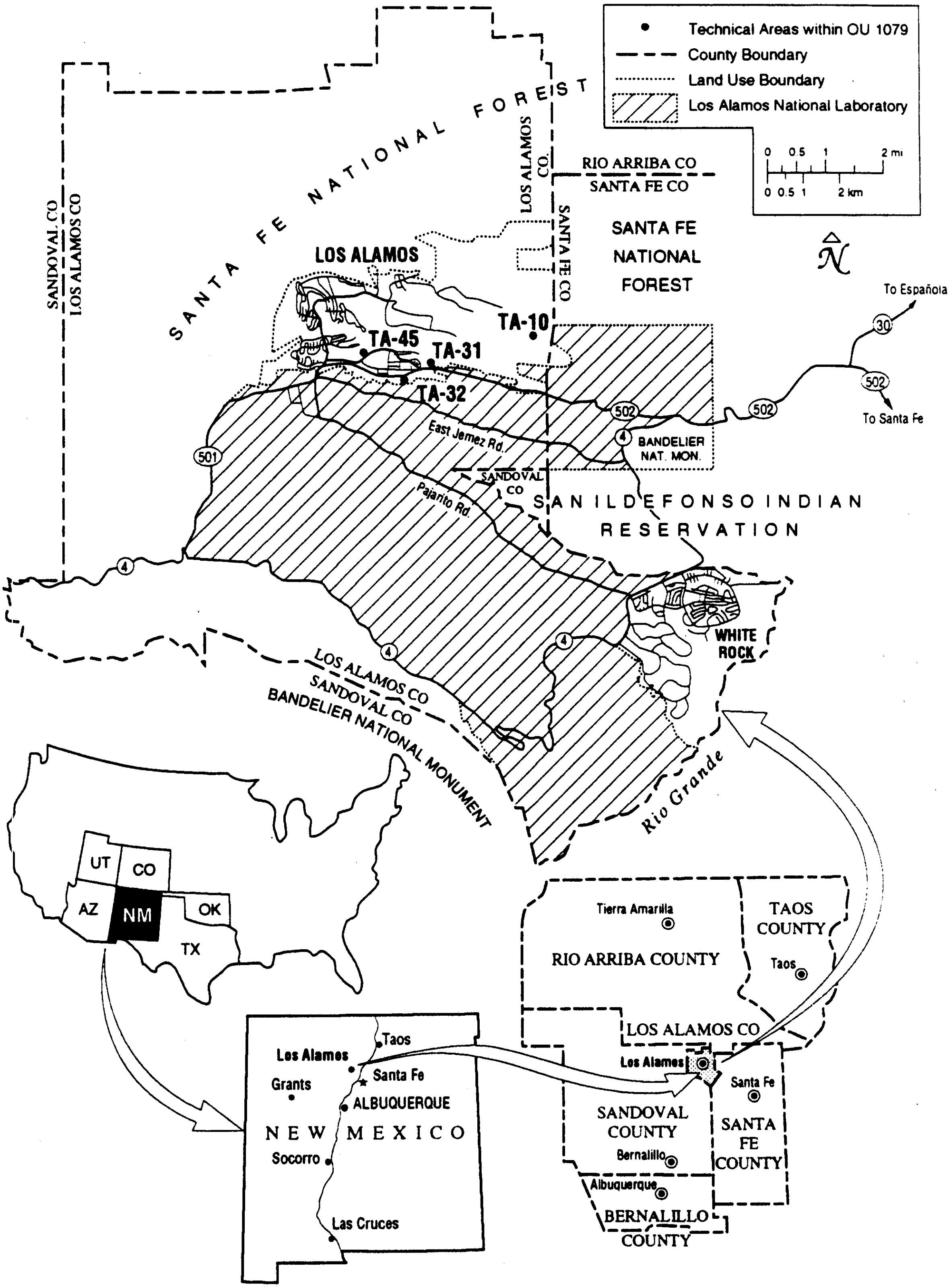
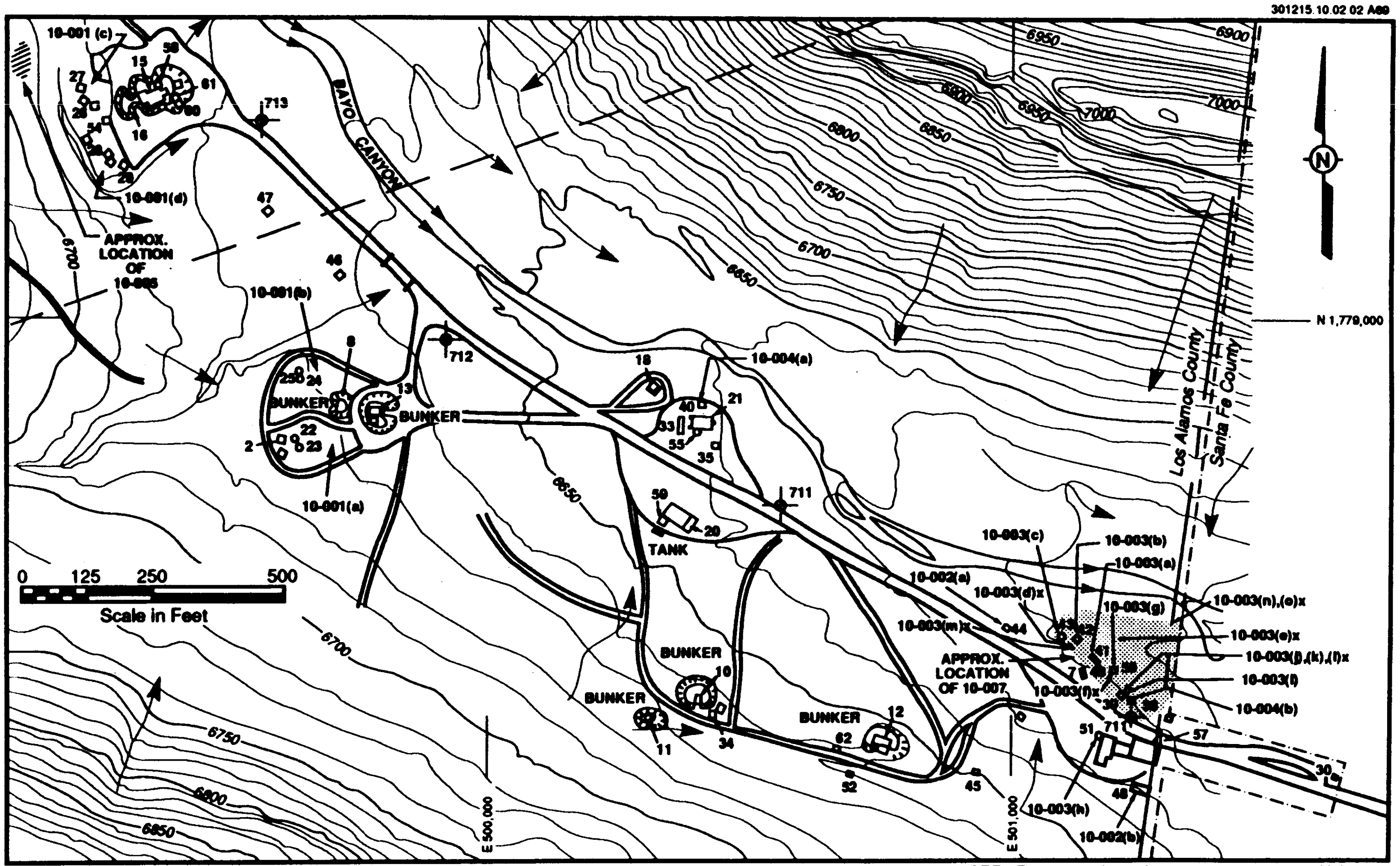


Figure 1.3-1. Location of areas with OU 1079 SWMUs.



NOTE: Exact Locations of 10-001(e) and 10-005, Unknown
x - Approximate Locations

LEGEND

10 – TA Structure Number
10-001(a) – SWMU Number
▨ – Probable Extent of 10-007
- - - – Fence

Figure 1.3-2. TA-10 Site Map and Associated SWMU Locations (modified from LANL 1990, 0145; AEC 1963, 06-0045; AEC 1963, 06-0044; AEC 1963, 06-0046; AEC 1963, 06-0047; AEC 1963, 06-0048; AEC 1963, 06-0049; AEC 1963, 06-0050; LASL 1961, 06-0056; LASL 1961, 06-0057; LASL 1962, 06-0058).

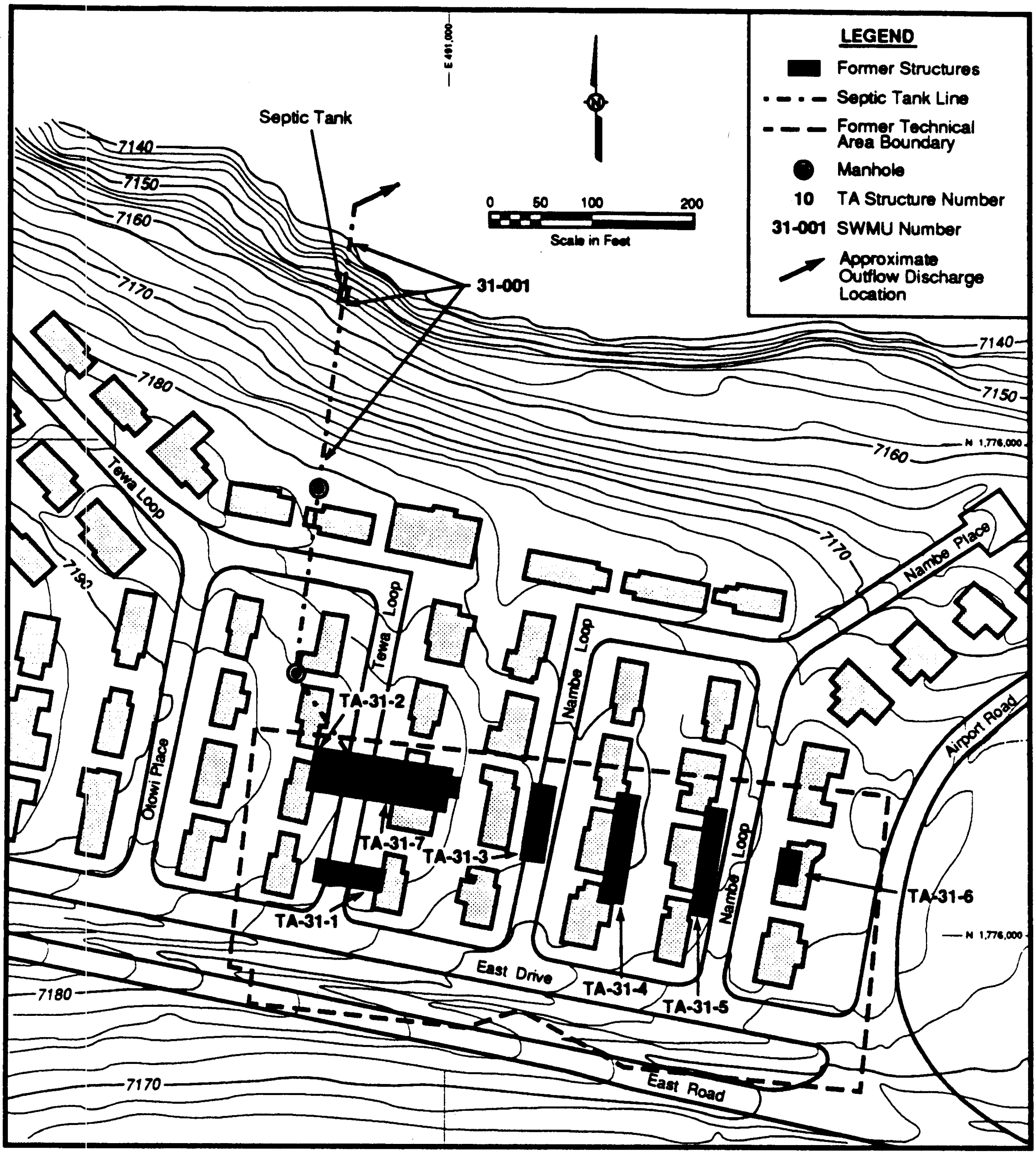


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Figure 1.3-3. TA-31 Site Map and Associated SWMU Locations (modified from LANL 1990, 0145; AEC 1963, 06-0016; AEC 1963, 06-0030; Los Alamos County 1986, 06-0061; LASL 1950, 06-0054).

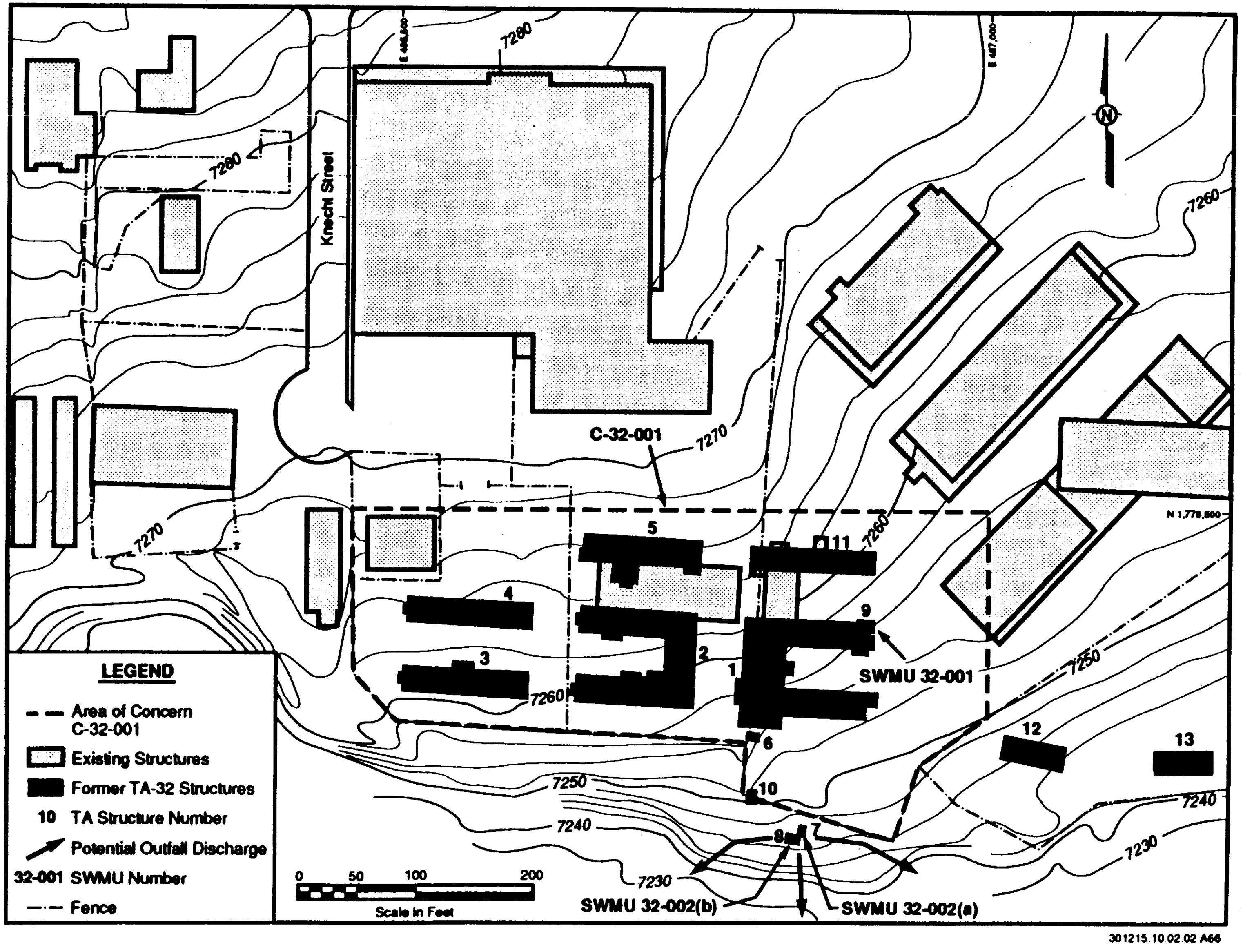

Figure 1.3-4. TA-32 Site Map and Associated SWMU Locations (modified from LANL 1990, 0145; AEC 1963, 06-0032; AEC 1963, 06-0031; Los Alamos County 1986, 06-0062; Los Alamos County 1986, 06-0063; LASL 1953, 06-0055).

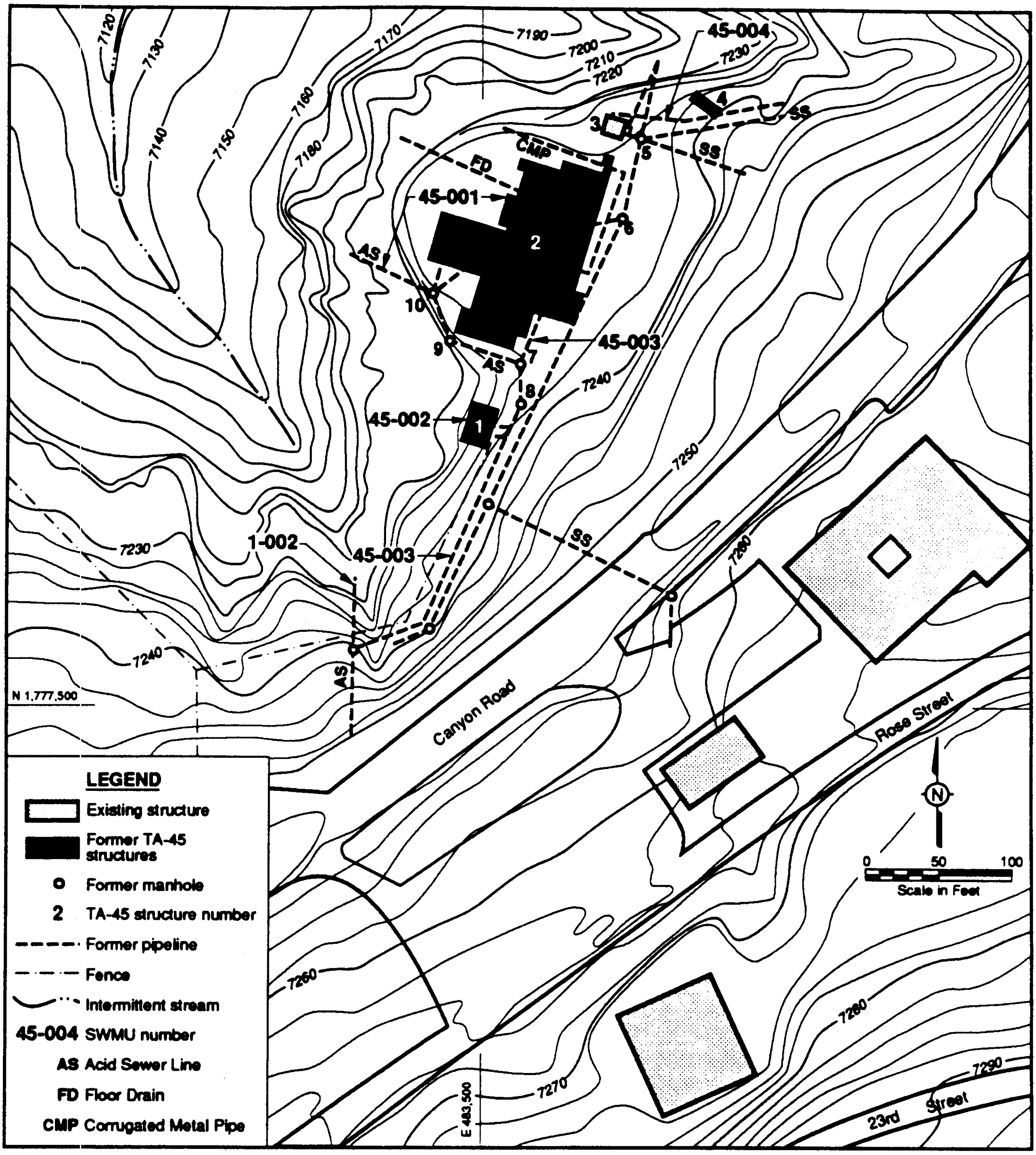

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Figure 1.3-5. TA-45 Site Map and Associated SWMU Locations (modified from LANL 1990, 0145; AEC 1963, 06-0036; Los Alamos County 1986, 06-0059; Los Alamos County 1986, 06-0060; LASL 1961, 06-0051; LASL 1955, 06-0052; LASL 1962, 06-0053).

1.4 Organization of This Work Plan

This RFI work plan is prepared pursuant to both the HSWA Module (EPA 1990, 0306) and the IWP (LANL 1991, 0553). The HSWA Module sets out the general scope of the work plan for the RFI, establishes the expected correspondence between the RFI tasks identified in EPA guidance documents (EPA 1989, 0088) and the equivalent ER Program tasks, and specifies the requirements to be fulfilled by the IWP and the contents expected in OU work plans such as this document.

These expectations are summarized in Table 1.4-1, extracted from page 32 of the HSWA Module (EPA 1990, 0306). In addition to the expectations defined in the HSWA Module, the IWP presents a proposed outline for OU work plans such as this document. The organization of this OU 1079 Work Plan with regard to these expectations is described in the following sections and compared to the HSWA Module Requirements and IWP proposed outline in Table 1.4-2 (LANL 1991, 0553).

1.4.1 Correspondence with RFI Scope from the HSWA Module

EPA defines five general tasks within the RCRA facility investigation process (EPA 1989, 0088; EPA 1990, 0306). Each of these tasks is discussed separately below, and the corresponding sections of this document are identified.

RFI Task I, Description of Current Conditions. This task consists of a presentation of facility background information and a discussion of the nature and extent of contamination.

Chapter 3 provides a description of each of the SWMUs in the operable unit and includes the following discussions: site location and physical description; historical overview and description of waste management activities; and the nature and extent of contamination of each SWMU, focusing on potential contamination to the environment, migration pathways, and potential public health and environmental impacts.

Also included is information on the environmental setting of the OU including topography, meteorology, geology, hydrology, biology, and cultural resources.

The Environmental Restoration work at the Laboratory is performed in compliance with a RCRA Facility Permit. However, this work is also performed in accordance with applicable sections of CERCLA, as required by DOE Order 5400.4. CERCLA Section 120 extends natural resource damage liability to federal facilities, which includes the Laboratory (DOE 1989, 0078). The first part of the natural resource damage assessment is a preassessment screen that is governed by regulations in Code of Regulations Title 43 (43 CFR) Part II. The preassessment screen will be used to determine whether a full natural resource damage assessment is appropriate. The preassessment screen will be integrated with the CERCLA ecological assessment process for this operable unit. A general description of the preassessment screen and the ecological assessment will be written for inclusion

TABLE 1.4-1
RFI GUIDANCE FROM THE LABORATORY'S RCRA PART B PERMIT

Scope of the RFI	ER Program Equivalent	
The RCRA Facility Investigation consists of five tasks:	LANL Installation RI/FS Work Plan	LANL Task/Site RI/FS
Task I: Description of Current Conditions A. Facility Background B. Nature and Extent of Contamination	I. LANL Installation RI/FS Work Plan A. Installation Background B. Tabular Summary of Contamination by Site	I. Quality Assurance Project Plan A. Task/Site Background B. Nature and Extent of Contamination
Task II: RFI Work Plan A. Data Collection Quality Assurance Plan B. Data Management Plan C. Health & Safety Plan D. Community Relations Plan E. Project Management Plan	II. LANL Installation RI/FS Work Plan A. General Standard Operating Procedures for Sampling, Analysis, and Quality Assurance B. Technical Data Management Program C. Health and Safety Program D. Community Relations Program E. Project Management Plan	II. LANL Task/Site RI/FS Documents A. Quality Assurance Project Plan and Field Sampling Plan B. Records Management Project Plan C. Health and Safety Project Plan D. Community Relations Project Plan E. Project Management Plan
Task III: Facility Investigation A. Environmental Setting B. Source Characterization C. Contamination Characterization D. Potential Receptor Identification	III.	III. Task/Site Investigation A. Environmental Setting B. Source Characterization C. Contamination Characterization D. Potential Receptor Identification
Task IV: Investigative Analysis A. Data Analysis B. Protection Standard	IV.	IV. LANL Task/Site Investigative Analysis A. Data Analysis B. Protection Standards
Task V: Reports A. Preliminary and Work Plan B. Progress C. Draft and Final	V. Reports A. LANL Installation RI/FS Work Plan B. Annual Update of LANL Installation RI/FS Work Plan C. Draft and Final	V. LANL Task/Site Reports A. Quality Assurance Project Plan, Field Sampling Plan, Records Management Project Plan, Health and Safety Project Plan, Community Relations Project Plan B. LANL Task/Site RI/FS Documents and LANL Monthly Management Status Report C. Draft and Final

TABLE 1.4-2
CROSS-REFERENCE OF HSWA MODULE VIII RFI WORK PLAN REQUIREMENTS AND THE OU 1079 WORK PLAN

HSWA MODULE VIII RFI WORK PLAN REQUIREMENTS		INSTALLATION WORK PLAN OUTLINE	OU 1079 WORK PLAN OUTLINE
Task I.	Description of Current Conditions		
	A. Facility Background	Section 2.1	Chapter 3
	B. Nature and Extent of Contamination	Sections 2.2, 2.3	Chapter 3
Task II.	RFI Work Plan		
	A. Data Collection Quality Assurance Plan	Chapter 6	Annex II (Quality Assurance Project Plan)
	B. Data Management Plan	Chapter 8	Annex IV (Records Management Project Plan)
	C. Health & Safety Plan	Chapter 7	Annex III (Health and Safety Project Plan)
	D. Community Relations Plan	Chapter 9	Annex V (Community Relations Project Plan)
	E. Project Management Plan	Chapter 5	Annex I (Project Management Plan)
Task III.	Facility Investigation		
	A. Environmental Setting	Section 2.3	Chapters 5 through 8*
	B. Source Characterization	Section 3.1	Chapters 5 through 8
	C. Contamination Characterization	Section 2.3	Chapters 5 through 8
	D. Potential Receptor Identification	Sections 2.3, 3.1	Chapters 5 through 8

* Chapters 5 through 8 of the OU 1079 Work Plan contain SWMU-specific Data Quality Objectives and Sampling and Analysis Plans; thus, Task III A. - D. of the HSWA Module VIII requirements are addressed individually in these chapters.

in the IWP. Any modifications of the general procedure that might be necessary for this operable unit will be described in future reports of progress pertaining to this operable unit facility investigation. This is consistent with the Guidance for Natural Resource Trusteeship and Ecological Evaluation for Environmental Restoration at DOE Facilities, 1991 (DOE 1991, 0560).

RFI Task II, RFI Work Plan. This task requires plans for project management, data collection quality assurance, data management, health and safety, and community relations. These plans are presented as Annexes I through V of this document (i.e., the Project Management Plan, the Quality Assurance Project Plan, the Health and Safety Project Plan, the Records Management Project Plan, and the Community Relations Project Plan).

RFI Task III, Facility Investigation. This task sets out requirements for further characterization of the environmental setting, source, contamination, and potential receptors. This work plan describes these efforts as follows:

- Environmental setting - individual TA sampling plans (Chapters 5 through 8). Existing information is presented in Chapter 3.
- Source characterization - individual TA sampling plans (Chapters 5 through 8). Existing information is presented in Chapter 3.
- Contaminant characterization - individual TA sampling plans (Chapters 5 through 8). Existing information is presented in Chapter 3.
- Potential receptor identification - migration pathways are assessed in individual TA sampling plans (Chapters 5 through 8). Existing information is presented in Chapter 3.

RFI Task IV, Investigative Analysis. This task contains subsets of data analysis and protection standards.

This task specifies that the permittee must identify all relevant and applicable standards for the protection of human health and the environment. Discussion of applicable, relevant, and appropriate requirements (ARARs) will not be included in individual OU work plans at this time. Module VIII of the HSWA Permit establishes Corrective Action Requirements (CARs). Task VI, Identification and Development of the Corrective Action Alternative or Alternatives, specifies that, based on the results of the RFI, the Permittee must identify, screen, and develop the alternatives for removal, containment, treatment, and/or remediation of contamination based on objectives established for corrective action. Cleanup requirements can be divided into three categories: (1) contaminant-specific requirements that address specific contaminants, (2) location-specific requirements based on a specific site setting, and (3) action-specific requirements associated with specific response actions. In the absence of more information about type and concentration of contaminants at the SWMUs being investigated, the identification of potential CARs at this time would be premature. The full tabulation of potential location-specific, contaminant-specific and action-specific requirements will be provided in future technical reports as adequate SWMU information is obtained through the RFI process.

RFI Task V, Reports. This task calls for preliminary, work plan, progress, draft, and final reports.

Work plans are provided on an installation-wide basis (the IWP), and for specific ER Program activities. This document is the RFI work plan for OU 1079. It contains the Field Sampling Plans, Project Management Plan, Quality Assurance Project Plan, Records Management Project Plan, Health and Safety Project Plan, and Community Relations Project Plan.

Monthly technical progress reports for the entire ER Program will be submitted as described in the IWP, as will draft and final RFI Reports.

1.4.2 Correspondence with RFI Outline Proposed in IWP

A proposed outline for an OU RFI work plan is presented in Table 3.2 of the IWP (LANL 1991, 0553). This work plan has not adhered explicitly to that outline but incorporates all elements of that outline. Although the HSWA Module requires that the IWP present an OU RFI outline for approval by the Administrative Authority, the IWP reserved the option to modify the outline as necessary for individual activities (IWP Section 3.5.1). This work plan exercises that option, consolidating common elements and eliminating excessive repetition. A cross-reference of the OU 1079 Work Plan outline and the IWP outline is presented in Table 1.4-2.

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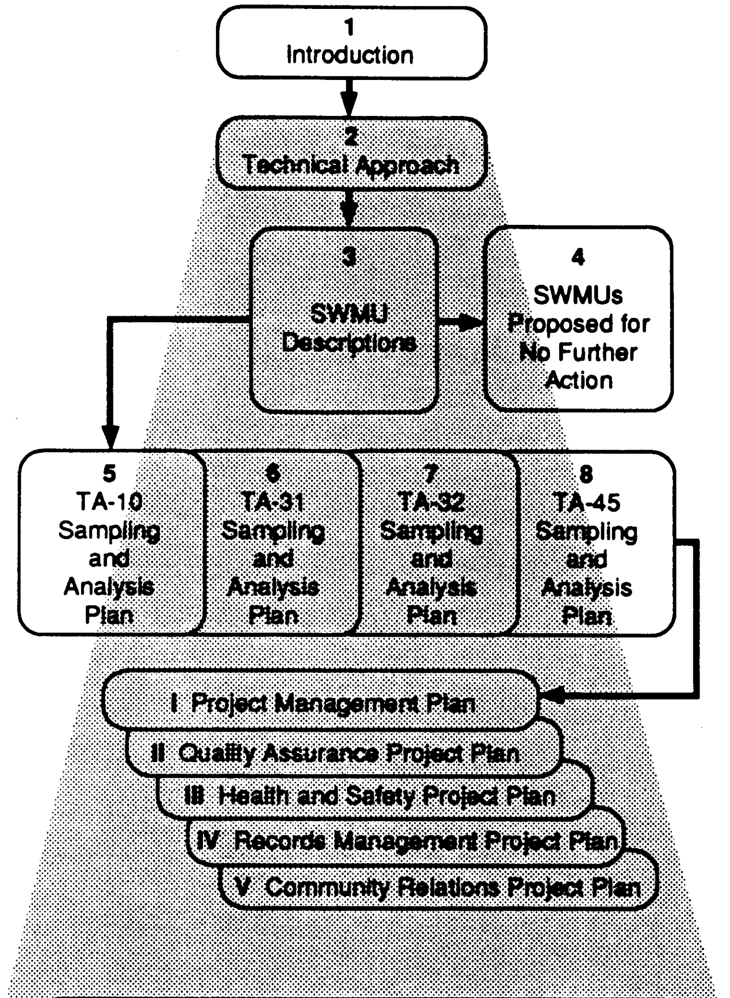
CHAPTER 2



Technical Approach

- Management of Uncertainty
- Observational Approach
- Data Quality Objectives
- Conceptual Exposure Models
- Analytical Levels
- Action Levels

2.0 Technical Approach

The goal of this RFI is to determine if there is a source of contamination at each of the sites comprising OU 1079 and, if there is contamination, to characterize it in the detail necessary to determine what corrective measures or remedial actions, if any, need to be taken. The characterization and remediation of hazardous waste sites, more than most engineering activities, are dominated by uncertainty. These projects must deal not only with variations in the complex, heterogeneous subsurface environment that play a large role in geotechnical engineering, but also with uncertainties about source waste characteristics, chemical fate and transport of contaminants, exposure risks, health effects, and the effectiveness of available remedial alternatives.

Appendices H, I, and J in the Installation Work Plan (IWP) (LANL 1991, 0553) describe in detail the approaches and tools used to deal with these uncertainties. These include

- the observational approach, which in the RFI process provides guidelines for determining the level of detail appropriate for site characterization prior to engineering a corrective measure;
- the DQO process, a formal procedure for ensuring that proposed data collection activities are carefully developed from, and tied back to, decision criteria and strategies; and
- phasing of the proposed investigations, so that data needs can be reevaluated after each phase, as required to develop the site conceptual model sufficiently for baseline risk assessment or corrective measures.

Sections 2.1 and 2.2 summarize the Appendices H, I, and J discussions of these approaches and outline their specific application to OU 1079. Section 2.3 describes the process for developing conceptual exposure models; Section 2.4 discusses required analytical levels; and Section 2.5 describes "action" or "trigger" levels as used in this work plan. Section 2.6 describes the installation-wide investigations that will provide data for the ecological risk assessments and evaluation of naturally-occurring background concentrations of contaminants of concern.

2.1 The Observational Approach

Attempting to reduce all uncertainties about a hazardous waste site to completely manageable levels during the RFI would lead to a lengthy characterization phase and unwarranted delays in initiating corrective actions. On the other hand, it is both expensive and impractical to design corrective measures for the "worst case." A practical alternative to these unacceptable extremes is provided by the "observational method." Developed in the field of geotechnical engineering, the observational method distributes the problem of dealing with uncertainty among the traditional study, design, and build phases of an engineering project. The key ideas, as applied to hazardous waste site remediation, are discussed by Brown et al. (1989, 0503). Using this approach, the goals of the three phases of the RCRA process are

- in the RFI, to establish the most probable site conditions with sufficient precision that the remaining uncertainties can be handled by contingency plans in the design;
- during the Corrective Measures Study (CMS), to base the design of remedial alternatives on those most probable conditions, but also to specify modifications that can be made should deviations materialize, and to plan an observational program to detect such deviations; and
- during Corrective Measures Implementation (CMI), to carry out the observational program with timely analysis of results, and to adopt design modifications if required.

The principal benefit of this approach during the RFI is a relatively precise definition of "how much is enough":

> "The key to knowing when to stop the iterative process of investigation and model development/testing, is finding that the remaining uncertainties can be handled as reasonable deviations [during design and implementation of a corrective measure]. If any of the residual uncertainties produce unreasonable deviations ('deal killers'), additional investigation is required." (Brown et al. 1989, p. 494, 0503)

In application, these ideas require us to identify possible remedial alternatives early in the RFI/CMS process, together with criteria and investigation strategies for arriving at the appropriate selection among them. Thus, the goal of the RFI is not a "full" site characterization; rather, it is site characterization to the extent necessary to evaluate a relatively small number of remedial alternatives, which may be a much smaller problem. The decision analysis approach, which provides for efficient identification and evaluation of corrective measures alternatives is described in Appendix I of the IWP (LANL 1991, 0553). This appendix describes how decision analysis will be used in the ER Program. Because the decision analysis process is being developed concurrently with this work plan, the process will be applied to this operable unit during the first year of field work, reflecting the decision-making framework described in the IWP. Future documents describing work at the operable unit will also reflect this approach.

2.2 The Data Quality Objectives Process and Phased Sampling

Data needs addressed during the RFI span the entire range of remedial action evaluation issues including health and safety, environmental, socioeconomic, managerial, and costs/resource. The derivation of these evaluation issues is discussed in Appendix I, Decision Analysis, of the IWP (LANL 1991, 0553). Only some of these data needs will be met by field investigations, specifically by sampling physical media at the SWMU and/or along pathways, or by surveying human or other biological populations. For investigations of this type, the Data Quality Objectives (DQO) process (Neptune 1990, 0511) provides a structured procedure for designing efficient sampling plans. In this work plan, the steps of the DQO process are embedded in Chapters 3 through 8 and summarized in Figure 2.2-1.

Chapter 3 reviews the available information about the sites: TA-10 Firing Sites SWMU Aggregate (Subsection 3.1.3); TA-10 Subsurface Disposal SWMU Aggregate (Subsection 3.1.4); TA-31 (Section 3.2); TA-32 (Section 3.3); and TA-45 (Section 3.4). Chapter 3 also formulates the initial conceptual model underlying the proposed investigations. This description comprises the first step of the DQO process, the "statement of the problem." If the review of the archival information indicates that there is no reason to suspect that a SWMU presents any potential risk to human health or the environment, then the SWMU is recommended for no further action. Chapter 4 describes those SWMUs recommended for no further action.

Chapters 5-8 present the sampling and analysis plans for each SWMU Aggregate. In these chapters, the findings of Chapter 3 are summarized in the subsection titled "Problem Statement." DQO step 2 and the remaining steps of the DQO process (Figure 2.2-1) are also described. The subsection titled "Decision Process," DQO step 2, identifies the decisions addressing the problem and presents the decision process. Figure 2.2-2 is a generic DQO decision process flow diagram.

The subsection titled "Date Needs" is DQO step 3 and identifies "inputs affecting the decisions." It is seldom possible to identify all the data needed to complete an investigation at the outset of the RFI process. This problem is recognized in the proposed RCRA Subpart S regulations, which recommend that investigations be "conducted in a step-wise fashion, with early screens to determine whether further investigation is necessary" (EPA 1990, 0432).

In this work plan, "conducted in a step-wise fashion" means implemented with phased sampling, as illustrated in Figure 2.2-2. Phase I samples are collected and analyzed, and the results are used to guide Voluntary Corrective Actions (VCAs) baseline risk assessments, or to evaluate remedial alternatives. If data are not sufficient to support these efforts, additional sampling (Phase II) is performed. Thus, phased sampling is a temporal concept. The initial Phase I investigation of each site, for which detailed sampling plans are provided in this work plan, addresses the most obvious gaps in the existing information about that site. In some cases, these investigations are designed to determine whether any source of contamination is present at the site. These investigations attempt to provide sufficient data to document the absence of a source, where appropriate, but additional Phase II investigations may be required if contamination is present. In this RFI work plan, many Phase I investigations consist of reconnaissance sampling. The DQO process has been used to design these reconnaissance sampling plans for TA-31 (Chapter 6), TA-32 (Chapter 7), and TA-45 (Chapter 8). The previously published DQO papers have not applied the DQO process to

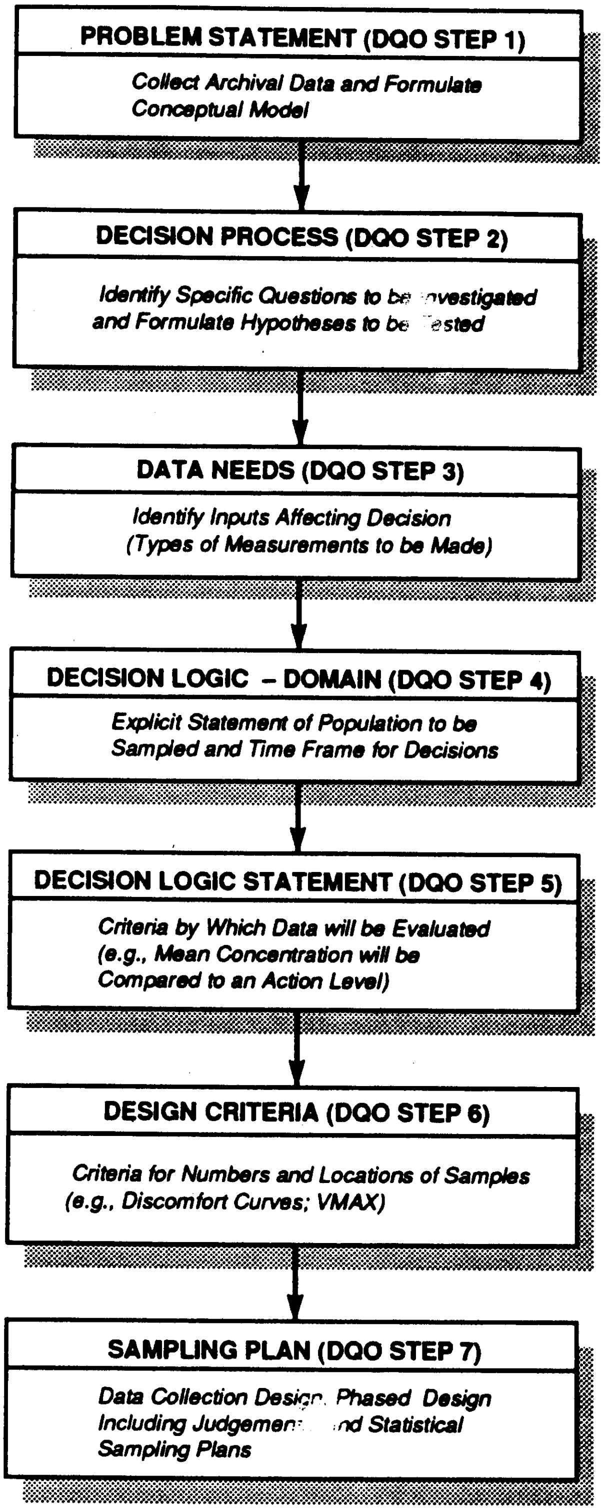


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Figure 2.2-1. DQO logic flow diagram.

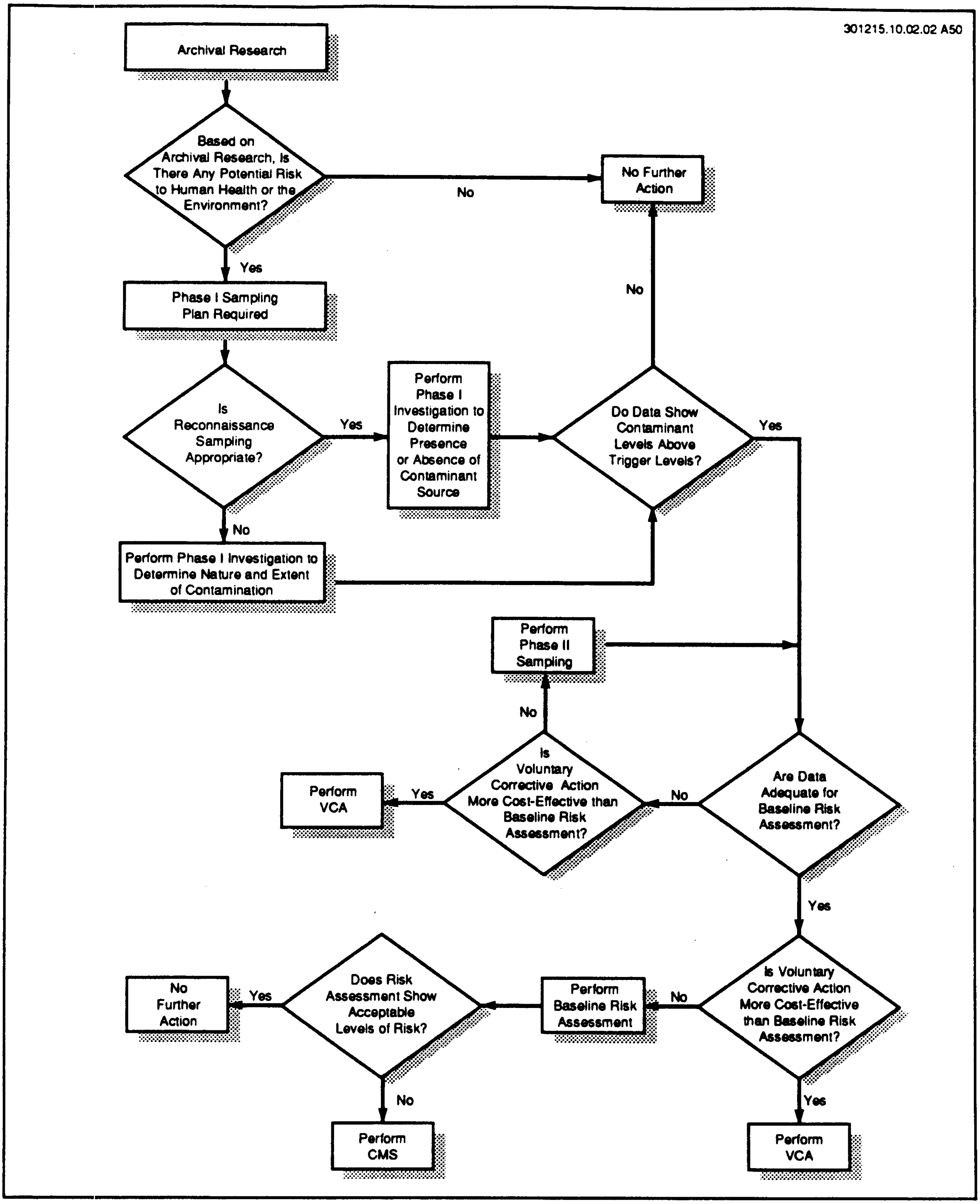

Figure 2.2-2. Generic DQO decision process flow for sampling plan. Flow illustrates use of phased sampling design.

reconnaissance sampling, but have used reconnaissance sampling to acquire information necessary for a statistically-based sampling plan. It should also be noted that the DQO process will be used to design Phase II investigations, and these designs will be presented in the appropriate phase reports (see Annex I of this work plan).

Other Phase I investigations in this work plan assume a source is present or probable, either on the basis of existing data or professional judgment. These investigations are designed to define or bound the extent of contamination, and provide sufficient data for a Voluntary Corrective Action (VCA) or a baseline risk assessment if the contamination exceeds a trigger level and is greater than background concentrations. These Phase I investigations may lead to Phase II investigations if a VCA is not performed or the data cannot support a baseline risk assessment. The Phase I investigations for the TA-10 Firing Sites SWMU Aggregate (Section 5.1) and the TA-10 Subsurface Disposal SWMU Aggregate (Section 5.2) are examples of this type of investigation.

The "domain of the decision," DQO step 4, is included in the "Decision Logic" subsections. This step provides an explicit statement of the populations to be sampled. At TA-31, TA-32, the TA-10 Subsurface Disposal SWMU Aggregate, and TA-45 SWMU Aggregates, investigations are based on sampling those areas most likely to be contaminated, based on existing information and expert judgment. Thus, in the terminology of the DQO process, the "domain" of this decision consists of the most probable contaminated subpopulations at or near the SWMU or SWMU Aggregate. This sampling of the most probable contaminated subpopulations is what is meant by judgmental sampling in this work plan. The underlying assumption is that results from these samples will provide upper bounds for contaminant levels.

The "logic statement," DQO step 5, also included in the "Decision Logic" subsection, is a brief statement of the criteria by which these data will be evaluated or how they will be used (e.g., sample mean will be compared to a trigger level based on acceptable risk, and the maximum of the sample will be compared to a trigger level).

The subsections titled "Design Criteria" provide the guidelines for determining the numbers and locations of samples. In previously published DQO applications, "constraints on uncertainty" or "discomfort curves" have been used as the only design criteria (DQO step 6). In this work plan, discomfort curves are used to determine the grid spacing and thus the number of samples for the TA-10 Firing Sites Aggregate surface sampling. However, for the TA-10 sediment sampling and the TA-31 and TA-32 investigations, which are reconnaissance sampling, the design criterion is expert judgment as to the areas with the highest probability of finding contamination if it exists. The assumption is that this judgmental sampling will bound the level of the contamination and provide data for Phase II investigations, when necessary. The design criteria for the TA-10 Subsurface Disposal SWMU Aggregate and the TA-45 SWMU Aggregates combine expert judgment, existing data, and field screening results. Again, following the philosophy of the observational approach, the goal is to gather information to bound the problem so that uncertainties can be assessed and decisions made as to the next phase of the investigation. The TA-10 Subsurface Disposal SWMU Aggregate sampling design introduces the concept of a feasible maximum volume (VMAX) to remediate through a removal action (see Subsection 5.1.2). This maximum volume is used to guide the placement of characterization boreholes and to provide guidance for choosing between characterization efforts and corrective measures evaluation. Developing criteria to determine when to stop the iterative process of investigation and when to begin corrective measures studies is the crux of the observational approach. The parameter VMAX is an attempt to develop such a criterion and does not impose removal as the remediation alternative.

Finally, Sections 5.1 (TA-10 Firing Sites SWMU Aggregate), 5.2 (TA-10 Subsurface Disposal SWMU Aggregate), 6.2 (TA-31), 7.2 (TA-32), and 8.2 (TA-45) describe the proposed data collection activities. These sections implement the step 7 of the DQO process, the "design for obtaining data." These sections also describe the preliminary surveys needed to define appropriate subpopulations for sampling and levels of analytical precision to be obtained. Only Section 5.1 (TA-10 Firing Sites SWMU Aggregate) has a statistically-based sampling plan. All other sampling plans are based on expert judgement and existing radiological data, and are designed to bound either the extent of contamination (TA-10 Subsurface Disposal SWMU Aggregate), or the level of contamination, and to provide data for Phase II investigations, if necessary (TA-31, TA-32, and TA-45).

2.3 Conceptual Exposure Models

Integral to the DQO process is the development of a conceptual exposure model. Each conceptual exposure model describes the potential sources of contamination, potential migration pathways for contaminants released from the source, and subsequent human and biota exposure pathways. The conceptual models then serve as the basis for the proposed field investigations.

Figure 2.3-1 presents an example conceptual exposure model for potential contaminant releases from a subsurface liquid waste disposal system at TA-10, and subsequent exposure to various potential receptors. The conceptual exposure models presented in this work plan (Chapter 3) are not meant to contain every possible release mechanism, migration pathway, or potential receptor. Rather, they are designed to illustrate only those considered to be the most relevant, on the basis of current site and regional understanding. The conceptual models include the dominant scenarios for risk assessment. Thus, if acceptable risk levels can be demonstrated for these scenarios, then acceptable levels will be met for all scenarios. A brief description of each column presented in the example conceptual model is provided below.

Primary Source	SWMU: e.g., liquid waste disposal system.

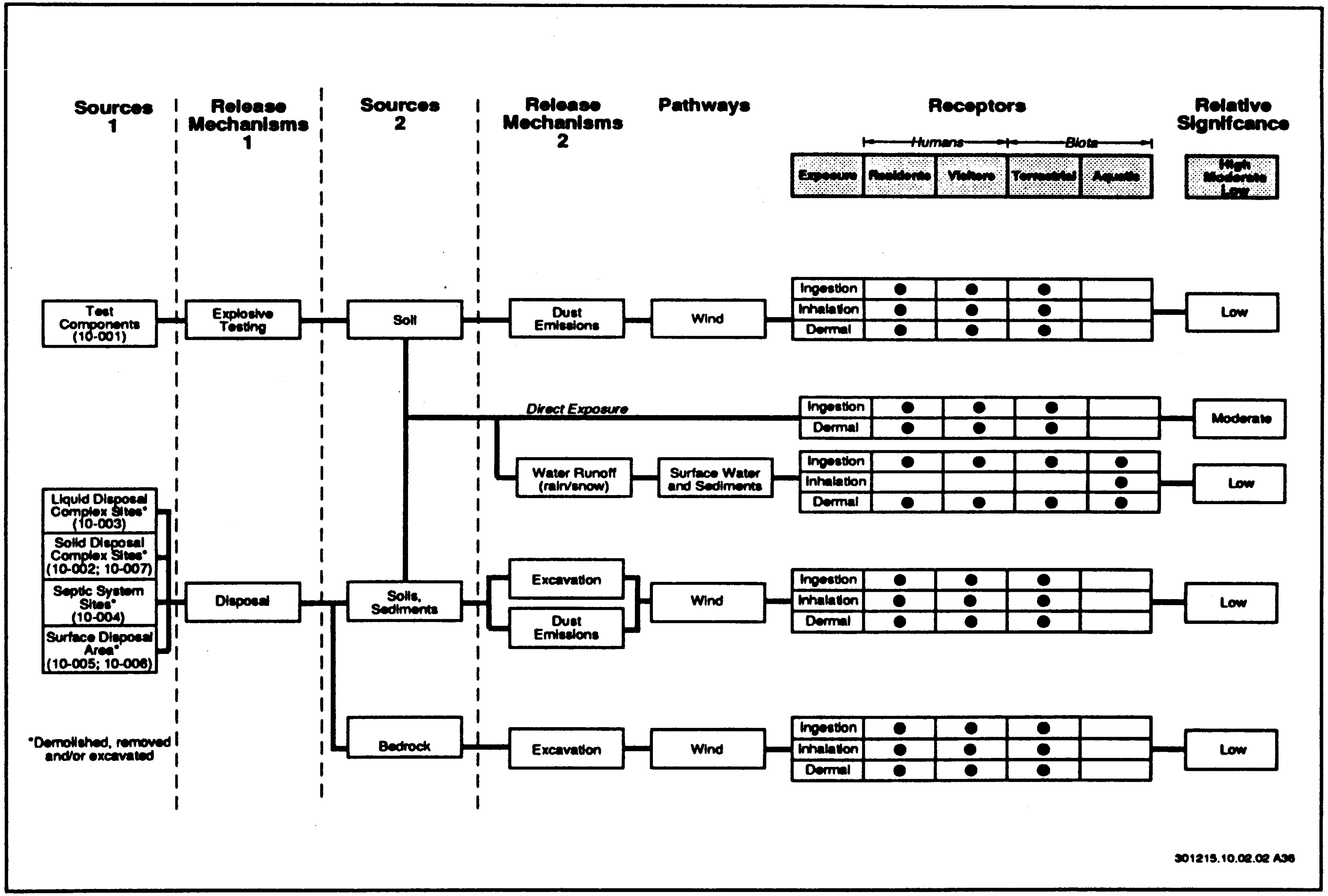

Figure 2.3-1. TA-10 conceptual model flow diagram.

Primary Release Mechanism	Release of contaminants from the SWMU into the environment: e.g., releases from the subsurface disposal system to a leach field.
Secondary Source	Environmental medium potentially contaminated by the primary release: e.g., soil surrounding a subsurface disposal system.
Secondary Release Mechanism	Potential mode for release of contamination from the secondary source: e.g., leaching of contaminants from soil surrounding a subsurface disposal system.
Migration Pathway	Environmental pathway by which contaminants may move from primary or secondary sources to receptors: e.g., leached contaminants may move through the vadose zone.
Potential Contact Medium	Environmental medium that a potential receptor may contact: e.g., soil beneath the subsurface disposal system that may be exposed during excavation.
Exposure Pathways/Receptors	Human and other receptors that may come in contact with a contaminated environmental medium: e.g., site workers having direct dermal contact with contaminated soil during excavation activities.
Relative Significance	The anticipated importance of the identified exposure pathway relative to other exposure pathways in the operable unit: e.g., the potential significance of exposure to contaminated soil at the subsurface disposal system may be lower than at another SWMU where the soil is exposed at the service or more likely to be disturbed.

The biologic uptake/ingestion pathway and vadose zone unsaturated flow pathway have been omitted from the OU 1079 conceptual models. Additionally, while contained in the conceptual models, characterization of the air transport pathway has not been addressed in the Phase I investigations contained in this work plan. Since the objective of most of the OU 1079 Phase I investigations is to determine if a contaminant source is actually present, release mechanisms from the potential sources will not be characterized at this time. If contaminant sources are identified at locations and depths from which air transport or biologic uptake/ingestion may occur, the conceptual model will be modified prior to design of the Phase II sampling plans.

In Los Alamos, worst-case infiltration scenarios range from zero to 5.61 in. (high antecedent moisture content) (Souder and Mello 1985, 06-0043). However, the conclusion that average annual infiltration is essentially zero has been observed by field experimentation at TA-54 (International Technology Corporation 1987, 0327). Therefore, vadose zone unsaturated flow as a contaminant pathway will not be considered during the Phase I investigations. If data collected during these investigations, particularly in the subsurface site investigations, indicate post-disposal migration of contaminants through unsaturated flow or fracture flow, the conceptual model will be modified prior to design of the Phase II sampling plans. The conceptual exposure models for each SWMU or SWMU Aggregate are presented in Chapter 3.

2.4 Analytical Levels

The analytical level required in field data depends in part on the proposed uses of the results. Appropriate analytical levels for various data uses are outlined in the EPA guidelines for the DQO process (EPA 1987, 0086). Table 2.4-1 summarizes these recommendations. Data collection at Levels I through IV is included in the Phase I sampling plans in Chapters 5 through 8.

Data collection in a field survey mode produces Level I or Level II data. Specific activities include land surveys and area-wide surveys for gross radiation. Results range from qualitative to semi-quantitative. The purpose of these preliminary data is to provide information to guide sample selection for higher quality data. Health and safety concerns are also addressed in part by field surveys. Field surveys can also include non-analytical activities such as geophysical surveys to locate features of interest.

Field screening data are also generally Level I or Level II, and are used to provide initial estimates of contamination in various media. Specific activities include sample screening by hand-held instruments such as an organic vapor analyzer (PID or FID) or a radiation detector. Results can be semi-quantitative and can provide indications of gross sample contamination or can aid in the selection of samples for subsequent laboratory analysis. Direct-reading devices can be used to guide the interactive approach during drilling activities for determining vertical or lateral extent of contamination. Health and safety concerns are also addressed in part by field screening techniques, for example, monitoring ambient air quality during investigative activities.

Field laboratory data are generally of Level III caliber. In the field sampling plans for OU 1079, field laboratories may provide rapid results and may be used along with real-time Level II field screening data to guide the interactive approach to

TABLE 2.4-1 SUMMARY OF ANALYTICAL LEVELS APPROPRIATE TO DATA USES (EPA 1987, 0086)

Data Uses	Analytical Level	Type of Analysis	Limitations	Data Quality
• Site Characterization • Monitoring During Implementation	Level I	• Field Screening for Organic Vapor and Radiological Detection Using Portable Instruments • Field Test Kits	• Instruments Respond to Naturally Occurring Compounds	• If Instruments Calibrated and Data Interpreted Correctly, Can Provide Indication of Contamination
• Site Characterization • Evaluation of Alternatives • Engineering Design • Monitoring During Implementation	Level II	• Variety of Organics by GC; Inorganics by AA, XRF	• Tentative Identification Analyte-Specific • Techniques/Instruments Limited Mostly to Volatiles, Metals, Some Radionuclides	• Dependent on QA/QC Steps Employed • Data Typically Reported in Concentration Ranges • Detection Limits Vary from Low PPM to Low PPB
• Risk Assessment • Site Characterization • Evaluation of Alternatives • Engineering Design • Monitoring During Implementation	Level III	• Organics/Inorganics Using EPA Procedures Other Than CLP Can be Analyte-Specific • RCRA Characteristic Tests • Radiological Constituents	• Specific Identification; Tentative Identification in Some Cases • Can Provide Data of Same Quality as Level IV	• Similar Detection Limits to CLP • Less Rigorous QA/QC
• Risk Assessment • Evaluation of Alternatives • Engineering Design	Level IV	• TCL/TAL Organics/Inorganics by GC/MS, AA, ICP	• Tentative Identification of Non-TCL Parameters • Some Time May be Required for Validation of Packages	• Goal is Data of Known Quality • Rigorous QA/QC • Low PPB Detection Limit
• Risk Assessment	Level V	• Non-conventional Parameters • Appendix 8 Parameters	• May Require Method Development/Modification • Mechanism to Obtain Services Requires Special Lead Time	• Quality is Method Specific • Method-Specific Detection Limits

GS = Gas Chromatography
AA = Atomic Absorption
XRF = X-ray Fluorescence

CLP = Contract Laboratory Program
TCL = Target Compound List
TAL = Target Analyte List
ICP = Inductively Coupled Plasma

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determine the vertical and lateral extent of contamination. Specific compounds or measurements to be analyzed in field laboratories may include radiological counts and volatile organic compounds. Results can be quantitative with detection limits approaching those of Level IV data.

Data from fixed-base analytical laboratories comprise Level IV data, for uses where accuracy, precision, and defensibility are of prime concern. These data may be used for site characterization, baseline risk assessment, and the evaluation and engineering of remedial alternatives. Detection limits are expected to be consistent with EPA standard methods.

As mentioned earlier, several of the sites in OU 1079 are being addressed initially through reconnaissance sampling to determine whether a source of contamination presents a current health risk. This determination will be based on analytical laboratory measurements. In the case of naturally-occurring or widely-distributed contaminants, the determination will require comparing sample data with trigger levels, regional background levels, or background levels in other geographic areas if they are higher than trigger levels. These comparisons will require that the analytical methods used must have detection levels below action or background concentrations. Changes in regional background concentrations for radioactive elements and metals are being determined by the Los Alamos Environmental Restoration (ER) Program's framework studies.

In addition, because many of these sites may be recommended for no further action, it is important to obtain the highest quality data. Therefore, analytical data of documented quality (Analytical Level IV) will be required for at least some reconnaissance samples, and data on a subset of the Target Analyte List and radionuclides will be obtained on the requisite number of samples from each site. To perform the baseline risk assessments, data at Analytical Level III or higher will be required.

2.5 Trigger Levels

An important component of the DQO process is the formulation of the hypotheses that will be tested using the data acquired during the RFI (DQO, step 2). Some of these hypotheses are in the "if-then" format. For example, "if a contaminant concentration is less than a trigger level (health-risk-based level), then no further action is required. Additionally, if a contaminant concentration exceeds a trigger level but is less than a naturally-occurring background concentration then no further action is required. If it is higher than a trigger level and the background concentration, then a baseline risk assessment or Voluntary Corrective Action (VCA) may be performed." The nonradionuclide trigger levels are the "action" levels as defined in the proposed RCRA Subpart S regulations (EPA 1990, 0432) or modified values as currently defined in the IRIS database. Radionuclide trigger levels were not required for the design of Phase I sampling plans developed in this work plan. However, they will be required for the analysis of the data obtained from the Phase I sampling. The ER Program is currently developing baseline risk assessment scenarios and criteria that will be presented in the 1992 IWP. This approach will be developed in time for data analysis. The radiological trigger levels for this work plan will be consistent with DOE Order 5400.5, Chapter IV, and will be based on a conservative residential use scenario (such as direct soil ingestion and/or inhalation) when appropriate (i.e., SWMU located on mesa top). The motivation for using trigger levels is to quickly eliminate non-problems so that resources can be focused effectively. ER program policy is that decision points will be based on health-risk-based trigger levels, not background levels, unless background levels are above trigger levels. Background levels are not used as "trigger" levels, but will demonstrate when constituents in the soil or tuff are derived from natural sources rather than from SWMU activities. Background levels are needed to study contaminant migration because they will be used to determine the extent of contaminant migration from a known SWMU source and differentiate the SWMU contribution from the naturally-occurring distribution of contaminants.

2.6 Installation-Wide Data Collection

In addition to the proposed sampling plans described in this work plan, there are several installation-wide characterization programs that are either currently underway or planned for the future. The ER Program is currently conducting a study to determine the background concentration ranges for Target Analyte List metals and radionuclides in soils and the Bandelier Tuff. The study will also collect data on some physical and chemical parameters that control mobilities of the constituents. Initial results of the study will be presented in the 1992 IWP, and will be available for use in time for data analysis.

A biological survey of each operable unit at the Laboratory is also ongoing. This survey is one of the first steps in evaluating the potential adverse impacts to the environment associated with current or past laboratory activities (see Chapter 1). This survey will augment the findings of the OU 1079 National Environmental Policy Act (NEPA) survey. The ER program has adopted the policy that a meaningful environmental evaluation must be based on a Laboratory-wide approach rather than on individual OUs, and final evaluation is deferred pending completion of all surveys.

Information regarding rates of erosion for transport modeling in baseline risk assessments and background concentrations of radionuclides with worldwide distribution due to fallout from atmospheric nuclear testing will also be developed as part of the installation-wide investigations. The results of these programmatic studies will provide critical information for analyzing data collected for OU 1079, including assessing the risks and carrying out the CMS for these sites.

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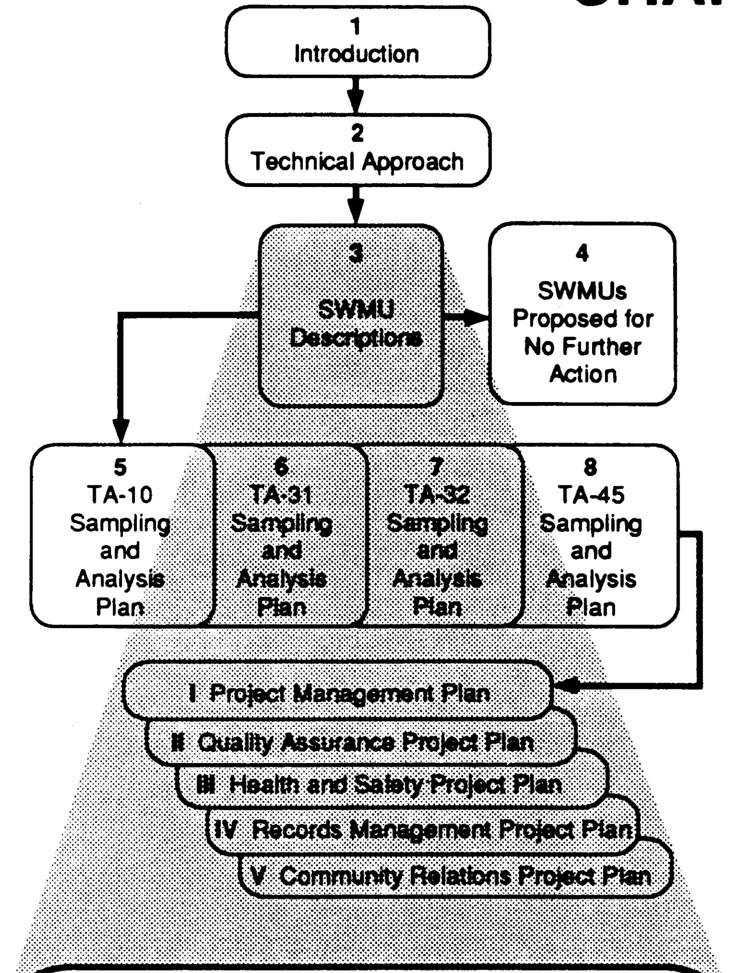
CHAPTER 3



SWMU Descriptions

- OU Background Information
- SWMU Aggregate Descriptions
- Environmental Setting
- Conceptual Models

3.0 SOLID WASTE MANAGEMENT UNIT (SWMU) DESCRIPTIONS

3.1 Technical Area 10 (TA-10) - Bayo Canyon

3.1.1 Overview of Historical Operations

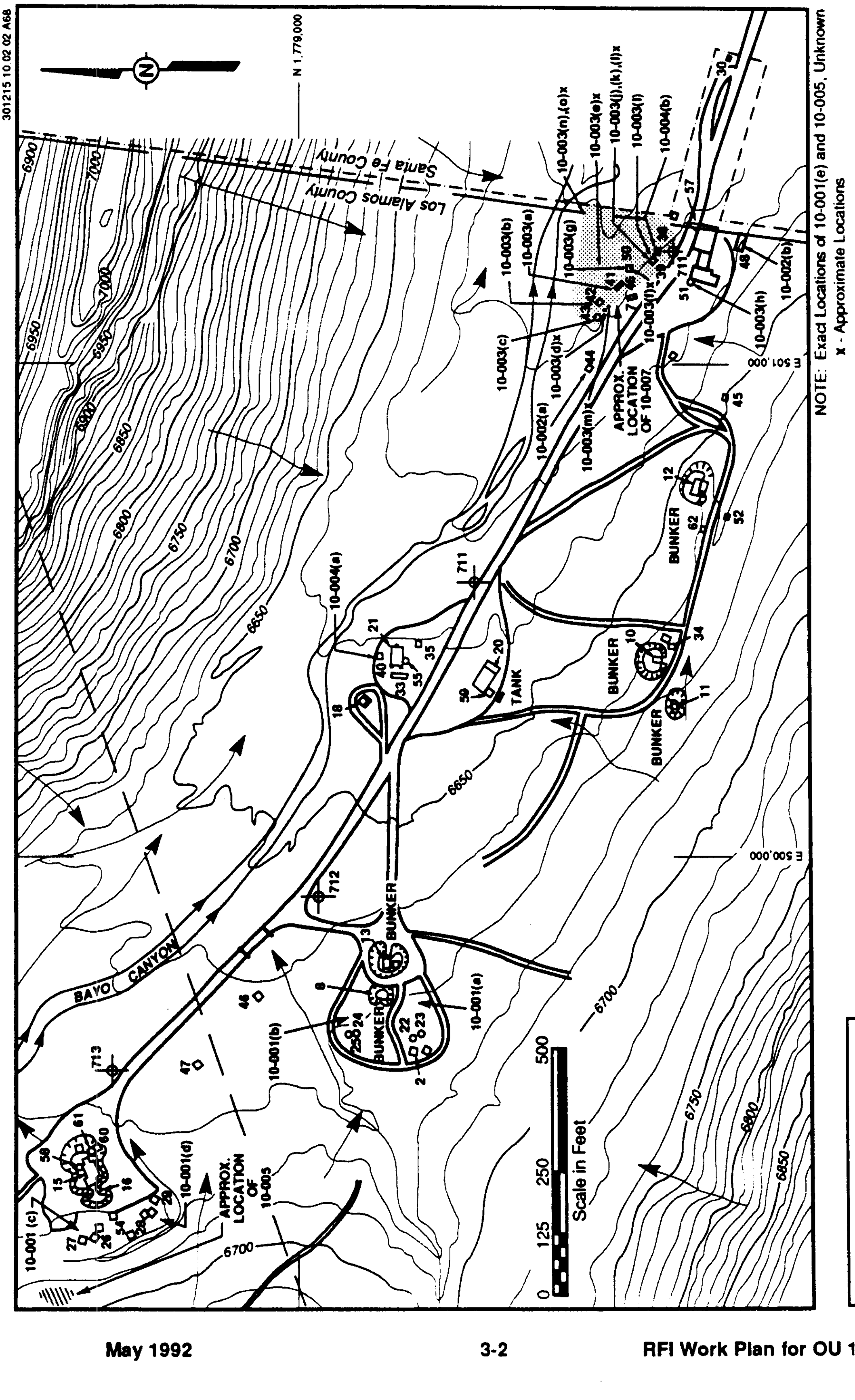
Technical Area 10 (TA-10) was located in a portion of Bayo Canyon and is sometimes referred to as the "Bayo Site." Used as a firing site from approximately 1944 through 1963, TA-10 also housed a radiochemistry laboratory to facilitate preparation of the shots. Initially, Group M-5 operated the firing sites and Group CMR-4 operated the radiochemistry laboratory. Four shot pads were rotated in use, because the area immediately surrounding a pad would be radioactively contaminated for up to a month after each shot (LASL 1947, 0461).

The principal structures comprising TA-10 included 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, particularly the control buildings (TA-10-13 and TA-10-15) and adjacent firing pads. Ancillary facilities, mainly for the laboratory, included sanitary and radioactive liquid waste sewage lines, manholes, septic tanks and seepage pits, and solid radioactive waste disposal pits (Mayfield et al. 1979, 06-0041).

TA-10 was constructed to test assemblies containing conventional high explosives (HE) that included components fashioned from depleted or natural uranium. The assemblies were loaded with a Lanthanum-140 (^{140}La) "source" of several hundred to several thousand curies for blast diagnostics. The ^{140}La (half-life 40.3 hours) was contaminated with a small portion of Strontium-90 (^{90}Sr) (half-life 28.8 years). The ^{140}La was separated from its host material and prepared as a source in the radiochemistry building. Detonation of the assemblies at the firing sites dispersed uranium and source activity to both air and ground. Liquid and solid wastes generated at the radiochemistry laboratory were placed in waste pits near TA-10-1, resulting in some subsurface contamination. The firing sites are shown at the west end of Figure 3.1-1, and the radiochemistry laboratory and associated structures are at the east end.

Bayo Site decontamination and decommissioning (D&D) activities started in 1960 with the demolition and/or burning of several buildings. Explosives testing at TA-10 ceased altogether in 1961; and site-wide decommissioning of both the firing sites and the radiochemistry laboratory and associated structures was completed in 1963. During cleanup activities in 1963, 90 truckloads of debris, shrapnel, and heavy explosives (HE) material were removed from a radius of 760 m from the detonation control buildings at the firing sites, and transported to Material Disposal Area (MDA)-C at TA-50 and MDA-G at TA-54. The liquid waste disposal system associated with the radiochemistry laboratory was also removed, and the contaminated waste pits were excavated (Courtright 1963, 06-0038).

TA-10 was released to Los Alamos County in 1967. Consequently, information on the site has been relatively well documented (e.g., Courtright 1963, 06-0038; Mayfield et al. 1979, 06-0041; Ferenbaugh et al. 1982, 0667; Ford, Bacon, and



LEGEND
10 – TA Structure Number
10-001(a) – SWMU Number
▨ – Probable Extent of 10-007
- - - – Fence

Figure 3.1-1. TA-10 site map and associated SWMU locations (modified from LANL 1990, 0145; AEC 1963, 06-0045; AEC 1963, 06-0044; AEC 1963, 06-0046; AEC 1963, 06-0047; AEC 1963, 06-0048; AEC 1963, 06-0049; AEC 1963, 06-0050; LASL 1961, 06-0056; LASL 1961, 06-0057; LASL 1962, 06-0058).

Davis Utah, Inc. 1981, 06-0039; DOE 1987, 0264) A chronology of activities at TA-10 is presented in Table 3.1-1. No documented product or waste spills occurred at TA-10 during its operation.

Because of the wide dispersal of debris by the tests and continuing natural erosion processes, it was recognized at the time of decommissioning that there was a reasonable probability that some HE waste and potentially radioactive materials remained in the canyon. Therefore, periodic surface surveys and searches were conducted in 1966, 1967, 1969, 1971, 1973, 1975, and 1976 (Blackwell 1966, 06-0005; Courtright 1966, 06-0013; Drake and Courtright 1967, 06-0018; Drake and Courtright 1969, 06-0019; Drake 1971, 06-0015; Courtright 1971, 06-0042; Drake 1973, 06-0016; Drake et al. 1975, 06-0020; Drake et al. 1976, 06-0017). During these surveys, additional surface debris was located, some of which was contaminated with ^{90}Sr and uranium.

A total of 27 SWMUs have been identified at former TA-10 (Figures 3.1-1, 3.1-2a, 3.1-2b, 3.1-2c and Table 3.1-2). For investigative purposes, these SWMUs logically fall into two SWMU aggregates (Table 3.1-3) based on location, SWMU use/history, results from prior cleanup activities, and potential for surface and/or subsurface contamination. The firing sites, in which contaminants were initially dispersed to the atmosphere or ground, comprise the first SWMU Aggregate (Table 3.1-3). The Subsurface Disposal SWMU Aggregate contains sites where liquid and solid wastes were released primarily to the subsurface environment. The identified SWMUs at TA-10 and associated structures are listed in Table 3.1-4.

3.1.2 Summary of Previous Investigations

Several investigations and studies conducted over the years have contributed data on the distribution and transport of contaminants at TA-10 and the surrounding area. Table 3.1-5 summarizes the investigations and their results. Additional investigations have occurred at the TA-10 site, and are described in the following subsections. The most recent investigations, test hole drilling and soil sampling in 1973 and 1974, and the 1977 radiological survey under the DOE's Formerly Utilized MED/AEC Sites Remedial Action Program (FUSRAP), are the basis for establishing the current conditions at the TA-10 site.

3.1.2.1 Test Hole Drilling and Soil Sampling - 1973

In 1973, subsurface samples at TA-10 were obtained as cuttings from three M-series test holes augered with a truck-mounted drill rig (Figure 3.1-3). Hole M-1 was drilled a few meters north of the location of the solid waste disposal pit SWMU 10-002(b) (TA-10-48). Hole M-1 penetrated alluvium to a depth of 7.9 m and bottomed in tuff at a depth of 12.2 m. A later engineering survey indicated that the hole was 6 m north of the actual pit location. Results of radiochemical analyses of samples for plutonium and ^{90}Sr showed levels lower than the analytical detection limit, indicating no subsurface migration at the location. A

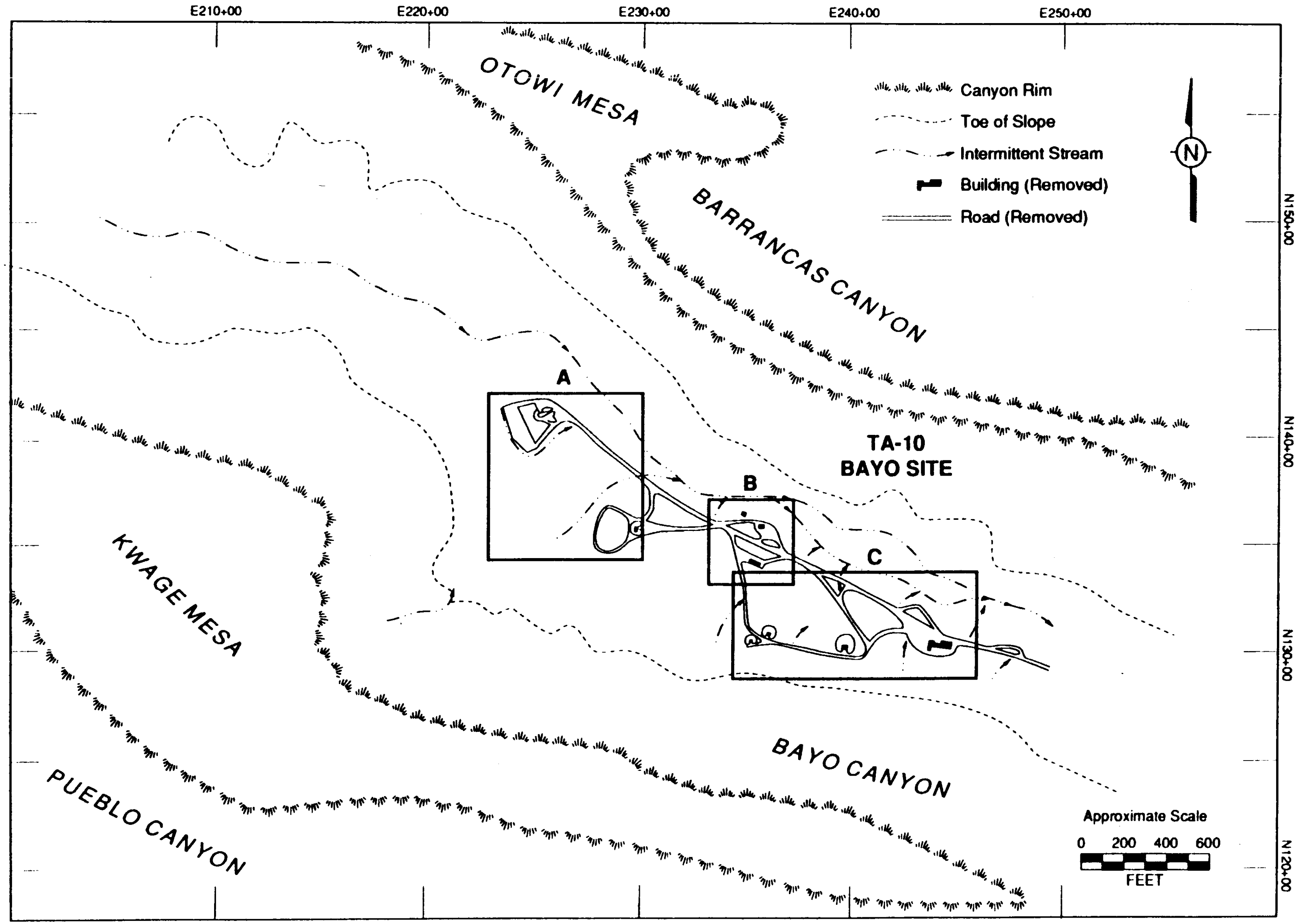


Figure 3.1-2a. Index map of TA-10 SWMUs (modified from Mayfield et al. 1979, 06-0041; LANL 1990, 0145).

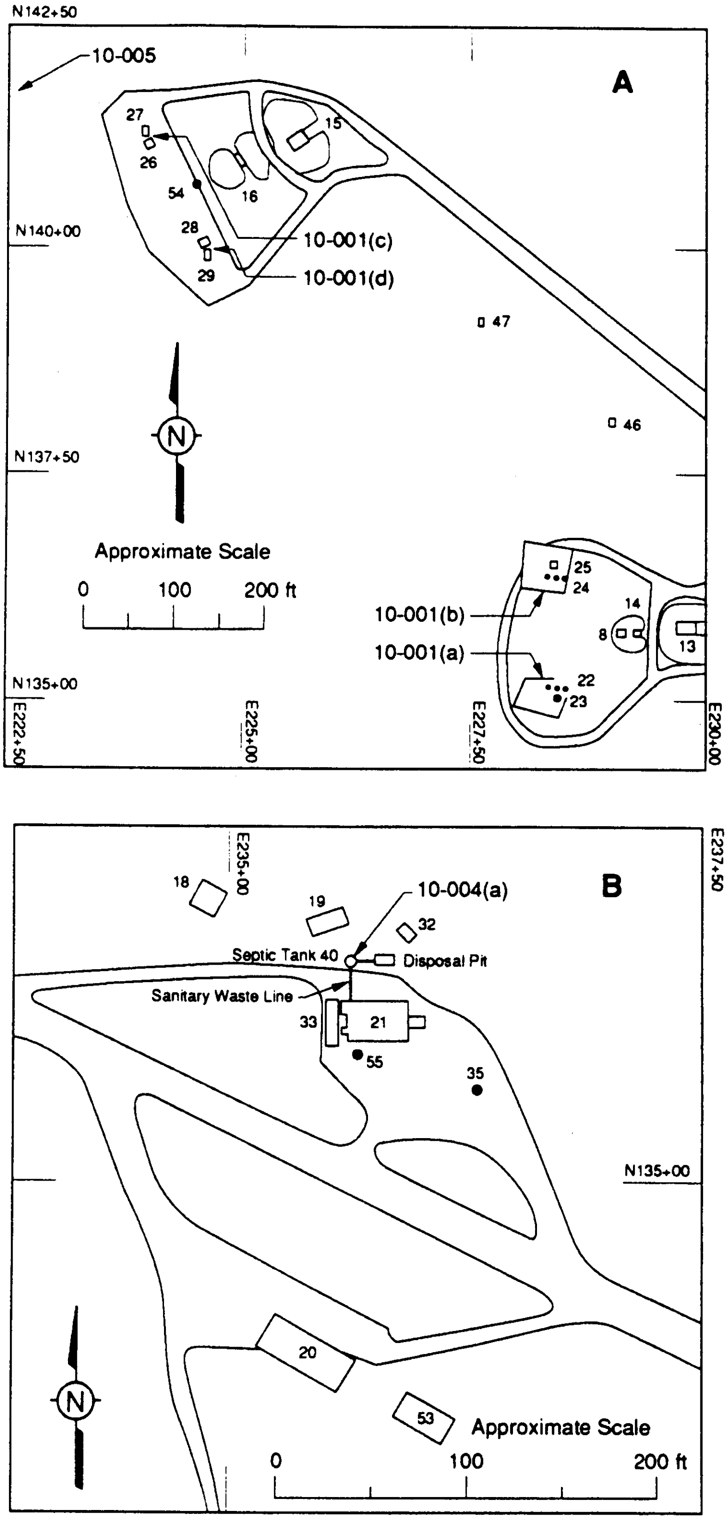


Figure 3.1-2b. Location of TA-10 SWMUs (areas A and B on index map—Fig. 3.1-2a; modified from LANL 1990, 0145).

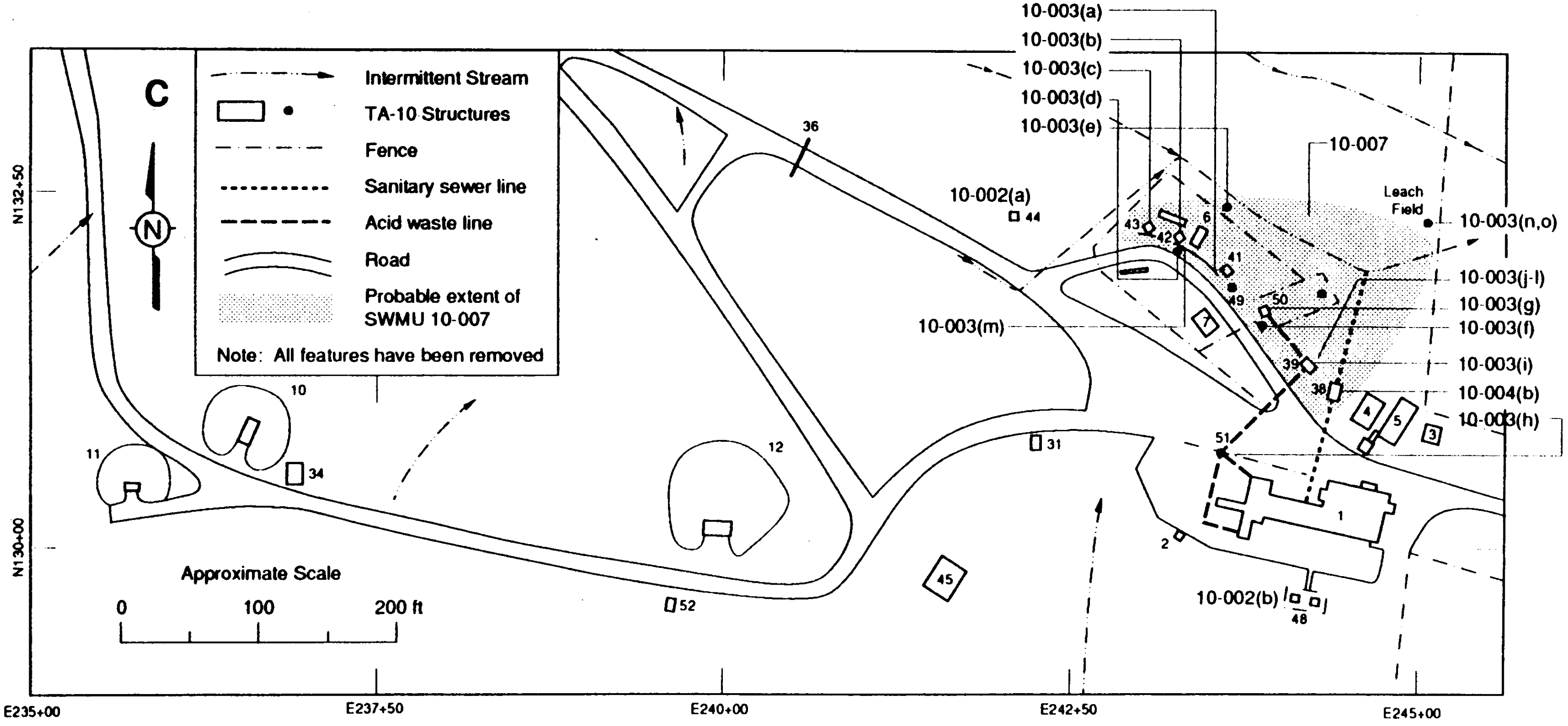


Figure 3.1-2c. Location of TA-10 SWMUs (area C on index map in Figure 3.1-2a; modified from LANL 1990, 0145).

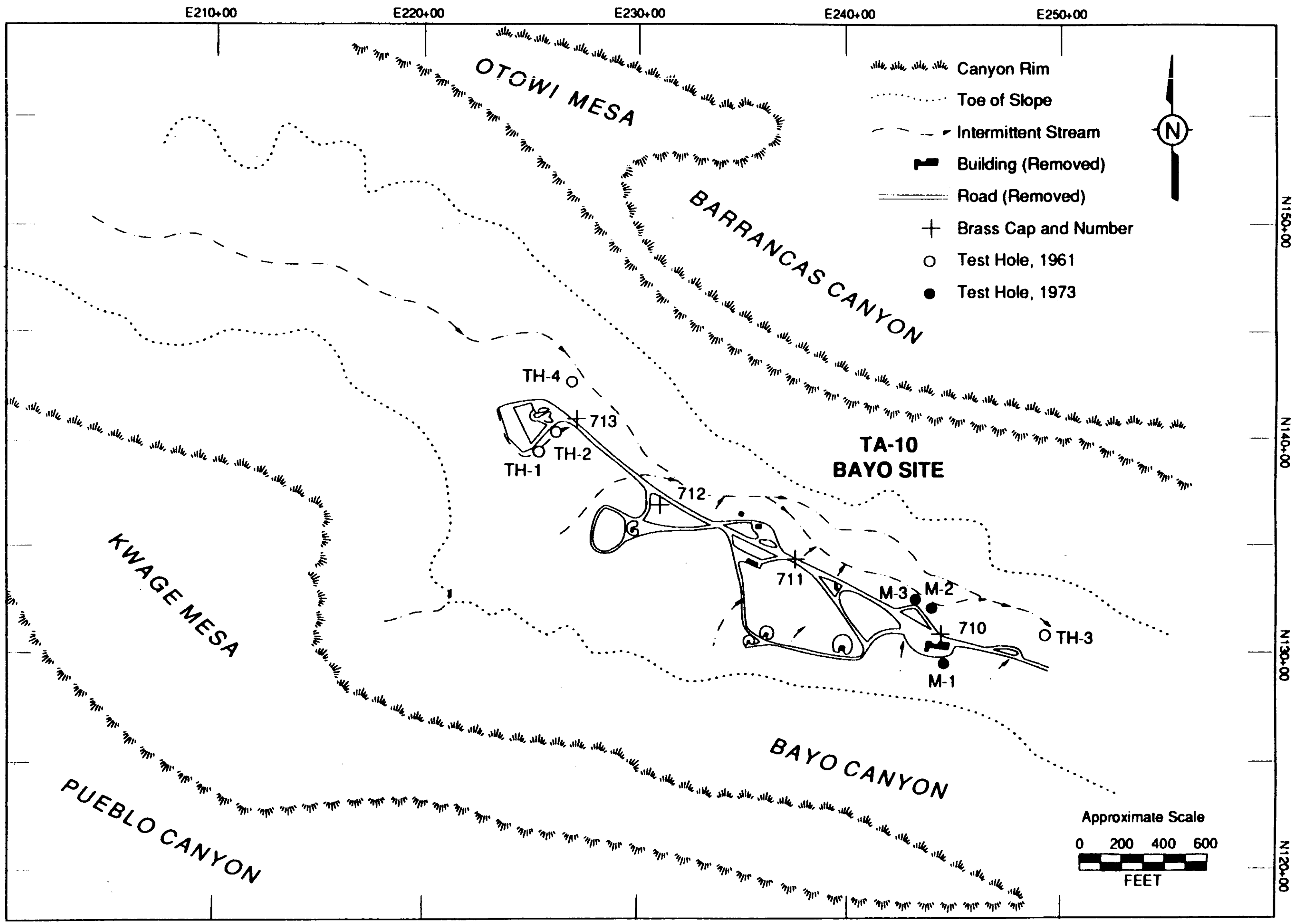


Figure 3.1-3. Test holes drilled at Bayo Site, 1961 and 1973 (modified from Mayfield et al. 1979, 06-0041).

TABLE 3.1-1 CHRONOLOGY OF EVENTS AT BAYO CANYON SITE (TA-10)

Date	Description
1943	Construction of site began
1944	Firing tests began in Bayo Canyon
1949	Firing tests created cloud dispersal both east and west of the site
1956	USGS/LASL contaminant monitoring study
1960	Decommissioning of site began
1961	Aerial gamma radiation survey (ARMS-II) Test holes drilled to determine if perched water present
1961	Firing tests ended in Bayo Canyon
1963	Ninety truckloads of surface debris removed from a radius of 2,500 ft from the firing sites
1963	Firing site structures removed
1965	Sediment sampling conducted
1973	Sediment and soil sampling conducted Three test holes drilled to examine subsurface contamination from waste pits and outfalls
1974	12 more holes drilled in same area
1976 - 1977	Radiological survey by the Formerly Utilized MED/AEC Sites Remedial Action Program (FUSRAP)
1982	Environmental (Dose) assessment conducted based on FUSRAP data fπrom 1976-77
1986	CEARP field survey
04/13/88	ER Program site reconnaissance visit
07/26/88	ER Program site reconnaissance visit

TABLE 3.1-2 TA-10 SWMUs

SWMU No.	Description
10-001(a)	Firing Site
10-001(b)	Firing Site
10-001(c)	Firing Site
10-001(d)	Firing Site
10-001(e)	Sand Pile Detonation Area
10-002(a)	Disposal Pit (Solid Waste)
10-002(b)	Disposal Pit (Solid and Liquid Waste)
10-003(a)	Liquid Disposal System
10-003(b)	Liquid Disposal System
10-003(c)	Liquid Disposal System
10-003(d)	Liquid Disposal System
10-003(e)	Liquid Disposal System
10-003(f)	Liquid Disposal System
10-003(g)	Manhole
10-003(h)	Manhole
10-003(i)	Industrial Waste (Acid Waste) Tank
10-003(j)	Stainless Steel Tank
10-003(k)	Stainless Steel Tank
10-003(l)	Stainless Steel Tank
10-003(m)	Clay Drain Pipe
10-003(n)	Leach Field
10-003(o)	Decontamination Holes
10-004(a)	Septic Tank System
10-004(b)	Septic Tank System
10-005	Surface Disposal
10-006	Open Burning Area
10-007	Landfill

(LANL 1990, 0145)

TABLE 3.1-3 SWMU AGGREGATES FOR TA-10

SWMU Aggregate	SWMU Nos. in Aggregate	SWMU Description	Comments
Firing Sites	10-001 (a,b,c,d)	Firing sites	High potential for ground surface contaminants widely dispersed, inability to separate source term by SWMU
Subsurface Disposal	10-002 (a-b)	Disposal pits	High potential for subsurface contamination, most SWMUs tightly grouped, surface contamination greatly reduced during cleanup
	10-003 (a-o)	Liquid disposal complex	
	10-004 (a-b)	Septic tank systems	
	10-005	Disposal pit	
	10-007	Landfill	

TABLE 3.1-4 TA-10 SWMUs AND ASSOCIATED STRUCTURES

SWMU Number	SWMU Description	Known Associated Structures	Structure Description
10-001(a)	Firing Site	TA-10-22	X-unit Chamber
		TA-10-23	Electronics Chamber
		TA-10-13	Control Building
		TA-10-14	Battery Building
		TA-10-8	Inspection Building
10-001(b)	Firing Site	TA-10-24	X-unit Chamber
		TA-10-25	Electronics Chamber
		TA-10-13	Control Building
		TA-10-14	Battery Building
		TA-10-8	Inspection Building
10-001(c)	Firing Site	TA-10-26	X-unit Chamber
		TA-10-27	Electronics Chamber
		TA-10-15	Control Building
		TA-10-16	Battery Building
		TA-10-8	Inspection Building
10-001(d)	Firing Site	TA-10-28	X-unit Chamber
		TA-10-29	Electronics Chamber
		TA-10-15	Control Building
		TA-10-16	Battery Building
		TA-10-8	Inspection Building
10-001(e)	Firing Site (Sand Pile Detonation)	None	None
10-002(a)	Disposal Pit	TA-10-44	Laboratory Disposal Pit
		TA-10-1	Radiochemistry Laboratory
10-002(b)	Disposal Pit	TA-10-48	Laboratory Disposal Pit
		TA-10-1	Radiochemistry Laboratory

TABLE 3.1-4 TA-10 SWMUs AND ASSOCIATED STRUCTURES (CONTINUED)

SWMU Number	SWMU Description	Known Associated Structures	Structure Description
10-003	**Liquid Disposal**	**TA-10-1 Laboratory**	**Radiochemistry Complex**
10-003(a)	Liquid Disposal Pit	TA-10-41	Liquid Disposal Pit
10-003(b)	Liquid Disposal Pit	TA-10-42	Liquid Disposal Pit
10-003(c)	Liquid Disposal Pit	TA-10-43	Liquid Disposal Pit
10-003(d)	Liquid Disposal Pit	Near TA-10-42	Liquid Disposal Pit
10-003(e)	Liquid Disposal Pit	Near TA-10-41	Liquid Disposal Pit
10-003(f)	Liquid Disposal Pit	Near TA-10-50	Industrial Waste (Acid Waste) Manhole
10-003(g)	Manhole	TA-10-50	Industrial Waste (Acid Waste) Manhole
10-003(h)	Manhole	TA-10-51	Industrial Waste (Acid Waste)Manhole
10-003(i)	Septic Tank	TA-10-39	Industrial Waste (Acid Waste)Septic Tank
10-003(j)	Stainless Steel Tank	Near TA-10-39	Industrial Waste (Acid Waste)Septic Tank
10-003(k)	Stainless Steel Tank	Near TA-10-39	Industrial Waste (Acid Waste)Septic Tank
10-003(l)	Stainless Steel Tank	Near TA-10-39	Industrial Waste (Acid Waste)Septic Tank
10-003(m)	Clay Drain Pipe	TA-10-41	Liquid Disposal Pit
		TA-10-42	Liquid Disposal Pit
		TA-10-43	Liquid Disposal Pit
10-003(n)	Leach Field	Near TA-10-50	Industrial Waste (Acid Waste)Manhole
10-003(o)	Decontamination Holes	Near TA-10-1	Radiochemistry Laboratory
10-004(a)	Septic Tank	TA-10-40	Septic Tank
		TA-10-21	Personnel Building
10-004(b)	Septic Tank	TA-10-38	Septic Tank
		TA-10-1	Radiochemistry Laboratory
10-005	Disposal Pit	--------------	All Firing Sites
10-006	Open Burning	Unknown	Unknown
10-007	Landfill	None	None

TABLE 3.1-5 SUMMARY OF PREVIOUS TA-10 INVESTIGATIONS

Investigation	Date of Investigation	Investigation Activities	Sample Media	Sample Analyses	Investigation Results
Aerial Gamma-Radiation Survey (ARMS-II)	1961	Aerial surveillance to measure gamma radiation			No anomalies measured in Bayo Canyon data. However, technique was insensitive to beta particle emitters such as ^{90}Sr.
Test Hole Drilling	1961	Four test holes (TH-series) were drilled at Bayo Site to determine if perched water occurred at the base of Bandelier Tuff at the Puye Formation contact.	None	None	No indication of perched water or excessive moisture in the tuff. This information and the fact that only small volumes of water were used at the site precluded any transport mechanism for contaminants to the top of the Puye Formation. In addition, ^{90}Sr in effluent is readily absorbed in alluvium or tuff.
Bayo Canyon Stream Channel Sediment Studies	1965	Two sediment sampling stations were established; one at the midreach of the canyon and the other just above the junction with Los Alamos Canyon. Radiochemical analyses were performed on sediment samples.	Sediments	Gross-alpha Gross-beta Gross-gamma ^{238}Pu ^{239}Pu	All sample results were within worldwide fallout range.
	1970	Radiochemical analyses were performed on sediment samples from the two established stations in Bayo Canyon.	Sediments	Gross-alpha Gross-beta Gross-gamma ^{238}Pu ^{239}Pu	All sample results were within worldwide fallout range.

TABLE 3.1-5 SUMMARY OF PREVIOUS TA-10 INVESTIGATIONS (CONTINUED)

Investigation	Date of Investigation	Investigation Activities	Sample Media	Sample Analyses	Investigation Results
	1973	Fourteen samples taken of stream bed sediments across four sampling locations.	Sediments	Gross-alpha Gross-beta ^{238}Pu ^{239}Pu	Sediment samples indicated gross-beta concentrations (range 19-38 pCi/g) twice the background level both at the site and up to 2200m west of the site. Pu results were higher than expected and attributed to contamination in collection or analyses.
	1973	Eight samples taken of channel bank soil across two sampling loclations.	Soil	Gross-alpha Gross-beta ^{238}Pu ^{239}Pu	Gross-alpha and plutonium were at background levels. Gross-beta concentrations (ranging from 26 to 41 pCi/g) were two to three times background.
Soil and Vegetation Uptake Study	1972	Sampling of soil and vegetation on Kwage Mesa to determine whether firing site activities produced persistent contamination on the mesa.	Soil/Biota	^{3}H Gross-beta ^{137}Cs ^{238}Pu ^{239}Pu ^{241}Am Total U	Most parameters were at background levels with the exception of ^{3}H, which was approximately 2.5 times background.
Aerial Gamma-Radiation Survey (ARMS-II)	1975	Aerial surveillance to measure gamma radiation.			No anomalies measured in Bayo Canyon data. However, technique is insensitive to beta particle emitters such as ^{90}Sr.
Study of Surface and Groundwater Quality at LANL and Adjacent Areas	1988	Analysis of surface and ground waters from 43 stations in the Los Alamos area.		Pesticides Herbicides	None detected.

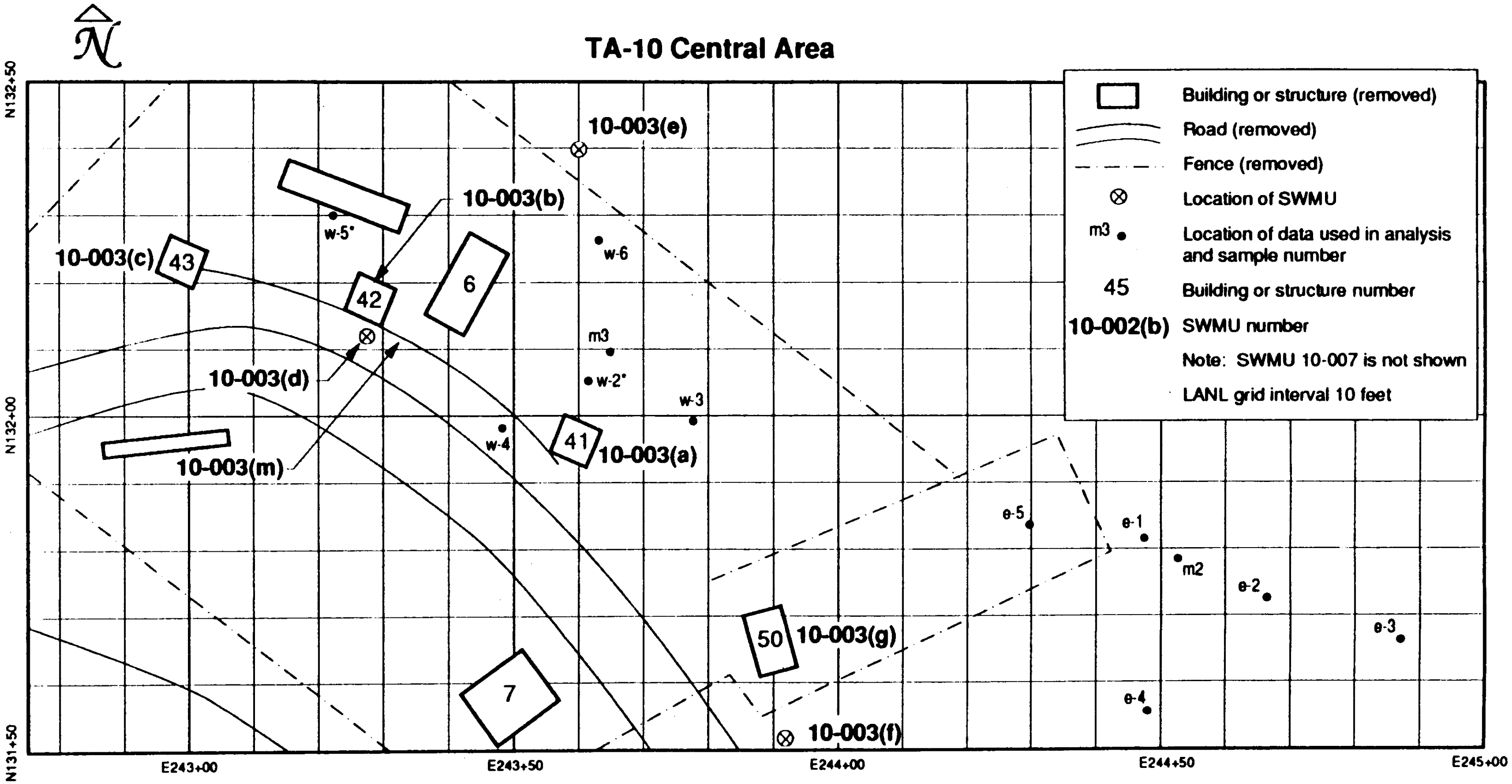
(Mayfield et al 1979, 06 0041 and Purtymun et al 1988, 0214) second hole, M-2, was drilled a few meters east of the sanitary sewer outfall of SWMU 10-004(b). The alluvial fill was approximately 4.6 m thick in the test hole, which was drilled to a total depth of 6.1 m in tuff. Radiochemical analyses of the samples indicated ^{90}Sr contamination to as much as 20 pCi/g (approximately 60 times average fallout levels) within 1.5 m of the surface. The third hole, M-3, was drilled between the location of two of the liquid waste disposal pits, TA-10-41 and TA-10-42 [SWMUs 10-003(a-b)]. This test hole was drilled to a total depth of 2.4 m in alluvial fill. Radiochemical analyses of the samples detected ^{90}Sr contamination at levels up to 3.3 pCi/g (approximately 10 times average fallout levels) within 1.5 m of the surface (Mayfield et al. 1979, 06-0041).

3.1.2.2 Test Hole Drilling and Soil Sampling - 1974

Because some subsurface contamination was indicated by the 1973 samples, an additional 11 auger holes (E-series and W-series) were completed around the 1973 M-series holes in 1974 (Figure 3.1-4). Soil samples were analyzed for gross-alpha and gross-beta activity. Sample results from a few meters north and west of pit TA-10-48 [SWMU 10-002(b)] supported the 1973 finding at the M-1 hole that no migration had occurred to the north of the pit. Sample results from the north end of the industrial waste (acid waste) leach field [SWMU 10-003(n)] and the sanitary outfall [SWMU 10-004(b)] (near M-2; Figure 3.1-4) indicated no migration from the leach field, but elevated gross-beta activity, 3 to 20 times above background levels, occurred in the top 122 cm of soil around the sanitary sewer outfall [SWMU 10-004(b)] (Tables 3.1-6 and 3.1-7). Sample results north of the former 10-003(a) and 10-003(b) industrial waste (acid waste) pits, near the M-3 hole (Figure 3.1-4), indicated both gross-alpha and gross-beta activity in the tuff to a depth of 10 m. A single sample taken from depths between 430 cm and 490 cm at hole W-6 had maximum gross-beta activity of 24,000 pCi/g. Most samples exhibited less than 10 pCi/g gross-beta activity (Mayfield et al. 1979, 06-0041).

3.1.2.3 Formerly Utilized MED/AEC Sites Remedial Action Program (FUSRAP) - 1977

An extensive survey of the Bayo Canyon site was undertaken in 1977 as a part of the FUSRAP program in a nationwide effort to investigate facilities and lands utilized by the Manhattan Engineer District (MED) and the Atomic Energy Commission (AEC) (Mayfield et al. 1979, 06-0041). The resurvey program was designed to provide a basis for estimating potential exposure scenarios under conditions of continued recreational use, light construction, and as an occupied residential area. The FUSRAP exposure estimates included data from soil and sediment sampling, air sampling, and dosimetry measurements.



* The original data did not include labels for these test holes.

Figure 3.1-4. Location of test holes at Bayo Site, 1973 and 1974 (modified from Mayfield et al. 1979, 06-0041; LANL 1990, 0145).

TABLE 3.1-6 GROSS-ALPHA ACTIVITY IN CUTTINGS FROM HOLES NEAR TEST HOLES M-2 AND M-3, 1974
(ANALYSES IN pCi/g)

Depth (m)		Near Test Hole M-2					Near Test Hole M-3				
From	To	E-1	E-2*	E-3	E-4	E-5	W-2	W-3	W-4	W-5	W-6
0.	0.6	2.5	3.1	4.1	2.8	3.4	1.8	3.4	1.7	---	3.1
0.6	1.2	2.6	---	4.0	2.1	4.2	4.2	3.3	2.8	---	----
1.2	1.8	1.9	1.2	5.0	1.0	---	3.8	3.7	2.4	2.1	3.3
1.8	2.4	1.8	1.6	3.3	1.0	2.7	---	2.3	1.9	---	3.9
2.4	3.0	2.6	---	---	1.6	---	---	2.9	1.0	---	6.9
3.0	3.7	2.2	1.5	3.0	1.3	2.8	---	---	1.4	---	2.5
3.7	4.3	3.0	1.4	5.2	1.8	2.4	---	3.1	---	---	12.0
4.3	4.9	2.4	1.3	43.0	3.0	3.7	---	3.6	2.1	---	59.
4.9	5.5	2.7	1.6	3.6	4.9	1.9	---	---	---	---	----
5.5	6.1	---	---	---	1.6	2.1	---	---	---	---	----
6.1	7.6	3.8	2.1	3.8	3.8	3.7	---	2.1	4.4	---	0.5
7.6	9.1	---	2.7	---	---	3.7	---	4.9	4.4	---	5.7
9.1	10.6	---	---	---	---	---	---	4.8	4.6	---	----

(Modified from Mayfield et al. 1979, 06-0041)

*Originally listed as E-1 in source document, however, source text did not identify any duplicate or double sampling.

TABLE 3.1-7 GROSS-BETA ACTIVITY IN CUTTINGS FROM HOLES NEAR TEST HOLES M-2 AND M-3, 1974 (ANALYSES IN pCI/g)

Depth (m)		Near Test Hole M-2					Near Test Hole M-3				
From	To	E-1	E-2	E-3	E-4	E-5	W-2	W-3	W-4	W-5	W-6
0.	0.6	35	10.3	9.2	11.2	186	6.7	47	5.9	---	34
0.6	1.2	31	—	9.9	3.2	89	10.9	36	16	---	18
1.2	1.8	10.7	1.1	15	1.1	---	7.8	30	2.1	22	21
1.8	2.4	3.9	1.5	8.1	3.4	39	----	30	1.6	---	4400
2.4	3.0	4.4	—	----	4.7	----	----	12	1.0	---	20
3.0	3.7	3.1	3.7	3.9	1.4	16	----	---	2.3	---	21
3.7	4.3	5.6	1.8	10.3	1.0	28	----	9.9	----	---	2300.0
4.3	4.9	4.1	3.4	5.2	7.5	---	----	12	5.4	---	24000.0
4.9	5.5	4.7	1.7	6.5	3.5	20	----	----	----	---	---
5.5	6.1	----	----	----	2.4	21	----	----	----	---	---
6.1	7.6	42.	5.5	6.1	2.9	16.0	----	4.6	4.1	---	6400.0
7.6	9.1	---	9.0	----	----	18	---	6.5	3.2	---	---
9.1	10.6	----	----	----	----	----	----	5.6	3.6	---	1510

(Modified from Mayfield et al. 1979, 06-0041)

3.1.2.3.1 FUSRAP Soil and Sediment Sampling

The sampling and measurement rationale for soil and sediment sampling was based on previous use of TA-10, and its history as a testing area. Sampling was also guided by data from previous investigations.

Four basic strata of sampling locations were laid out to assess surface and subsurface soil contamination.

- Firing Sites - A polar coordinate scheme was constructed with nine concentric circles centered at a point between the two main firing pads and extending out 404 meters with sampling points located at intervals of 61 m or less on each circle.
- Canyon Floor - Rectangular grids were appended on either side of the circular pattern to provide more complete coverage of the area that may have been affected by the testing operations. Sampling points were located at 61 m intervals.
- Structures - Sampling points were located around the perimeter of former building locations; along the alignments of industrial and sanitary liquid waste lines; and in the vicinity of former locations of waste pits, septic tanks, and the leach field.
- Stream Channel - Sampling points were located in natural drainage channels and the main stream channel to assess any redistribution or deposition of residual contaminants by surface water runoff.

The basic patterns of the four strata are depicted in Figures 3.1-5, 3.1-6, and 3.1-7. The patterns were used to collect samples by various techniques, to identify subsets of randomly chosen or selected sample types or analyses, and to locate *in situ* measurements.

Using sensitive portable instruments, the general areas were first surveyed to determine any locations of particularly anomalous radiation levels at the surface that might require special investigation. The instruments used were a "micro-R" meter, sensitive to a wide range of gamma radiation, and a phoswich detector, particularly sensitive to low-energy x-ray and gamma radiation. Either instrument would have responded to any major concentrations of uranium, and the phoswich would have responded to any major concentrations of plutonium. Extra samples were taken at locations of anomalous (high) activity. Additional *in situ* penetrating-radiation dose measurements were made at 78 points in the firing site and canyon floor strata during sampling. Soil samples were collected using five basic techniques to gain information on possible contamination at the surface, as in soil resuspension in shallow profiles, in light construction and gardening, and in deep foundation or utility construction at depth. The techniques included

- surface samples taken with a 12.7 cm diameter ring to a depth of 0-5 cm;

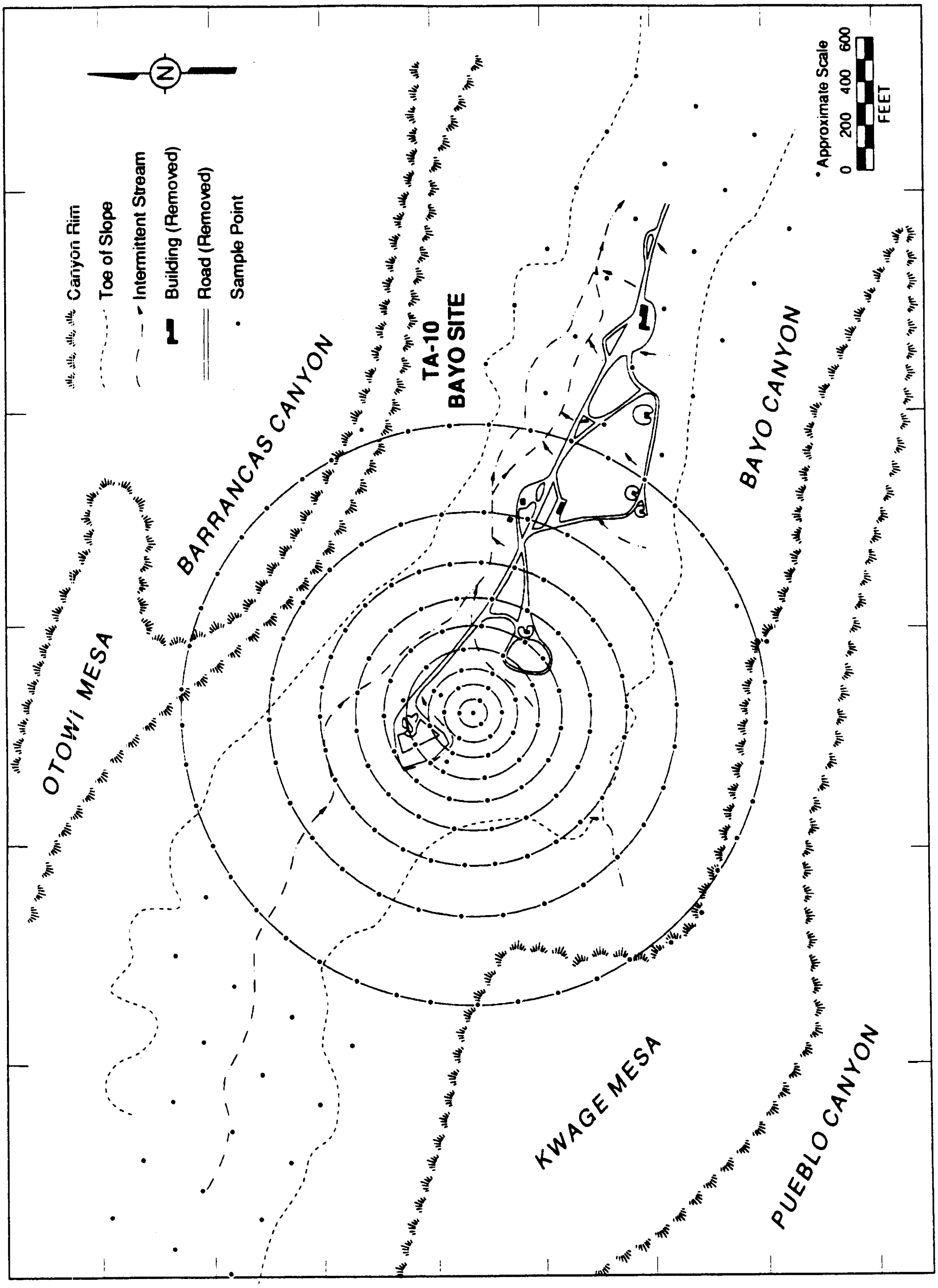


Figure 3.1-5. Firing site grid and canyon floor grid for TA-10 FUSRAP sample locations (modified from Mayfield et al. 1979, 06-0041).

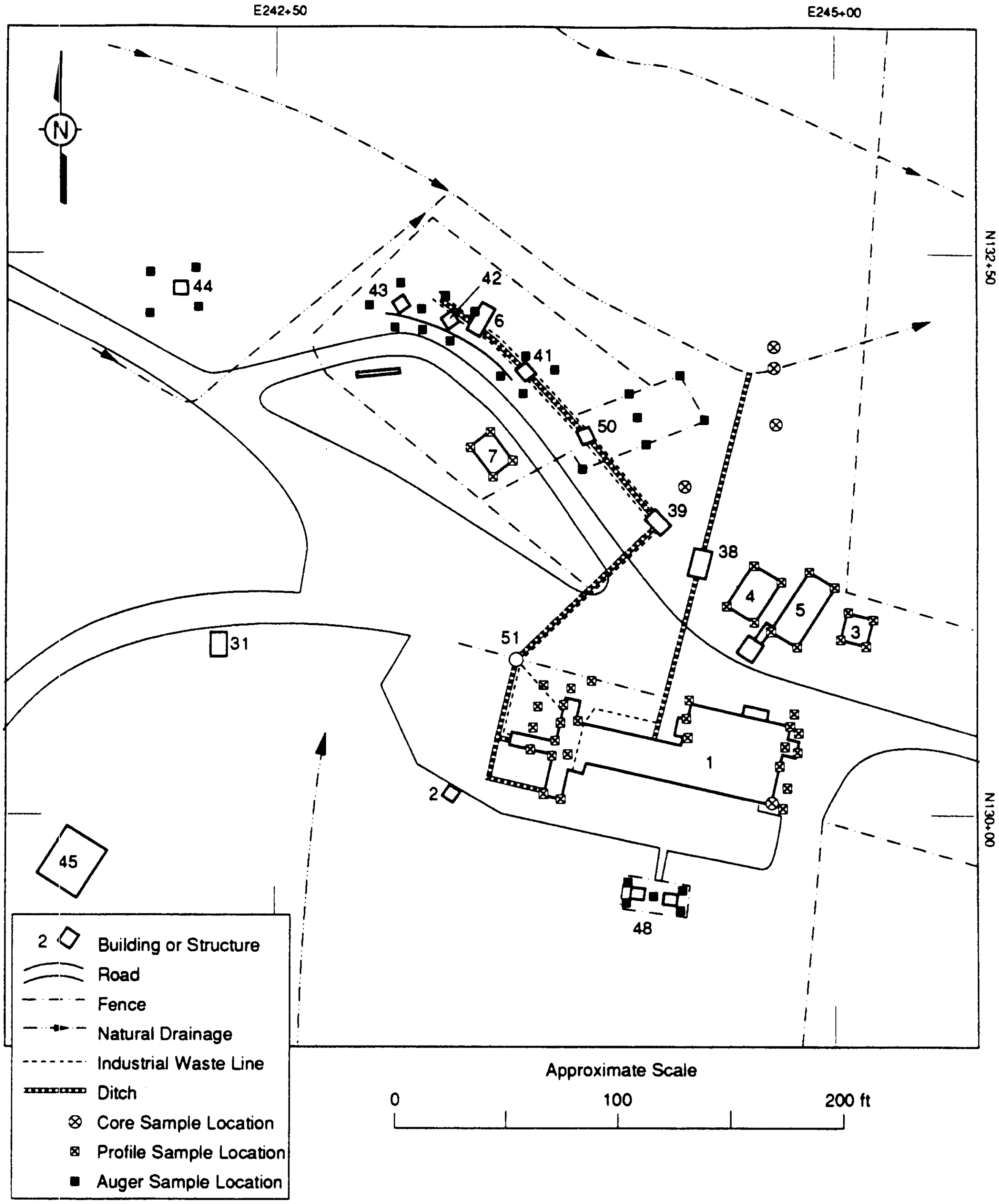


Figure 3.1-6. FUSRAP sample locations for the Subsurface Disposal SWMU Aggregate (modified from Mayfield et al. 1979, 06-0041).

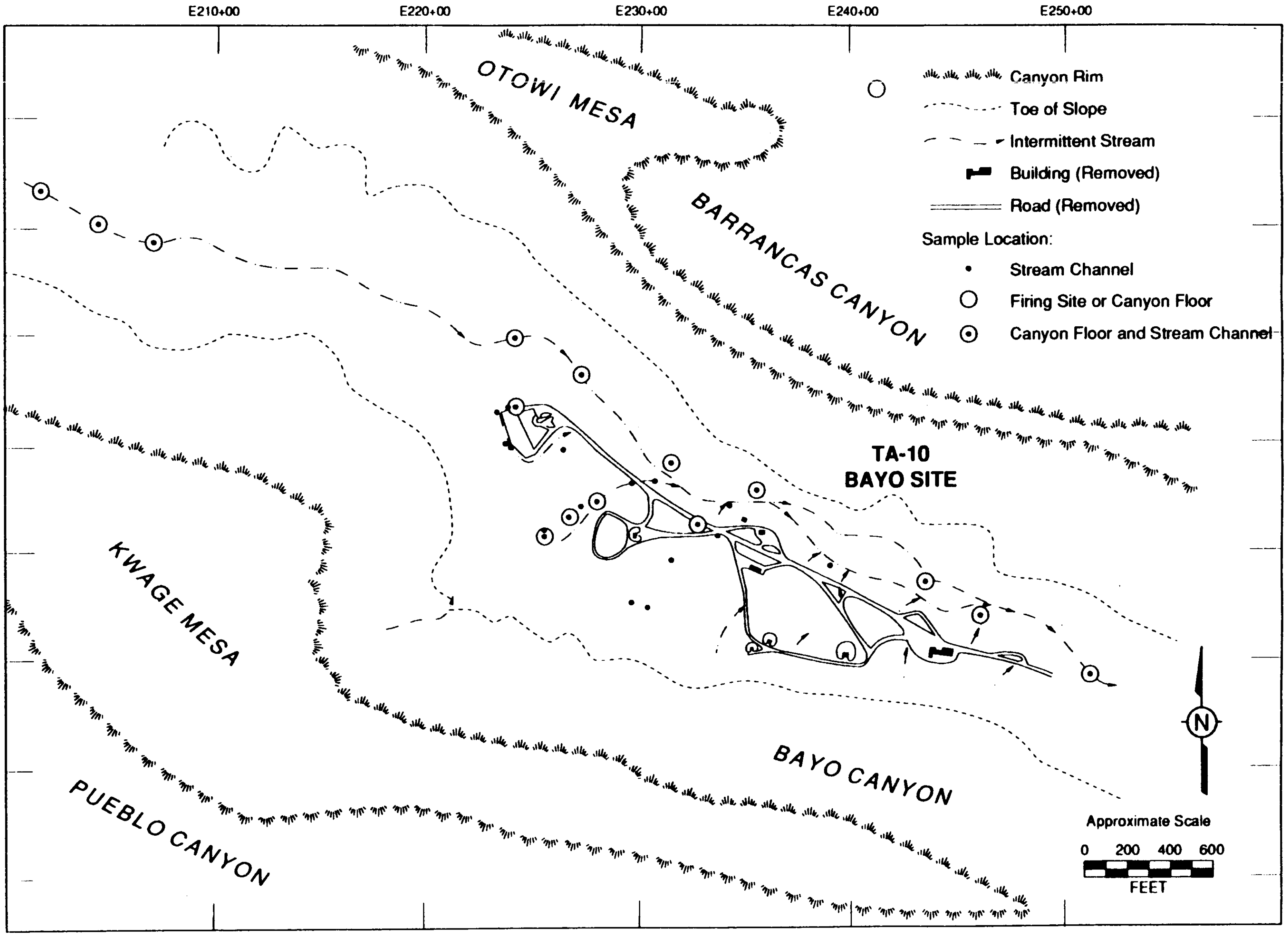


Figure 3.1-7. FUSRAP stream channel sampling stations (modified from Mayfield et al. 1979, 06-0041).

- core samples taken with a 2.5 cm diameter PVC pipe to a maximum depth of 30 cm;
- profile samples taken with a ring or core, but sectioned into intervals of 0-5, 5-10, 10-20, and 20-30 cm;
- trench grab-samples taken with a scoop from walls or the bottom of backhoe-dug trenches to depths of about 1.2 m; and
- auger samples taken from cuttings of augered holes drilled by a truck-mounted rig at various intervals to maximum depths of 12.8 m.

Detailed descriptions of the sampling techniques are presented in Mayfield et al. (1979, 06-0041).

The soil samples were analyzed for gross and specific radioactivity content according to several selection schemes. All samples were analyzed for gross-alpha and gross-beta activity using ZnS and plastic scintillator detectors, respectively. Subsets of the samples were selected randomly to provide unbiased estimates, or systematically to confirm the presence of a contaminant or to provide a basis for correlation with gross-activity analyses. These subsets were submitted for various radiochemical analyses. The largest number of radiochemical analyses were performed for ^{90}Sr, followed closely by total uranium, Plutonium-239 (^{239}Pu), Plutonium-238 (^{238}Pu), and Cesium-137 (^{137}Cs). Some radiochemical analyses were performed for Radium-236 (^{236}Ra) and Thorium-232 (^{232}Th) to provide supplementary information; however, no ^{226}Ra data and minimal ^{232}Th data were reported in the FUSRAP report. Further detail is provided in Mayfield et al. 1979 (06-0041).

A summary of the soil sampling plan and analyses grouped by the four principal sampling strata appears in Table 3.1-8.

Survey results with the micro-R meter and the high pressure ion chambers (HPIC) indicated no anomalous increases in gamma activity on the firing site and canyon floor grids. The phoswich survey did not indicate any anomalous increases in 17 keV x-ray activity on the east side of the firing site grid or on the east side of the canyon floor (i.e., no measured $^{239,\ 240}$Pu activity).

Background estimates for ^{90}Sr and uranium were based on strontium from weapons testing (fallout ^{90}Sr) and naturally-occurring uranium (primordial uranium). Site-specific background measurements of these nuclides were not taken prior to the establishment of Bayo Site in 1943. Consequently, estimates of fallout ^{90}Sr and primordial uranium were made on the basis of a literature review and observations from the 1977 FUSRAP resurvey effort (Mayfield et al. 1979, 06-0041). Background estimates of ^{90}Sr concentrations are lower than 0.4 pCi/g, and estimates of uranium range from 3 to 8 µg/g (Table 3.1-9), depending on depth.

TABLE 3.1-8 RESURVEY SAMPLING AND ANALYSIS SCHEME

Sampling Location	Sample Location	Number of Sample Locations	Type of Analysis	Total Number of Samples	Comment
Firing Site	Surface (0-5 cm)	168	Gross α, β	168	One sample at each point of grid
			Radiochemical	13	Random selection
				5	Discrete selection
	Core (0-30 cm)	168	Gross α, β	168	One sample at each point of grid
			Radiochemical	14	Random Selection
				0	Discrete selection
	Profile (0-30 cm)	8	Gross α, β	4x8	Random selection
			Radiochemical	4x8	Random selection
Canyon Floor	Surface (0-5 cm)	41	Gross α, β	41	One sample at each point of grid
			Radiochemical	0	Random selection
				6	Discrete selection
	Core (0-30 cm)	41	Gross α, β	41	One sample at each point of grid
			Radiochemical	0	Random selection
				5	Discrete selection
	Profile (0-30 cm)	4	Gross α, β	4x4	Random selection
			Radiochemical	4x4	Random selection
Natural Drainage	Core (0-30 cm)	17	Gross α, β	17	One sample at each point on grid
			Radiochemical	0	Random selection
				6	Discrete selection
	Profile (0-30 cm)	10	Gross α, β	4x10	Sample each grid point
			Radiochemical	4x4	Random selection

TABLE 3.1-8 RESURVEY SAMPLING AND ANALYSIS SCHEME (CONTINUED)

Sampling Location	Sample Location	Number of Sample Locations	Type of Analysis	Total Number of Samples	Comment
				4x6	Discrete selection
Structures	Cores (0-30 cm)	18	Gross α, β	18	Perimeter of TA-10-1
			Radiochemical	18	Perimeter of TA-10-1
	Profiles (0-30 cm)	7	Gross α, β	4x7	Composites of building corners; 6 buildings
			Radiochemical	4x7	
	Trench grab (0-122 cm)	68	Gross α, β	68	3.048 m increments of sanitary and industrial waste (acid waste) lines
			Radiochemical	8	Expected contaminants
	Auger (>122 cm)	290	Gross α, β	290	Waste pits and leaching field
			Radiochemical	60	Expected contaminants

(Modified from Mayfield et al. 1979, 06-0041)

TABLE 3.1-9 FALLOUT ^{90}Sr AND PRIMORDIAL URANIUM IN BAYO CANYON SOIL

Sample Depth (cm)	^{90}Sr (pCi/g)	Primordial Uranium (µg/g)
0-5	0.36	3.39
0-10	0.32	3.39
0-30	0.24	3.39
0-122	<0.1	5.50
122-244	<0.1	8.50
>244	<0.1	8.50

(Modified from Mayfield et al. 1979, 06-0041)

The mean ^{90}Sr concentration in the 0-5 cm layer of soil and sediments from all sampling strata (1.37 x 10^6 m^2 area) was 1.4 pCi/g (Table 3.1-10) based on a randomly selected subsample with the largest value removed. Statistical comparisons to background could not be made because the distribution and variability of the background measurements were unknown. However, the FUSRAP survey adopted the use of 0.40 pCi/g as representative of background ^{90}Sr, and 3.40 µg/g as representative of background uranium levels. The highest ^{90}Sr level encountered was in a small area a few meters south and east of the former waste pit TA-10-48 [SWMU 10-002(b)], where the concentration (132 pCi/g) was about 330 times the estimated background level of 0.40 pCi/g (Mayfield et al. 1979, 06-0041).

The concentrations of ^{90}Sr in soil and sediments generally decreased with depth in the firing site, canyon bottom and natural drainage sampling areas (Table 3.1-9), but increased with depth in the structures sampling grid. These findings were consistent with a surface input of contamination in the firing site, canyon bottom and natural drainage sampling strata, and a subsurface input in the structures sampling strata.

3.1.2.3.2 FUSRAP Air Quality Sampling

For the 1977 FUSRAP survey, atmospheric concentrations of fallout ^{90}Sr and primordial uranium were estimated from regional and local samples (Tables 3.1-11 and 3.1-12, respectively) collected from the Laboratory air surveillance network. These background values were used as a basis for comparison of ^{90}Sr and uranium results from air samplers located adjacent to Bayo Canyon (Tables 3.1-11 and 3.1-12). One sampler was roughly 3 m above the canyon floor at the confluence of Pueblo and Bayo Canyons, about 1.2 km east of Bayo Site. The other two samplers were located roughly 6 m above the mesa top: one sampler was located a few hundred meters north of the west end of Bayo Canyon, and the other was located a few hundred meters southwest of the west end of Bayo Canyon (Mayfield et al. 1979, 06-0041).

Fallout, or background, ^{90}Sr samples were collected during the fourth quarter of 1976 from three regional stations located between 28 and 44 km east of Bayo Canyon. The fourth quarter 1976 results from both the canyon floor and the mesa top compare well with the regional results, and the results reported for other North American locations during the fourth quarter of 1975. All three sets of results are presented in Table 3.1-11 for comparison. Tests for significance of differences between locations could not be conducted reliably with the small sample sizes.

Primordial uranium in soil varies markedly in North Central New Mexico depending on the geology of the region. Consequently, estimates of uranium background in air were obtained from the routine Laboratory air surveillance network (Table 3.1-12). The 18 perimeter stations, located on the volcanic tuff of the Pajarito Plateau, were expected to be more representative of local conditions than regional results taken in the Rio Grande Valley. Three of these perimeter stations were used to monitor Bayo Canyon during the 1977 resurvey. Samples were collected quarterly

TABLE 3.1-10 ^{90}Sr IN SOIL BASED ON RESURVEY OF BAYO CANYON IN 1977 (ANALYSES IN pCi/g)

	Strata: Firing Sites, Canyon Floor, and Natural Drainage				
	Random Samples			All Samples Analyzed	
Depth (cm)	Range	$\bar{X} \pm \sigma$	No.	Range	No.
0 - 5	0.0 - 8.2	1.4 ± 1.9	29	0.0 - 132.0	43
0 - 10	0.1 - 5.5	0.9 ± 1.4	16	---	---
0 - 30	0.2 - 4.0	0.7 ± 0.9	30	0.1 - 23.2	37
Strata: Natural Drainage					
	All Samples Analyzed				
0 - 5	0.0 - 8.2	2.2 ± 4.0	4		
0 - 10	0.1 - 5.5	1.5 ± 2.6	4		
0 - 30	0.2 - 4.0	1.3 ± 1.8	4		
Strata: Structures					
	All Samples Analyzed				
0 - 5	0.5 - 5.4	2.1 ± 1.7	7		
0 - 10	0.3 - 4.7	2.2 ± 1.5	7		
0 - 30	0.3 - 6.9	2.4 ± 1.5	30		
0 - 122	0.1 - 67.2	10.3 ± 19.3	12		

(Modified from Mayfield et al. 1979, 06-0041)

TABLE 3.1-11 COMPARISON OF ^{90}Sr SURFACE AIR CONCENTRATIONS OFFSITE AND IN BAYO CANYON (ANALYSES IN fCi/m^3)[a]

	Range	$\overline{X} \pm \sigma$	No.
Moosonee, Ontario	0.09 - 0.15	0.13 ±0.03	3[b]
Helena, Montana	0.17 - 0.18	0.18 ± 0.01	3[b]
New York, New York	0.19 - 0.24	0.21 ±0.03	3[b]
Rocky Flats, Colorado	0.14 - 0.27	0.21 ± 0.04	6[b]
Richmond, California	0.14 - 0.22	0.19 ±0.04	3[b]
Group Summary	0.09 - 0.27	0.18 ± 0.07	18
Espanola, New Mexico		0.17	1[c]
Pojoaque, New Mexico		0.14	1[c]
Santa Fe, New Mexico		0.14	1[c]
Group Summary		0.15 ± 0.02	3
Bayo Canyon floor		0.13	1[c]
Mesa top (townsite)		0.09	1[c]
Group Summary		0.11 ± 0.03	2

[a] fCi/m^3 is 1 X 10^{-15} Ci/m^3 where "f" is "femto."

[b] EML-339 Department of Energy, Environmental Measurements Laboratory, 4th Quarter 1975.

[c] Los Alamos Scientific Laboratory Surveillance Net, 4th Quarter 1976.

(Modified from Mayfield et al. 1979, 06-0041)

TABLE 3.1-12 COMPARISON OF TOTAL URANIUM IN SURFACE AIR CONCENTRATIONS OFFSITE AND IN BAYO CANYON[a] (ANALYSES IN pg/m^3)

Station Location	Range	$\overline{X} \pm \sigma$	No. of 12-14 Wk Samples
Perimeter Stations (0 - 4 km)			
Arkansas Avenue	27 - 105	66 ± 4	4
Golf Course	40 - 64	54 ± 3	4
Diamond Drive	50 - 179	111 ± 6	3
48th Street	39 - 63	53 ± 4	4
Fuller Lodge	64 - 109	80 ± 6	4
LA Airport	40 - 68	49 ± 4	4
Gulf Station	51 - 102	72 ± 4	3
Acorn Street	9 - 134	75 ± 4	4
Royal Crest	-7 - 35	23 ± 4	2
White Rock STP	47 - 77	56 ± 2	4
Pajarito Acres	32 - 56	45 ± 3	4
Bandelier	24 - 55	34 ± 4	4
Group Summary	7 - 179	59 ± 14	44
Bayo Canyon Stations			
Canyon Floor	37 - 61	45 ± 5	4
Mesa top (townsite) 1	2 - 134	67 ± 6	3
Mesa top (townsite) 2	4 - 77	43 ± 4	3
Group Summary	2 - 134	52 ± 9	10

[a] Measurements taken in 1976.

(Modified from Mayfield et al. 1979, 06-0041)

for uranium analysis, and the results were averaged for the year 1977 (Table 3.1-12). The concentration of uranium in the air around Bayo Canyon was statistically indistinguishable from the concentration expected locally from primordial uranium (Mayfield et al. 1979, 06-0041).

3.1.2.3.3 FUSRAP Dosimetry Measurements

During the 1977 FUSRAP study, surveys of external penetrating radiation were performed at the Bayo Site with both an RS-111 ion chamber and a Germanium-Lithium (GeLi) detector. Exposure rates were taken at 1 m above the ground. Two background locations west of the site were also sampled. Dose rates from the TA-10 site were typical of those measured at the Laboratory (Table 3.1-13). Dose calculations based upon radionuclide concentrations that could be attributed to Bayo site debris represented less than 1% of the dose rates measured at the TA-10 site (Mayfield et al. 1979, 06-0041).

3.1.2.3.4 Summary of 1977 FUSRAP Survey

In summary, the 1977 FUSRAP survey detected ^{90}Sr and uranium in all strata and in most depth profiles in soil and sediment. This contamination was principally found within the 1.37 x 10^6 m^2 area covered by the firing site and canyon floor grids. The 0-5 cm layer appeared to have slightly more radionuclide contamination than other layers of the 0-30 cm surface zone. An exception was the structures grid at the site of the former radiochemistry laboratory, where the highest levels were deeper in the soil profile. The mean ^{90}Sr concentration in the 0-5 cm layer was 1.4 pCi/g. Of the 50 representative samples from this layer analyzed for ^{90}Sr, one exceeded 9 pCi ^{90}Sr/g, and 17 exceeded 1.0 pCi ^{90}Sr/g. The estimated background level for ^{90}Sr was 0.4 pCi/g. The maximum sample contained 132 pCi ^{90}Sr/g. The mean uranium level among these 50 samples was 4.9 µg/g. One sample exceeded 10 µg/g, and 21 exceeded 4 µg/g. Background levels for uranium ranged from 3 to 8 µg/g (Mayfield et al. 1979, 06-0041).

The vertical and horizontal distributions of the radionuclides varied considerably. As expected, most surface radioactivity was found around the firing pads. Results from data collected in 1973 indicated that no elevated levels of ^{90}Sr were present in stream channel alluvium 2 km downstream from the firing sites. However, that measurement represented one time-constrained datum and did not suggest that contaminants have never been transported to downstream areas.

To evaluate the radiological exposure of the above-background ^{90}Sr and uranium concentrations in the surface soil, air concentrations of ^{90}Sr, uranium, and external penetrating radiation were monitored in Bayo Canyon and the surrounding area. Concentrations of airborne ^{90}Sr were statistically indistinguishable from fallout levels measured at regional northern New Mexico sites and at other North American locations. Uranium levels in air were not statistically different from the concentration expected locally from naturally occurring uranium.

TABLE 3.1-13 EXTERNAL EXPOSURE MEASURED IN BAYO CANYON IN 1977

Measured Total Exposure Rates (μR/hr)

Background	Ion Chamber	GeLi
Mesa Top (1.61 km SW of Bayo Site)	22.9	23.9
Mesa Top (3.22 km W of Bayo Site)	19.1	20.4

	Ion Chamber			GeLi		
Bayo Site	**Range**	**$\overline{X} \pm \sigma$**	**No.**	**Range**	**$\overline{X} \pm \sigma$**	**No.**
Canyon Floor	17.7-24.3	20.6±1.6	45	20.6-26.1	22.6±2.5	4
Talus Slope	19.3-26.1	23.2±1.6	21	—	—	—
Mesa Top	17.8-20.3	19.1±0.9	12	—	—	—
Group Summary	17.7-26.1	21.0±2.1	3			

		Calculated Exposure Rates Attributable to Bayo Debris
Debris Contribution	^{90}Sr - ^{90}Y	4.1 X 10^{-3}
	Total Uranium	4.3 X 10^{-1}

(Modified from Mayfield et al. 1979, 06-0041)

External penetration radiation levels at Bayo Canyon were within the range expected for the Pajarito Plateau area. Measurements using gamma spectroscopy to identify radionuclides generating external terrestrial radiation indicated no detectable levels of radionuclides in above-background concentrations. Because external radiation levels from Bayo debris were below sensitive instrument detection limits, they were theoretically calculated to be 0.43 mrem/yr from the soil concentrations (Mayfield et al. 1979, 06-0041).

3.1.3 Firing Sites SWMU Aggregate

As described in Subsection 3.1.1, the SWMUs have been aggregated for the purpose of this investigation. The Firing Sites SWMU Aggregate consists of SWMUs 10-001(a-d): the four shot pads at the two TA-10 firing sites.

3.1.3.1 Firing Sites Shot Pads [SWMUs 10-001(a-d)]

3.1.3.1.1 SWMU Description and Historical Operation

As described in Subsection 3.1.1, two firing areas were located in the western third of TA-10 (Figure 3.1-1; Figure A-10-1, Appendix A). Each firing site contained two shot pads, a battery building, and a fire control building. The southeast firing site included an x-unit chamber (TA-10-22) and an electronics chamber (TA-10-23) for Firing Site 1 [SWMU 10-001(a)], and an x-unit chamber TA-10-24 and an electronics chamber (TA-10-25) for Firing Point 2 [SWMU 10-001(b)]. The associated control building (TA-10-13) and battery building (TA-10-14) (the power source) served both Firing Points 1 and 2. The northwest firing site included an x-unit chamber (TA-10-26) and an electronics chamber (TA-10-27) for Firing Point 3 [SWMU 10-001(c)], and an x-unit chamber (TA-10-28) and an electronics chamber (TA-10-29) for Firing Point 4 [SWMU 10-001(d)]. Associated control building TA-10-15 and battery building TA-10-16 were used for both Firing Points 3 and 4 [SWMUs 10-001(c-d)].

The explosive detonation at TA-10 resulted in the dispersion of radioactive materials including uranium, ^{140}La, and ^{90}Sr in the form of aerosols and solid debris. Each shot was estimated to contain 500-600 lbs of HE (Mayfield et al. 1979, 06-0041). Depending on wind conditions, aerosols were dispersed to varying degrees within Bayo Canyon and beyond. Standard procedures required that wind be from the southwest at the time of detonation. However, routine post-shot surveys (Mayfield et al. 1979, 06-0041; H-Division 1949, 0072) at times found ^{140}La contamination south and east of Bayo Canyon, in the vicinity of State Road 4 and on Otowi and Kwage Mesas. On one occasion, an aircraft was able to track airborne ^{140}La activity eastward across the Rio Grande Valley. On another occasion, the winds shifted just after a detonation, and contamination was detected several miles to the west in the Camp May area (H Division 1949, 0072). Solid debris, including fragments of uranium and other metal components, was scattered around the firing points, largely within 125 m of each firing pad, although some large fragments were found 300-600 m away (Courtright 1963, 06-0038).

Some radioactivity was redistributed around the firing pads by water used to wash the pad area following a shot. Radiation levels around the pads were frequently in the range of a few tenths to a few R/hr (Mayfield et al. 1979, 06-0041).

Estimated quantities of certain materials expended at the firing sites were made by Mayfield et al. (1979, 06-0041), using TA-10 operating records and ancillary information (Table 3.1-14). Mayfield et al. (1979, 06-0041) estimated that 2,000 kg of natural uranium and 3,380 kg of depleted uranium were expended at the two firing site areas. A total of 1,322,400 Curies (Ci) ^{140}La with a ^{90}Sr content of about 40 Ci was also expended at the firing sites. These estimates do not include the estimated 117 Ci of ^{90}Sr that were released as liquid and solid waste from the support facilities at TA-10. Initially, at least, all of the ^{140}La and ^{90}Sr in the explosive tests was released to the atmosphere. By 1992, all of the ^{140}La and about half of the ^{90}Sr has decayed since testing ceased in 1961.

The amount of HE expended at the site is unknown, but is probably on the order of several thousand kilograms. As mentioned, each shot was estimated to contain about 270 kg of HE for a total of about 69,000 kg for the 254 tests. Other chemical parameters that may have been dispersed by the tests include beryllium, barium, lead, aluminum, and iron (LANL 1990, 0145).

3.1.3.1.2 SWMU Investigations and Remediation

Decontamination and decommissioning of the firing sites took place mainly in 1963 (Figures A-10-2 and A-10-3, Appendix A). The asphalt firing pads had 0.5 millirad per hour (mrad/hr) readings on the surface. The asphalt and top layer of soil were removed to MDA-G at TA-54. After the surface soil was removed, readings of up to 1.0 mrad/hr were detected. An additional layer of soil was excavated to an unspecified depth and removed (Blackwell and Babich 1963, 06-0009).

In addition to the excavation work, crews were sent out to a radius of 2,500 ft from each shot pad to recover any surface exposed debris from the shots (Figure A-10-4, Appendix A). The crews collected 90 truckloads of debris that were taken to MDA-G at TA-54 for disposal (Mayfield et al. 1979, 06-0041).

An area west of Firing Point 2 [SWMU 10-001(b)] had been used to wash sources over a period of years. The surface soil did not indicate any contamination during the 1963 D & D, and an area 8 ft wide, 80 ft long, and 4 ft deep was excavated and no contamination was found (Blackwell and Babich 1963, 06-0009). It is not known whether the excavated soil was replaced or taken to a MDA at the Laboratory. This area is not a listed SWMU, but should be treated as an area of concern.

The two concrete bunker detonation control buildings (TA-10-13 and -15) were drilled and blasted for demolition. The concrete from these bunkers was considered uncontaminated. This concrete, along with soil around the inspection building (TA-10-8) and the battery building (TA-10-14) for the southeast firing site, was used as fill material for the landfill created within the liquid disposal complex

TABLE 3.1-14 ESTIMATES OF MATERIALS AT THE BAYO CANYON FIRING SITES[a] (TA-10-15 AND TA-10-13)

^{140}La (T 1/2 = 40.3h; β, γ emitter)	1,322,400 Ci
Natural uranium (T 1/2 = 4.5×10^9 y; α emitter)	2,000 kg
Depleted uranium (T 1/2 = 4×10^9 y; α emitter)	3,380 kg
^{90}Sr (T 1/2 = 28.8y; β emitter)	~ 40 Ci
High Explosives	69,000 kg (estimated)
Lead	Unknown
Berylium	Unknown
Aluminum	Unknown
Iron	Unknown
Cable	Unknown
Electronics	Unknown
Cobalt nitrate	Unknown

[a] A total of 254 explosive tests were conducted at the Bayo Canyon Site from 1944 -1961.

[SWMUs 10-003(a-o)] excavation (Blackwell and Babich 1963, 06-0009).

After the decontamination and decommissioning of the site in 1963 (Figure A-10-5, Appendix A), periodic surface surveys and searches were conducted until 1976 to recover any firing site debris that have become exposed by natural weathering and erosion processes.

The 1977 FUSRAP survey included sampling in a polar scheme around the firing sites and in a rectangular grid on either side of the polar pattern to cover the area influenced by the testing operations. The samples indicated ^{90}Sr and uranium in both strata and in most depth profiles. Most of the contamination was found within a 1.37 x 10^6 m^2 area covered by the firing sites and canyon floor. As expected, the contamination was concentrated near the surface, specifically in the 0-5 cm layer (Mayfield et al. 1979, 06-0041).

3.1.3.1.3 Nature and Extent of Existing Contamination

3.1.3.1.3.1 Radionuclide Contamination in Surface Soils

As described in Subsection 3.1.2, the 1977 FUSRAP radiological survey data is the basis for establishing the current conditions at the TA-10 site. To determine the nature and extent of existing contamination in the Firing Sites SWMU Aggregate, surface soil sample data from the FUSRAP firing site and canyon floor grids (Figure 3.1-5) were evaluated. The 0-5 cm depth interval samples contained the highest gross-alpha activity as compared to the other layers of the 0-30 cm depth interval. Therefore, these data have been used to describe residual surface contamination. The background level for gross-alpha activity ranged from 20 to 40 pCi/g (Mayfield, et. al. 1979, 06-0041). Figure 3.1-8a shows histograms of the gross-alpha measurements. There were 18 measurements greater than 40 pCi/g and seven measurements greater than 50 pCi/g. Figure 3.1-9 shows bubble plots for the gross-alpha measurements. The sizes of the bubbles are proportional to the gross-alpha measurement. The seven locations with measurements above 50 pCi/g occurred near the center of the firing sites and the outermost edges of the canyon (Figure 3.1-9). This pattern of elevated gross-alpha measurements at the sampling boundaries may indicate areas where the periodic surface searches and surveys of the firing sites did not extend (see Subsection 3.1.1). The average or mean (m) value for gross-alpha measurements is 20.8 pCi/g, and the standard deviation (sd) is 13. The coefficient of variation (cv) is the ratio of the standard deviation to the mean. The cv can be used to compare variability between contaminants that have very different concentrations. The cv for gross-alpha measurements is 0.63.

The gross-alpha levels should correspond to the uranium levels; however, calculations showed a very small correlation coefficient (0.09), indicating that other naturally-occurring radionuclides may be influencing the gross-alpha measurements. Uranium levels above background concentrations are assumed to be from firing site testing activities. The histograms for uranium concentrations and gross-alpha measurements are shown in Figure 3.1-8a-b, respectively. The

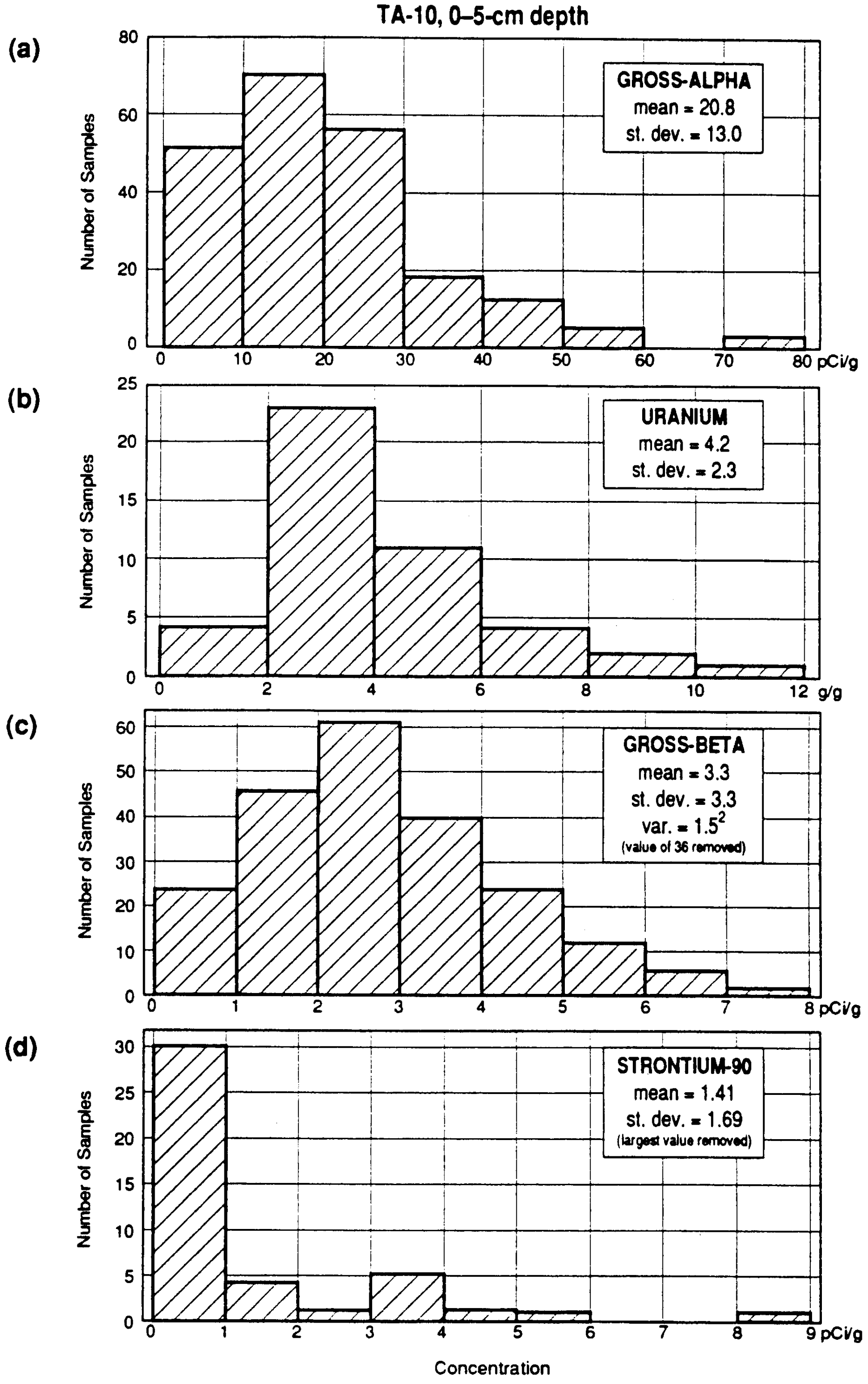


Figure 3.1-8. Histograms of gross-alpha, uranium, gross-beta, and strontium-90 measurements for TA-10 at 0–5-cm depth (modified from Mayfield et al. 1979, 06-0041).

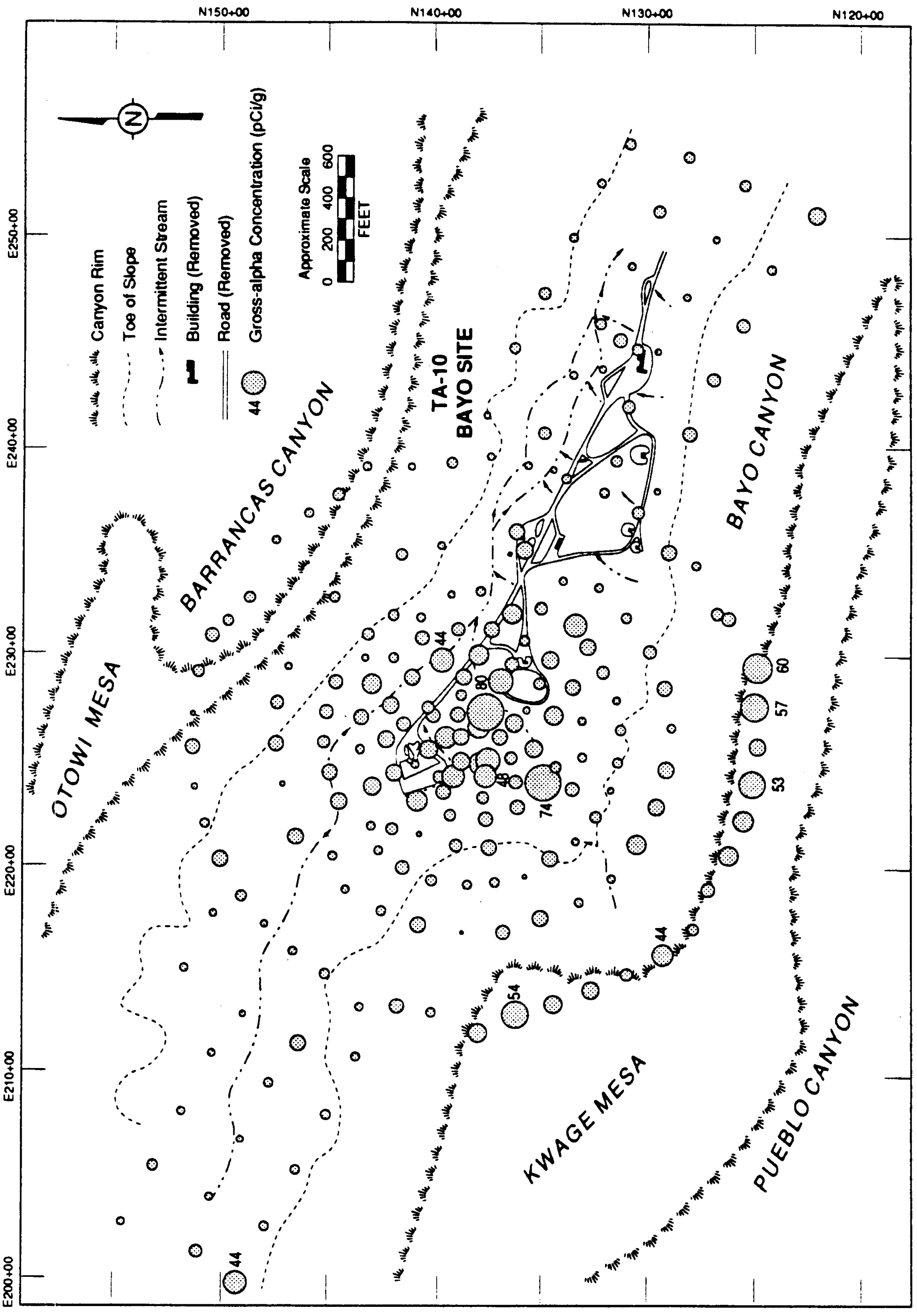


Figure 3.1-9. TA-10 locations of gross-alpha measurements (modified from Mayfield et al. 1979, 06-0041).

background level for uranium in the 0-5 cm depth interval is 3.39 µg/g (Mayfield et. al. 1979, 06-0041). However, background levels for uranium can range from 3.39 µg/g to 8.5 µg/g, depending on the sample depth. The histogram (Figure 3.1-8b) and the bubble plots for uranium (Figure 3.1-10) show that only three samples had uranium concentrations that were greater than 8.0 µg/g. The mean of the uranium concentration measurements was 4.2 µg/g, the standard deviation was 2.3, and the coefficient of variation was 0.55. The maximum DOE recommended concentration of ^{238}U in the surface soils is 75 pCi/g (Gunderson et al. 1983, 06-0671). Assuming that all uranium chemically reported is ^{238}U, the highest uranium measurement was approximately 4 pCi/g (12 µg/g). None of the uranium measurements exceeded the 75 pCi/g concentration limit.

The background levels for gross-beta measurements ranged from 2 to 6 pCi/g (Mayfield et al. 1979, 06-0041). The histograms and bubble plots for gross-beta measurements (Figures 3.1-8c and 3.1-11, respectively) show that only nine samples contained levels above 6 pCi/g. Of these nine samples, only one exceeded 8 pCi/g. This sample is not included in the histogram, but is shown on the bubble plot (Figure 3.1-11). This sample also contained a high ^{90}Sr concentration. During the FUSRAP survey, additional surface samples were taken near this location and analyzed for ^{90}Sr. None of these samples contained levels above background. Therefore, this sample was not included when calculating the mean and standard deviation. The mean of the gross-beta samples was 3.2 pCi/g, the standard deviation was 1.5, and the coefficient of variation was 0.478. Figure 3.1-12 shows the bubble plots for gross-beta measurements when the high (36 pCi/g) measurement is removed. Although these measurements are at low levels, the bubble plot indicates that the highest levels of gross-beta measurements are in the center of the firing site areas and at the outermost boundaries of the sampling area. This result is consistent with the analysis of the gross-alpha measurements.

The world-wide fallout level for ^{90}Sr is 0.4 pCi/g. Thirty-three of the ^{90}Sr samples were above this background level. Of these 33 samples, one had a level of 132 pCi/g, and the remaining samples were approximately 8 pCi/g, or less. The histogram for all samples (excluding the one sample with the highest concentration) is shown in Figure 3.1-8d. The bubble plots show the distribution of contaminants (Figure 3.1-13). The 132 pCi/g sample location is denoted by an X. Again, the major contamination was in the center of the firing site areas and the outermost boundaries of the sampling area. The DOE recommended guidance for acceptable levels of ^{90}Sr is 100 pCi/g (Ford, Bacon, and Davis Utah Inc. 1981, 06-0039). Only one sample exceeded this recommended level. As discussed above, analyses of another portion of the sample, an adjacent core sample, and several supplementary samples taken within 2 m showed only background concentrations of ^{90}Sr. The mean of the ^{90}Sr sample concentrations (excluding the high concentration sample) was 1.41 pCi/g, the standard deviation was 1.69, and the coefficient of variation was 1.14. ^{90}Sr has the only coefficient of variation greater than 1. ^{90}Sr has very low background levels (due to world-wide fallout), while uranium has very high natural background levels. This may be the reason for the much greater variability in the concentration of ^{90}Sr.

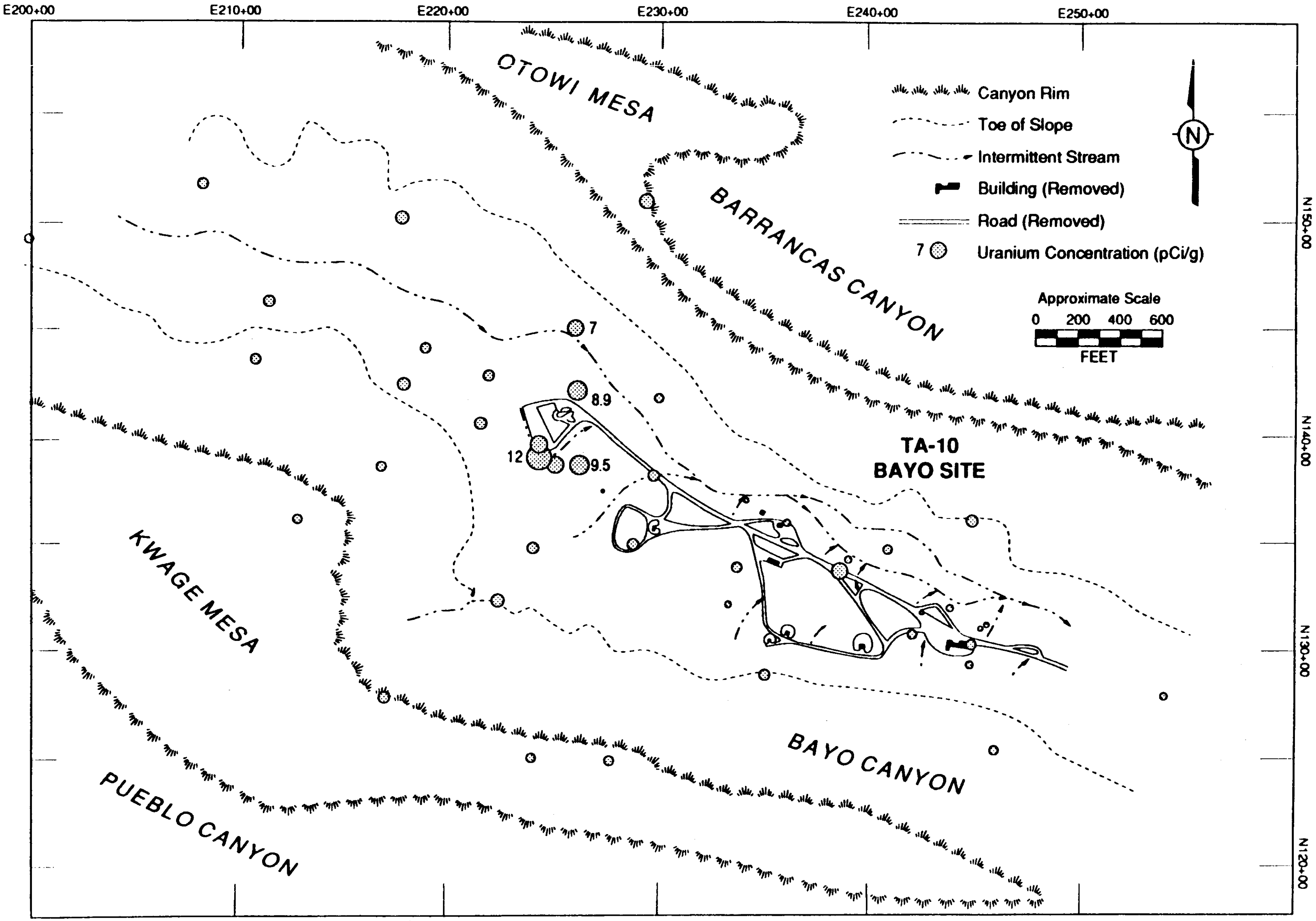


Figure 3.1-10. TA-10 locations of uranium analyses (modified from Mayfield et al. 1979, 06-0041).

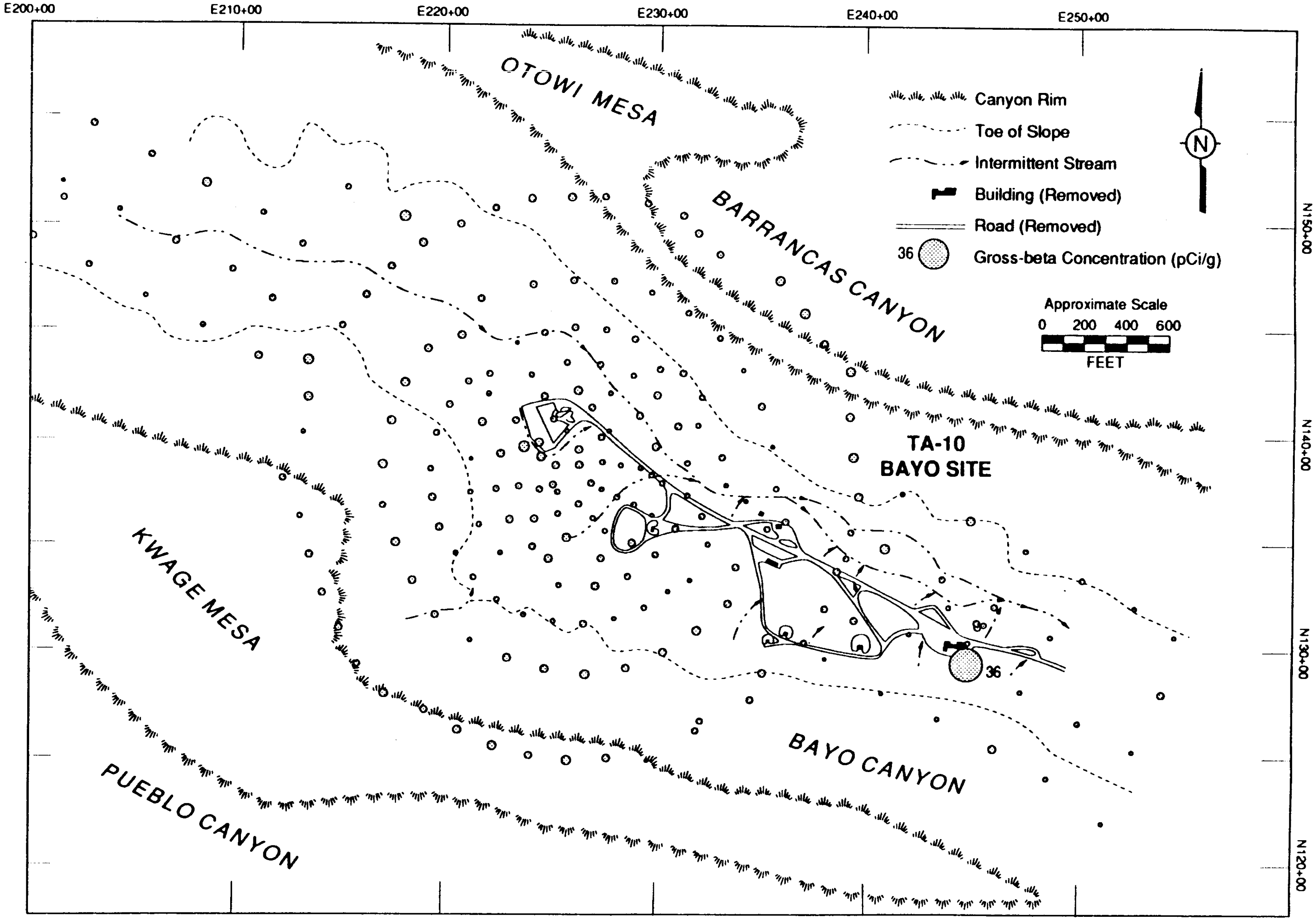


Figure 3.1-11. TA-10 locations of gross-beta measurements (modified from Mayfield et al. 1979, 06-0041).

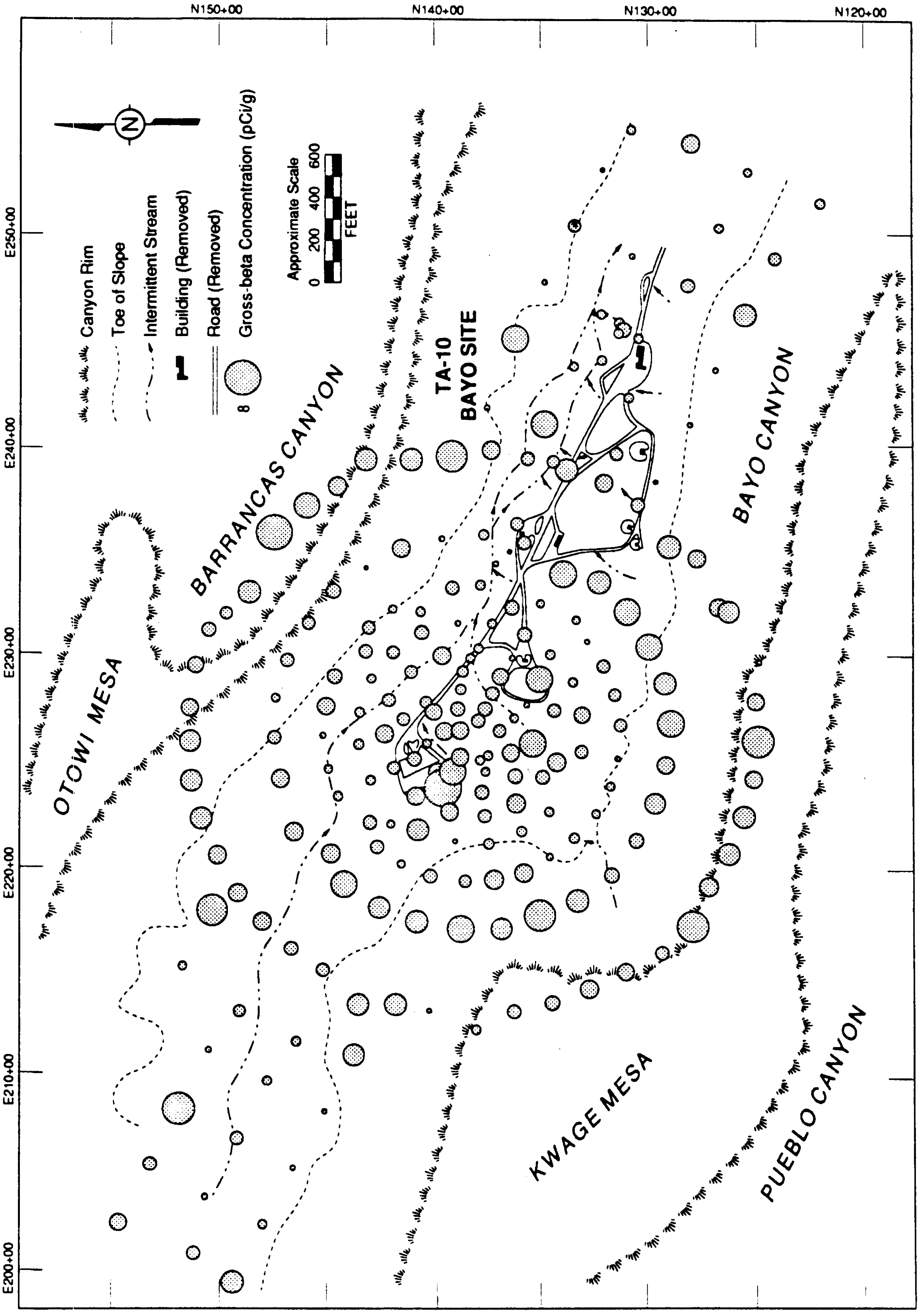


Figure 3.1-12. TA-10 locations of gross-beta measurements with largest value removed (modified from Mayfield et al. 1979, 06-0041).

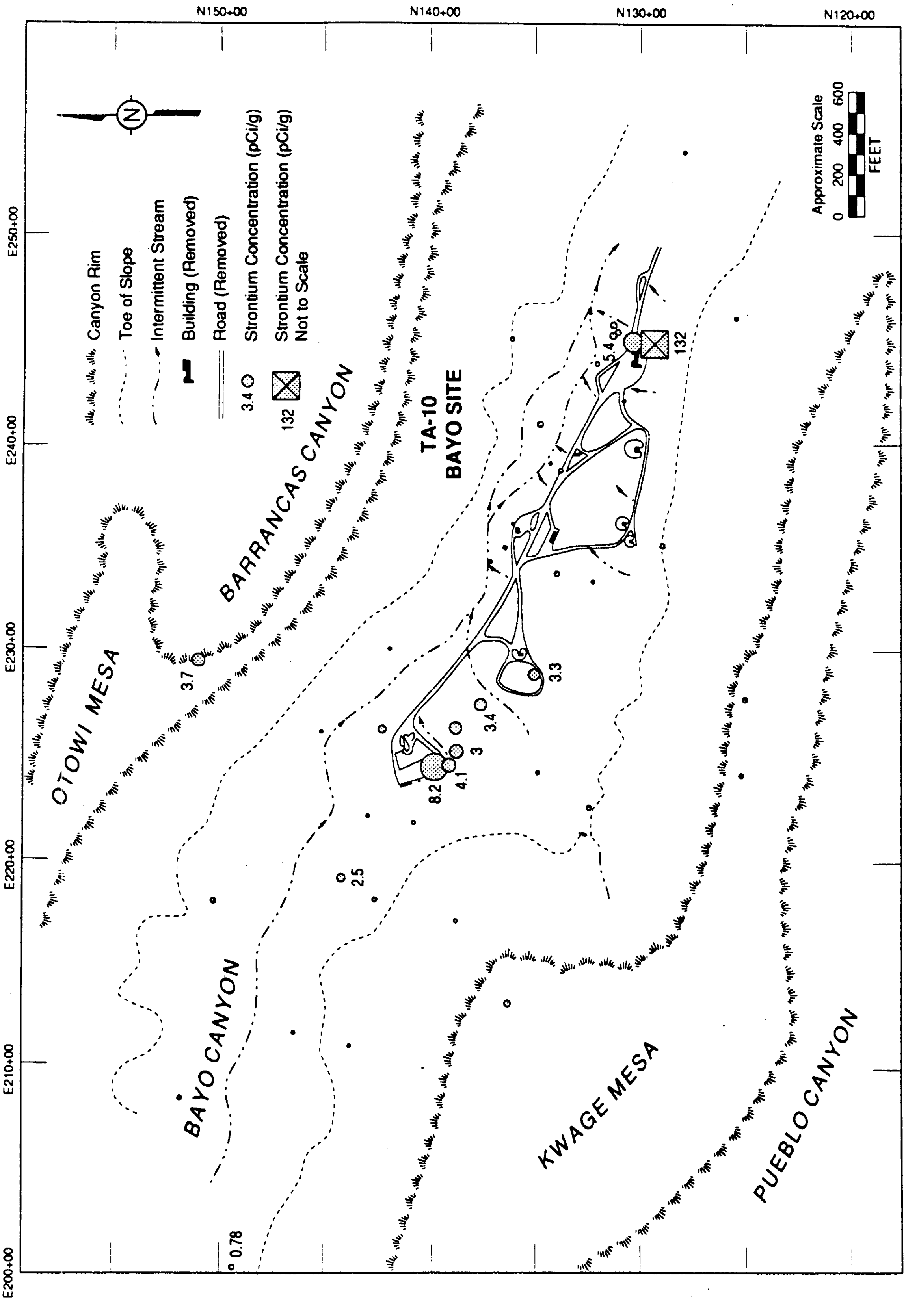


Figure 3.1-13. TA-10 locations of ^{90}Sr analyses (modified from Mayfield et al. 1979, 06-0041).

3.1.3.1.3.2 Radionuclide Contamination in Channel Sediments

In 1965 and 1970, sediments were collected from two locations in the channel downstream from the Bayo Site (see Subsection 3.1.2). Radiochemical analyses showed no indication of contamination (Mayfield et al. 1979, 06-0041). In 1973, the sampling plots in the canyon channel centered at 2,000 m intervals (one upstream from the Bayo Site, one at the Bayo site, and two downstream from the Bayo Site) contained only world-wide fallout concentrations of ^{90}Sr, ^{238}Pu, and ^{239}Pu (Mayfield et al. 1979, 06-0041).

3.1.3.1.3.3 Metals Contamination in Soils and Sediments

Other particulates that may have been dispersed by the explosive testing are lead, barium, and beryllium (see Subsection 3.1.3.1.1). There are no existing data describing metals concentration in the surface soils and sediments. However, it is reasonable to assume that these metals were dispersed with the uranium and ^{90}Sr and that historical removal of the radionuclides would have also included the metals.

3.1.4 Subsurface Disposal SWMU Aggregate

This aggregate consists of SWMUs 10-002(a-b), 10-003(a-o), 10-004(a-b), 10-005, and 10-007. These SWMUs were aggregated due to their potential for subsurface contamination in and near the area of the radiochemistry laboratory (TA-10-1). For the purpose of data analyses and discussion, the SWMUs have been grouped within the aggregate. The Central Area includes portions of the radiochemistry laboratory liquid waste disposal complex [SWMUs 10-003(a-g,m)], and the building debris landfill [SWMU 10-007] created during the 1963 D&D of TA-10. The TA-10-44 Area [SWMU 10-002(a)] includes a former solid waste disposal pit for the radiochemistry laboratory. The TA-10-48 Area [SWMU 10-002(b)] is another former solid waste disposal pit for the radiochemistry laboratory. Also discussed are SWMUs 10-003(h-l,n-o), which were additional portions of the radiochemistry laboratory liquid waste disposal complex; SWMUs 10-004(a-b), which were sanitary septic tanks that served the personnel building and radiochemistry laboratory; and SWMU 10-005, which was a waste disposal pit for the firing sites.

The 1977 FUSRAP survey report (Mayfield et al. 1979, 06-0041) contains subsurface data collected in 1977 for gross-alpha and gross-beta activity based on scintillation counting. This report also contains comparable data from thirteen holes drilled in 1973-1974. The data from 1973-1974 was combined with the 1977 FUSRAP data for the data analysis in this section, with the exception of one of the thirteen 1973-1974 holes. One hole could not be satisfactorily located with respect to the 1977 data (hole M1). This data analysis covers the Central Area, the TA-10-44 Area, and the TA-10-48 Area. Figure 3.1-14 shows the TA-10 sample locations for the data in the 1977 FUSRAP survey. The combined data set is provided in Appendix B.

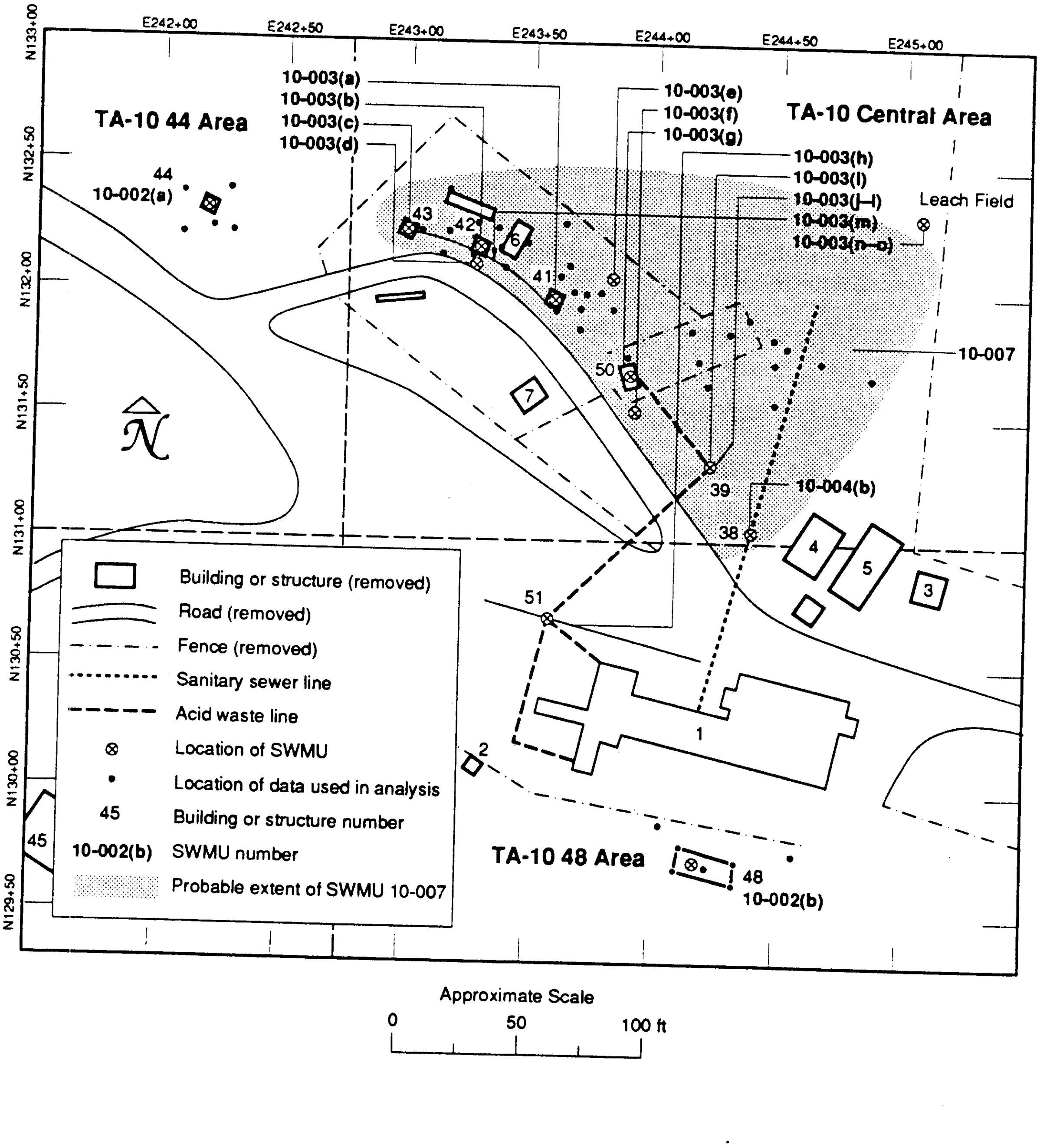


Figure 3.1-14. Location of Subsurface Disposal SWMU Aggregate and samples used in data analysis (modified from Mayfield et al. 1979, 06-0041; LANL 1990, 0145).

Throughout the TA-10 area, ^{90}Sr contamination has been a primary concern. The available data on ^{90}Sr are sparse in comparison to the data on gross-beta activity. Since elevated levels of gross-beta activity should be associated with elevated levels of ^{90}Sr, the gross-beta activity data were the focus of the data analyses. Data from samples at a depth of 225 cm or deeper were used to characterize the subsurface contamination. Prior to 1977, the site has been remediated to background (i.e., 6 pCi/g) along well-defined trenches, to depths of at least 120 cm (Figure 3.1-6). These trenches were dug for sampling purposes during the 1977 FUSRAP survey. Low gross-beta activity in the 0-225 cm depth is expected due to this previous remediation effort. For the 1977 data, only three observations above 225 cm had gross-beta activity above 6 pCi/g. Twenty-eight observations from the 1973-1974 data had gross-beta activity above 6 pCi/g in the 0 to 225 cm depth range. There is no indication in the 1977 FUSRAP report (Mayfield et al., 1979, 06-0041) that any remediation efforts exceeded 225 cm in depth.

3.1.4.1 TA-10 Central Area [SWMUs 10-003 (a-g,m); 10-007]

3.1.4.1.1 SWMU Description and Historical Operation

SWMUs 10-003(a-g,m)

SWMUs 10-003(a-g,m) are all part of a liquid waste disposal complex which served the radiochemistry laboratory, TA-10-1 (Figure 3.1-2c; Figure A-10-7, Appendix A). The radiochemistry laboratory was used to separate, precipitate, and encapsulate ^{140}La into sources. The liquid disposal complex consisted of liquid disposal pits, industrial waste (acid waste) manholes and septic tanks, industrial waste (acid waste) lines, and a leach field that handled the liquid radioactive and chemical wastes generated by the radiochemistry laboratory operations. SWMUs 10-003(a-c) were three liquid disposal pits (TA-10-41, -42, and -43) constructed of reinforced concrete with steel covers. Each pit was 2 ft wide, 2 ft long, and 5 ft deep. A leach field was found beneath SWMU 10-003(c). A clay drain pipe [SWMU 10-003(m)] that connected SWMUs 10-003(a-c) was discovered 10 ft below the surface during the decontamination and decommissioning of TA-10 in 1963 (LANL 1990, 0145).

SWMUs 10-003(d-f) were three liquid disposal pits with unidentified structure numbers. These pits were discovered during the 1963 decontamination and decommissioning of TA-10. SWMU 10-003(d) was 1 ft in diameter and was located 2 ft south of SWMU 10-003(b) (TA-10-42). SWMU 10-003(e) was 4-ft^2 and was located 40 ft north of SWMU 10-003(a) (TA-10-41). SWMU 10-003(f) was located 6 ft south of SWMU 10-003(g) (TA-10-50) (LANL 1990, 0145).

SWMU 10-003(g) was an industrial waste (acid waste) manhole (TA-10-50) constructed of reinforced concrete, and was 4 ft wide, 5 ft long, and 5 ft deep. This manhole was along the industrial waste (acid waste) line leading from the radiochemistry laboratory. A drain pipe from SWMU 10-003(g) (TA-10-50) discharged to a leach field [SWMU 10-003(n)] in the stream channel approximately 125 ft north-northeast of SWMU 10-003(g) (LANL 1990, 0145).

SWMU 10-007

SWMU 10-007 is a landfill located in and near the arroyo at TA-10 (Figures 3.1-1 and 3.1-2a) and was used to dispose of building debris from the decommissioning of TA-10 facilities in 1963. The size of the landfill is not known. However, it was sited within the excavation created by the removal of the liquid disposal complex [SWMUs 10-003(a-o)]. Some of the items in the landfill include concrete from the two firing site detonation control buildings (TA-10-13 and -15); and soil from the vicinity of the inspection building (TA-10-8), one of the battery buildings (TA-10-14), and building TA-10-13 (Blackwell and Babich 1963, 06-0009; LANL 1990, 0145).

3.1.4.1.2 SWMU Investigations and Remediation

SWMUs 10-003(a-g,m)

During the 1963 D&D of TA-10, the highest levels of radioactivity encountered were associated with this liquid waste disposal complex that served the radiochemistry laboratory. This entire complex of tanks, lines, manholes etc. was excavated to a depth of approximately 6 m. (Figures A-10-8, A-10-9, A-10-10, and A-10-11, Appendix A). During the excavation, radiation levels ranged as high as 35 mrad/hr, and the bottom of this excavation had readings of 1.5 mrad/hr. This large excavation was then backfilled with dirt from other parts of the canyon and building debris from the D&D of the Bayo site (Figure A-10-12, Appendix A) (see Subsection 3.1.4.1.1) (Blackwell and Babich 1963, 06-0009).

In 1973, a test hole (M-3) was drilled at or near the vicinity of a former industrial waste (acid waste) manhole, SWMU 10-003(g). The drill encountered blocks of concrete from the building debris (SWMU 10-007) left in the liquid waste disposal complex excavation of 1963, and it took three attempts to drill a hole to a depth of 6.1 m. Sample analyses indicated surface and subsurface ^{90}Sr contamination. Five additional holes were drilled in 1974. Samples from these holes indicated above background gross-beta activity and movement of contamination, especially at depth (Mayfield et al. 1979, 06-0041).

During the FUSRAP survey, extensive sampling was performed at the former radiochemistry laboratory and liquid waste disposal complex site through trenching and drilling. The sample results indicated that subsurface contamination was mostly low level and was within 10 m of the radiochemistry laboratory and the liquid waste disposal complex. The highest levels were found near SWMU 10-003(b), a former liquid waste disposal pit (Mayfield et al. 1979, 06-0041).

SWMU 10-007

SWMU 10-007, a landfill, has not been removed. It was created during the 1963 decontamination and decommissioning of TA-10, when uncontaminated building debris was placed in the liquid waste disposal complex excavation [SWMUs 10-003(a-o)]. No investigations specific to this SWMU have been initiated.

3.1.4.1.3 Nature and Extent of Existing Contamination

As described in Subsection 3.1.4, a combined data set was prepared from the most recent site study, and has been analyzed to provide current side conditions. The data set is provided in Appendix B of this work plan. The data on gross-beta activity were used to analyze the nature and extent of contamination in the TA-10 Central Area. Figure 3.1-15 shows the surface locations of the data used in the analysis of the TA-10 Central Area. The labels on the surface locations correspond to the auger hole labels in the 1977 FUSRAP study (Mayfield, et al. 1979, 06-0041). Some of the locations have data to a depth of 47 ft. Data at, or below, 225 cm were analyzed using kriging. The analysis was based on 217 data points.

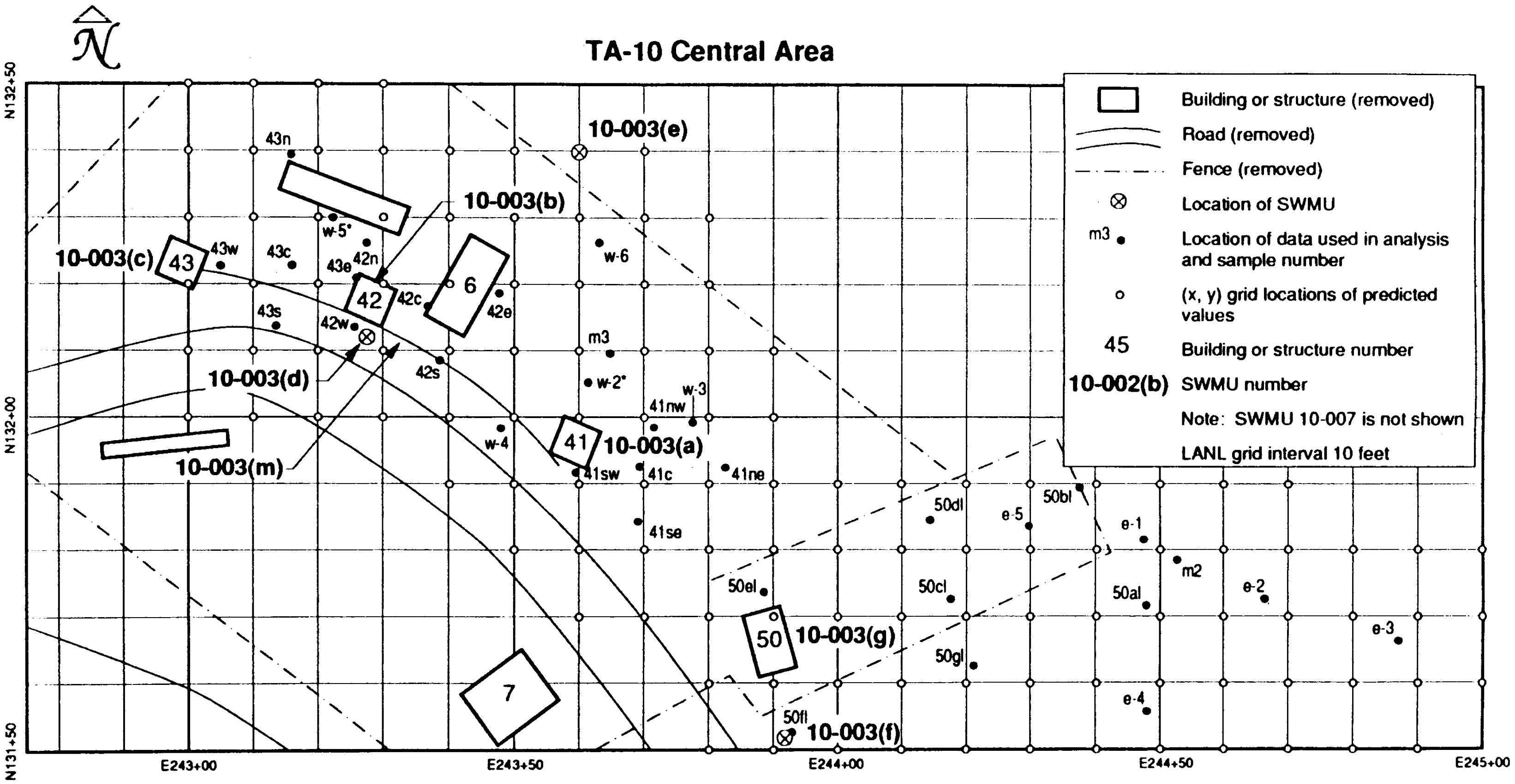
Figures 3.1-16a-f presents the contour maps from the spatial analysis for five depths (7, 17, 27, 37, and 47 ft). To produce the contour maps, gross-beta activity was predicted (kriged) at five depths for the surface grid locations in Figure 3.1-15. Only grid locations that were within 20 ft of actual data were used. Five plumes of contamination have been identified. Figure 3.1-17 clearly shows the five plumes. Three plumes appear at 7 ft. Plume 1 is located to the east of SWMU 10-003(g) (TA-10-50), Plume 2 is between the liquid waste disposal pits, SWMU 10-003(a) (TA-10-41) and SWMU 10-003(b) (TA-10-42), and Plume 3 is located in the center of TA-10-41. Plume 2 grows in size and intensity as it moves from 7 to 17 ft and then slowly diminishes by a depth of 47 ft. Plume 3 is not as large as the two plumes to the northwest of it, but this plume does remain obvious even at a depth of 47 ft. The remaining two plumes appear at 17 ft. The largest of these, Plume 4, is located between SWMU 10-003(d) (TA-10-43) and SWMU 10-003(b) (TA-10-42). Even at 47 ft this plume shows elevated gross-beta activity. The final plume, Plume 5, is smaller than the others, but still shows some activity at 47 ft.

The plumes of high gross-beta activity in the TA-10 Central Area are displayed three-dimensionally in Figure 3.1-17. This figure illustrates the lateral and vertical extent of the plumes.

3.1.4.2 TA-10-44 Area [SWMU 10-002(a)]

3.1.4.2.1 SWMU Description and Historical Operation

SWMU 10-002(a), TA-10-44, was a pit dug for the disposal of spent chemicals, laboratory equipment, and trash, and received such items as gloves, rags, and acid bottles (Figure 3.1-2c). The exact dates of use for this pit are unknown, but are thought to have been between 1945 and 1950. This SWMU measured about 8 ft wide, 5 ft long, and 12 ft deep (LANL 1990, 0145).



* The original data did not include labels for these test holes.

Figure 3.1-15. Locations of samples and data points used in data analysis for the TA-10 Central Area (modified from Mayfield et al. 1979, 06-0041; LANL 1990, 0145).

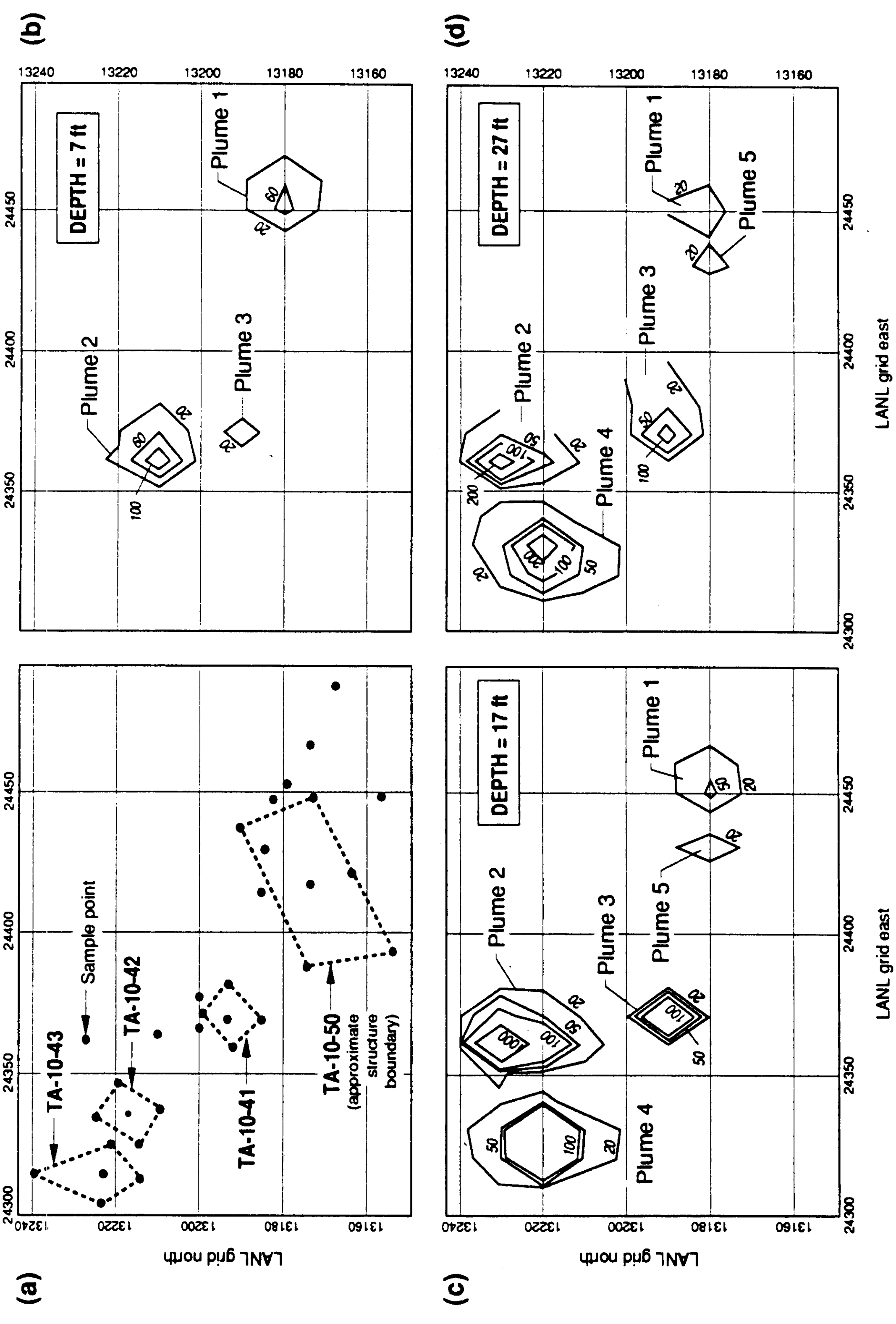


Figure 3.1-16a–d. Gross-beta activity (pCi/g) contour plots for TA-10 Central Area at depths of 7, 17, and 27 feet (modified from Mayfield et al. 1979, 06-0041).

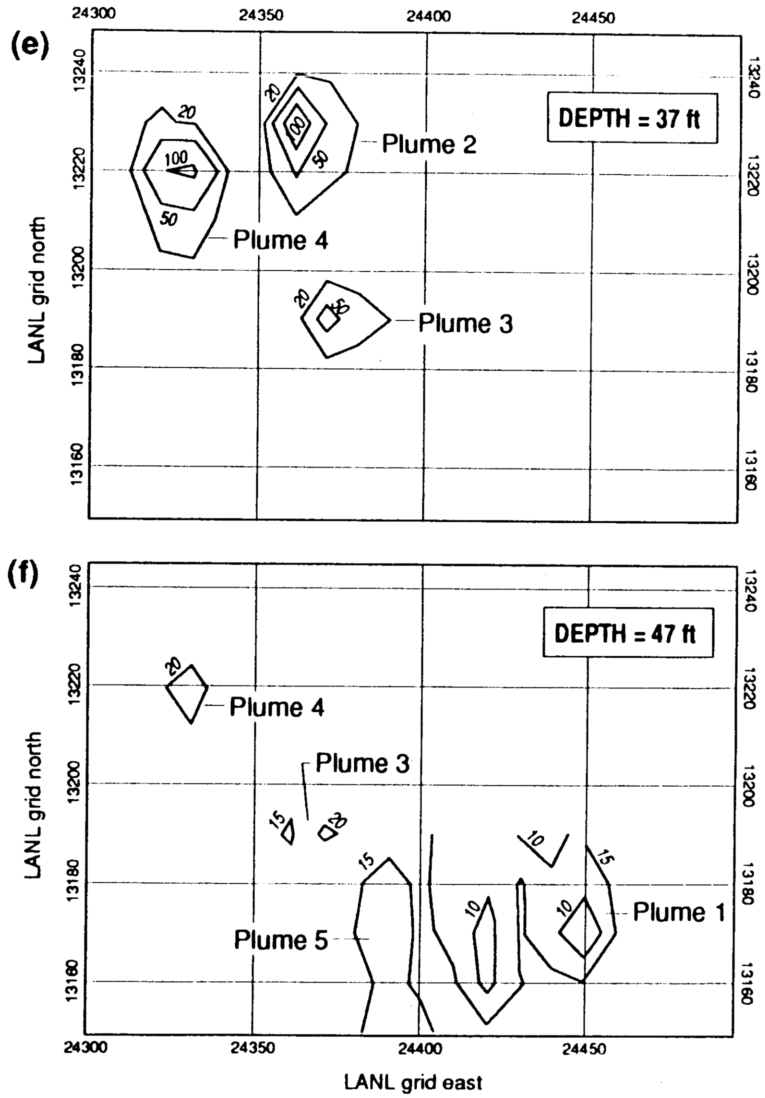


Figure 3.1-16e–f. Gross-beta activity (pCi/g) contour plots for TA-10 Central Area at depths of 37 and 47 feet (modified from Mayfield et al. 1979, 06-0041).

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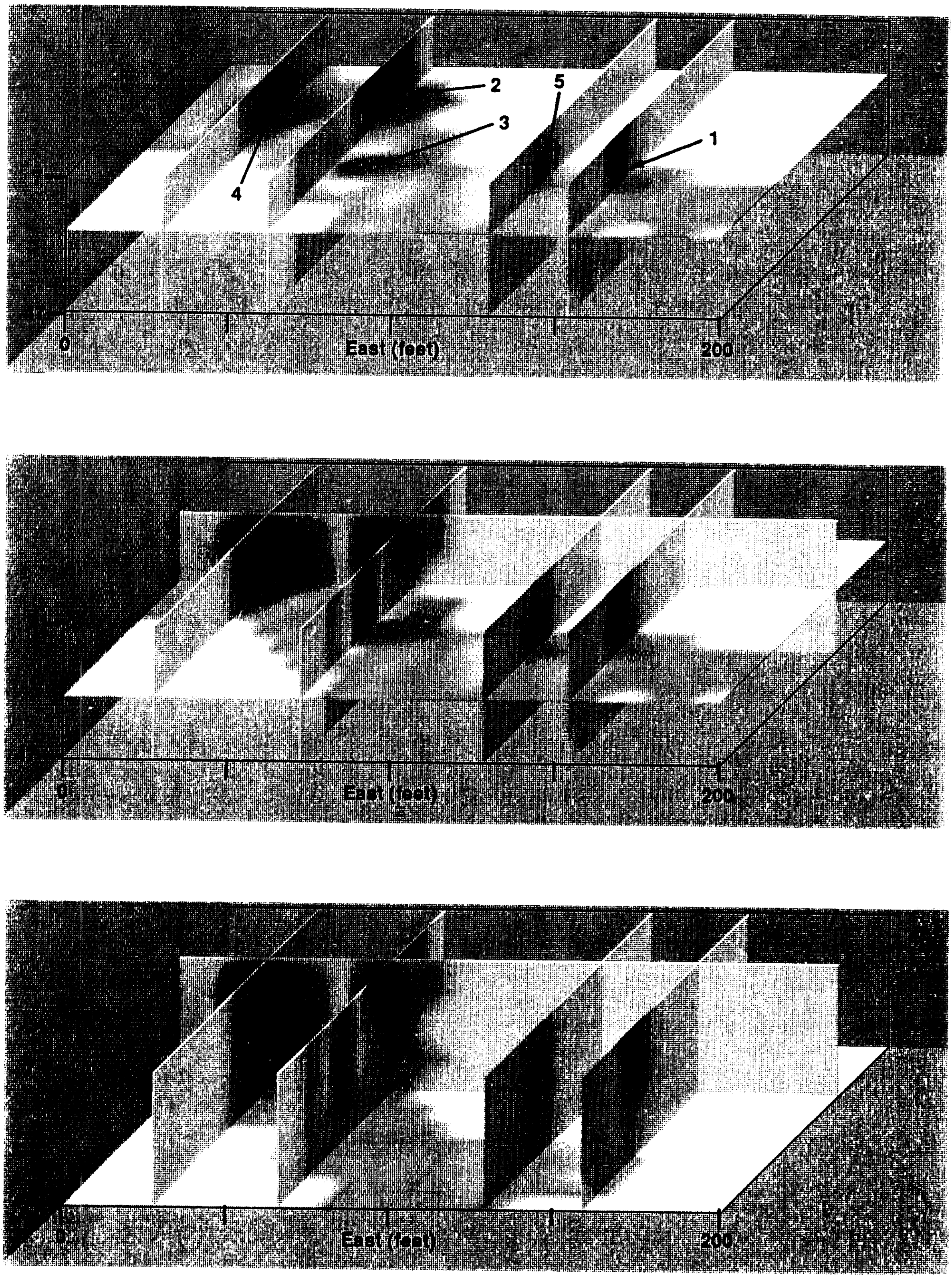


3.1-17. 3-dimensional views of gross-beta activity at the TA-10 Central Area. Note five distinct plumes (modified from Mayfield et al. 1979, 06-0041).

It is unknown whether this pit was covered or open during or after the period of active use, but it is thought that after it was no longer in use in the early 1950s, it was covered with soil until cleanup activities began in 1963. The quantities of contaminants buried in this pit are also unknown. Specific contaminants potentially present include ^{90}Sr, uranium, barium, cadmium, platinum, benzene, carbon tetrachloride, unspecified acids (probably nitric, hydrochloric, hydrofluoric and sulfuric acids), and unspecified organics and inorganics. Other radionuclides may have been in the waste, but were not documented (Mayfield et al. 1979, 06-0041; LANL 1990, 0145).

3.1.4.2.2 SWMU Investigations and Remediation

SWMU 10-002(a) was decontaminated and decommissioned in 1963. All waste items were removed, and the pit was excavated to a depth of 15 ft. Readings at the bottom of the pit after excavation indicated 1.5 mR/hr beta/gamma. The pit was then backfilled with clean soil (LANL 1990, 0145).

Five holes were drilled in or near SWMU 10-002(a) during the FUSRAP survey. These holes indicated no above background gross-beta activity, but did indicate above background gross-alpha activity (Mayfield et al. 1979, 06-0041).

3.1.4.2.3 Nature and Extent of Existing Contamination

As described in Subsection 3.14, a combined data set was prepared from the most recent site study, and has been analyzed to provide current site conditions. The data set is provided in Appendix B of this work plan. Figure 3.1-18 shows the surface locations of the data from the 1977 FUSRAP survey that were used to establish the nature and extent of contamination near SWMU 10-002(a) (Mayfield et al. 1979, 06-0041). All data on gross-beta activity from the 1977 FUSRAP survey near SWMU 10-002(a) were below 6 pCi/g. Some of the data points, such as those at holes 44c and 44w, indicated gross-alpha activity slightly exceeding 40 pCi/g, which was considered background in the FUSRAP survey. Hole 44c had gross-alpha activity to a maximum of 48 pCi/g at a depth of 33 ft, and hole 44w had 56 pCi/g at a depth of 37 ft.

3.1.4.3 TA-10-48 Area [SWMU 10-002(b)]

3.1.4.3.1 SWMU Description and Historical Operation

SWMU 10-002(b) was a pit dug for the disposal of spent chemicals, laboratory equipment, and trash, and received gloves, rags, and acid bottles (Figure 3.1-2c; Figure A-10-7, Appendix A). In addition, this pit was used for the disposal of residues from the ^{140}La extraction process performed in the radiochemistry laboratory. The total amount of liquid waste generated at the radiochemistry laboratory contained an estimated 117 Ci of ^{90}Sr (Mayfield et al. 1979, 06-0041). The exact dates for use of this pit are unknown, but are thought to have been between 1945 and 1950. SWMU 10-002(b) was divided into two sections, each

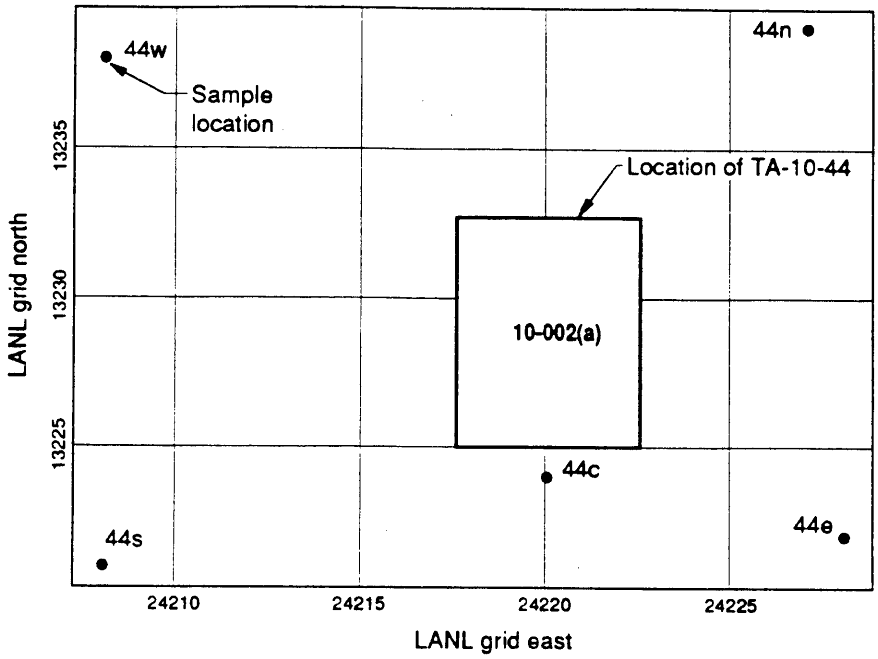


Figure 3.1-18. Locations of samples near 10-002(a) in the TA-10-44 Area (modified from Mayfield et al. 1979, 06-0041).

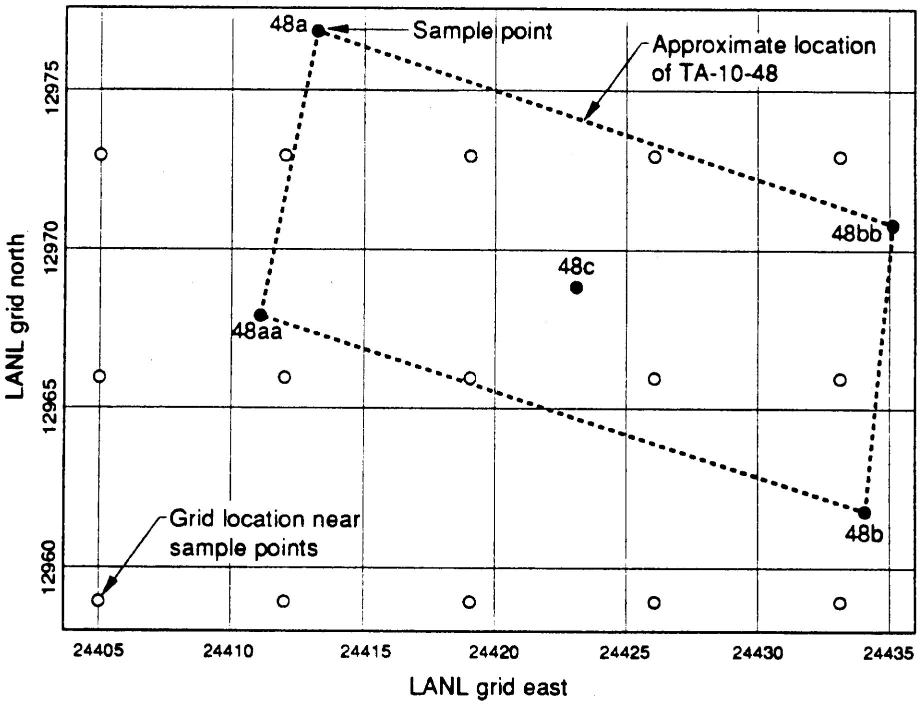


Figure 3.1-19. Grid locations for TA-10-48 within 20 feet of some data (modified from Mayfield et al. 1979, 06-0041).

measuring approximately 5 ft wide, 5 ft long, and 10 ft deep. The pit sections were lined with boards and had wood covers (LANL, 1990, 0145).

It is thought that after its use was discontinued in the early 1950s, SWMU 10-002(b) was covered with soil until cleanup activities began in 1963. The quantities of contaminants buried in this pit are unknown. Specific contaminants listed as being present in the wastes include ^{90}Sr, uranium, barium, cadmium, platinum, benzene, carbon tetrachloride, unspecified acids (probably nitric, hydrochloric, hydrofluoric and sulfuric acids), and other unspecified organics and inorganics. Other radionuclides may have been in the waste, but were not documented (Mayfield et al. 1979, 06-0041; LANL 1990, 0145).

3.1.4.3.2 SWMU Investigations and Remediation

SWMU 10-002(b) was decontaminated and decommissioned in 1963. All solid waste was removed, and the pit was excavated to a depth of 26 ft. The waste and excavated material was taken to MDA-G at TA-54. Slight strontium contamination remained in the bottom of the pit, but because the gross-beta activity was approaching background, the pit was backfilled with clean fill.

Several test holes were drilled at or near SWMU 10-002(b) in 1973 and 1974. Hole M1, drilled in 1973 to a depth of 12.2 m, was a few meters north of the SWMU. Plutonium and ^{90}Sr analyses indicated only background activity, indicating no subsurface migration had occurred from the pit. Another hole, drilled in 1974 to a depth of 3.6 m in the pit, contained only background gross-alpha and gross-beta activity (Mayfield et al. 1979, 06-0041).

During the FUSRAP survey, five holes were augered in or near SWMU 10-002(b). These holes indicated gross-beta activity to 290 pCi/g, especially at depths of 460-600 cm (Mayfield et al. 1979, 06-0041).

3.1.4.3.3 Nature and Extent of Existing Contamination

As described in Subsection 3.1.4, a combined data set was prepared from the most current site study, and has been analyzed to provide current site conditions. The data set is provided in Appendix B of this work plan.

Figure 3.1-19 shows the surface locations of the data points taken from the 1977 FUSRAP survey (Mayfield et al. 1979, 06-0041) that were used to establish the nature and extent of contamination near SWMU 10-002(b). The locations correspond to the auger hole identifiers in that report. Data at most of the surface locations extended to a depth of 47 ft. The analysis was based on 42 data points. As in the TA-10 Central Area [SWMUs 10-003(a-g, m)], gross-beta activity was analyzed, and only data below 225 cm were used.

The data were analyzed using kriging. For this area, kriged values were projected onto a grid with 7-ft spacing in all directions. Figures 3.1-20a-h show the contour

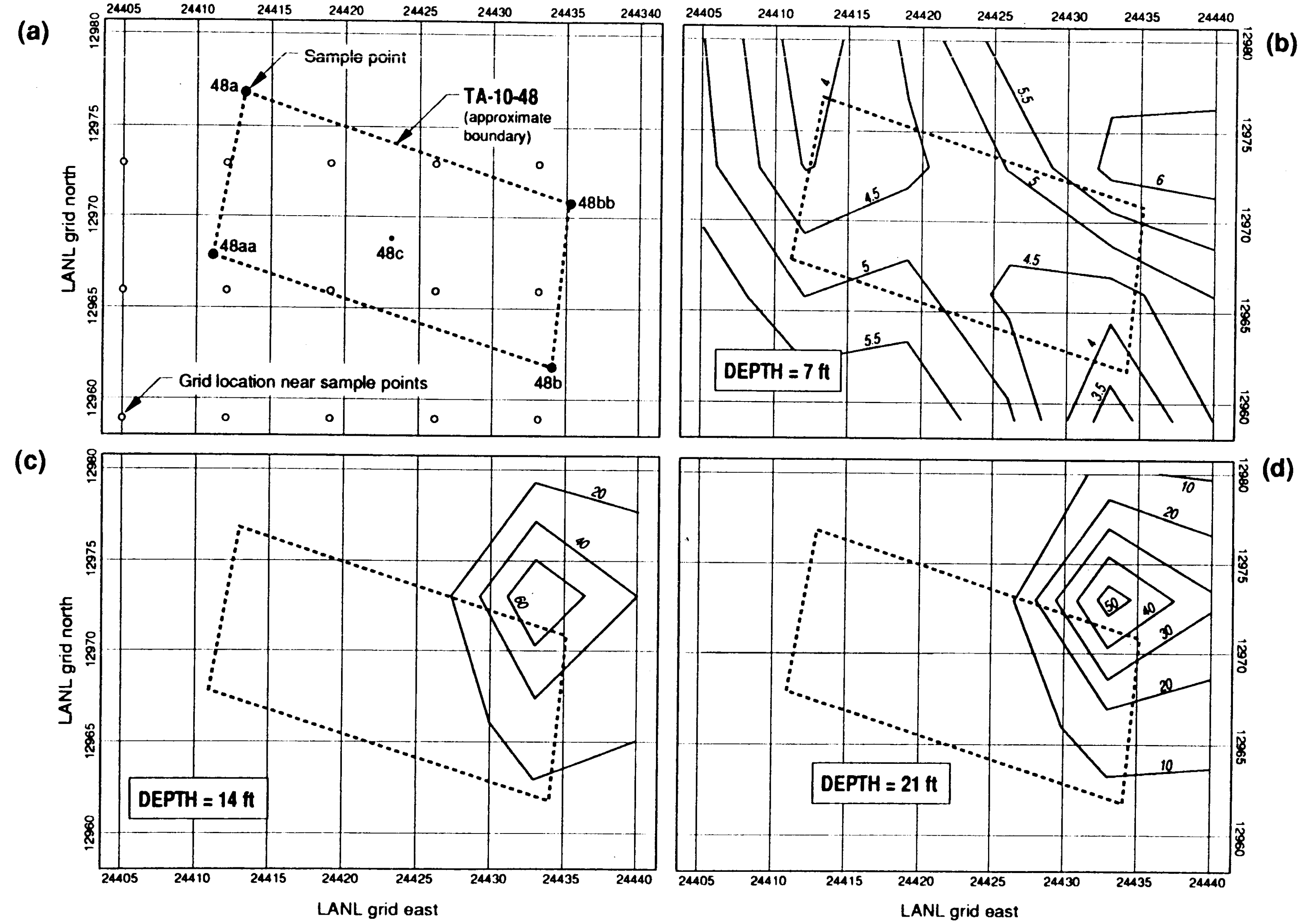


Figure 3.1-20a–d. Gross-beta activity (pCi/g) contour plots for 10-002(b) at TA-10-48 Area for depths of 7, 14, and 21 feet (modified from Mayfield et al. 1979, 06-0041).

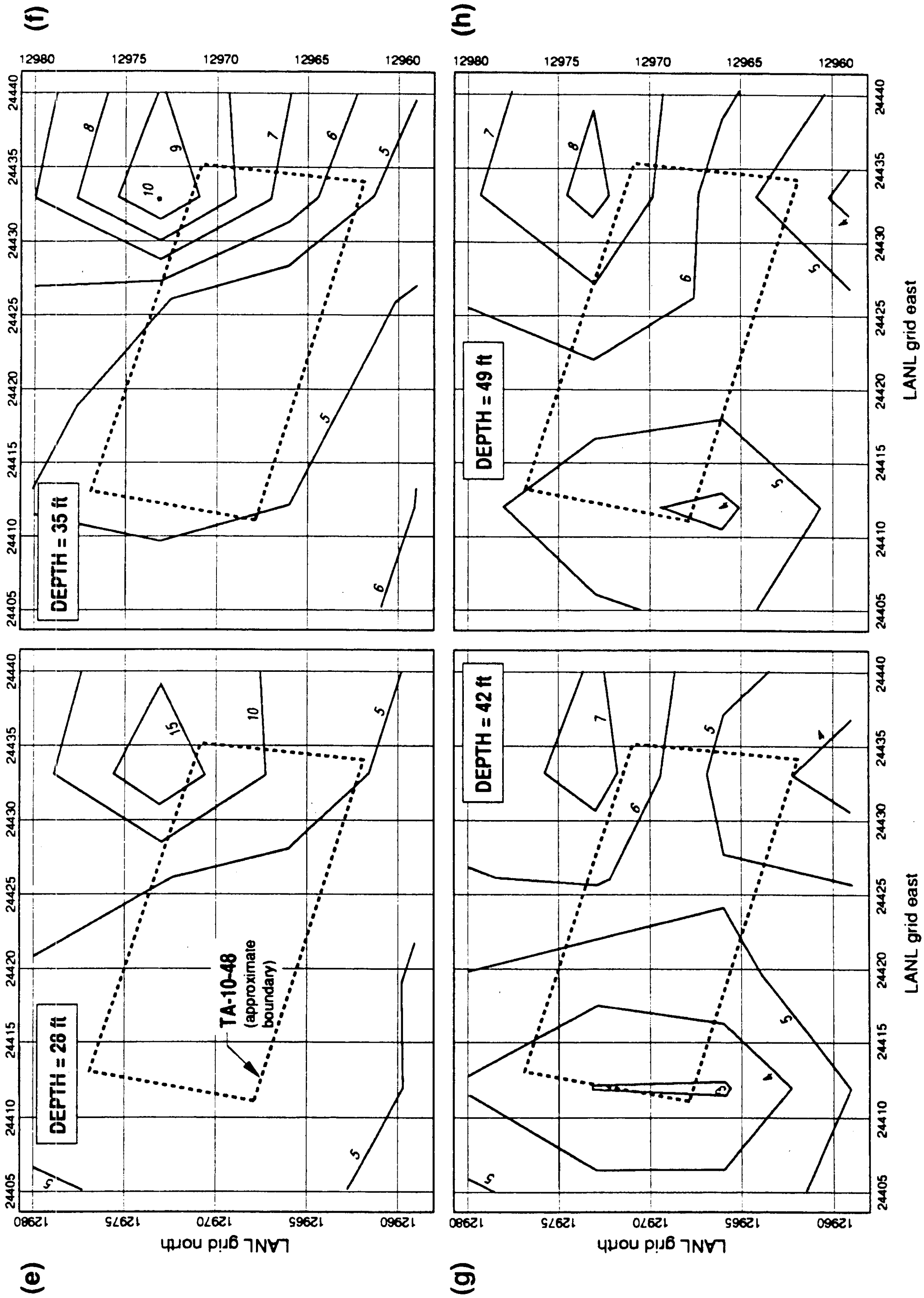


Figure 3.1-20e–h. Gross-beta activity (pCi/g) contour plots for 10-002(b) at TA-10-48 Area for depths of 28, 35, 42, and 49 feet (modified from Mayfield et al. 1979, 06-0041).

maps from the spatial analysis. One plume in this analysis appears at the east side of SWMU 10-002(a). The data were insufficient to completely characterize the lateral and vertical spacing at which the data becomes uncorrelated. Figure 3.1-21 is a three dimensional contour map of this area and indicates a single plume of contamination. The single plume is obvious, with its largest area and highest concentration values occurring between 14 and 28 ft.

3.1.4.4 SWMU 10-003(h)

3.1.4.4.1 SWMU Description and Historical Operation

SWMU 10-003(h) was an industrial waste (acid waste) manhole (TA-10-51) constructed of reinforced concrete, and measured 4 ft wide, 5 ft long, and 5 ft deep. This manhole was along the industrial waste (acid waste) line leading from the radiochemistry laboratory (Figure 3.1-8c).

3.1.4.4.2 SWMU Investigations and Remediation

SWMU 10-003(h) was removed during the 1963 D&D of TA-10.

During the 1977 FUSRAP survey, sampling was done along a 120 cm deep trench that was dug along the industrial waste (acid waste) lines leading from the radiochemistry laboratory to SWMU 10-003(h) (TA-10-51) and then on to SWMU 10-003(i) (TA-10-39).

3.1.4.4.3 Nature and Extent of Existing Contamination

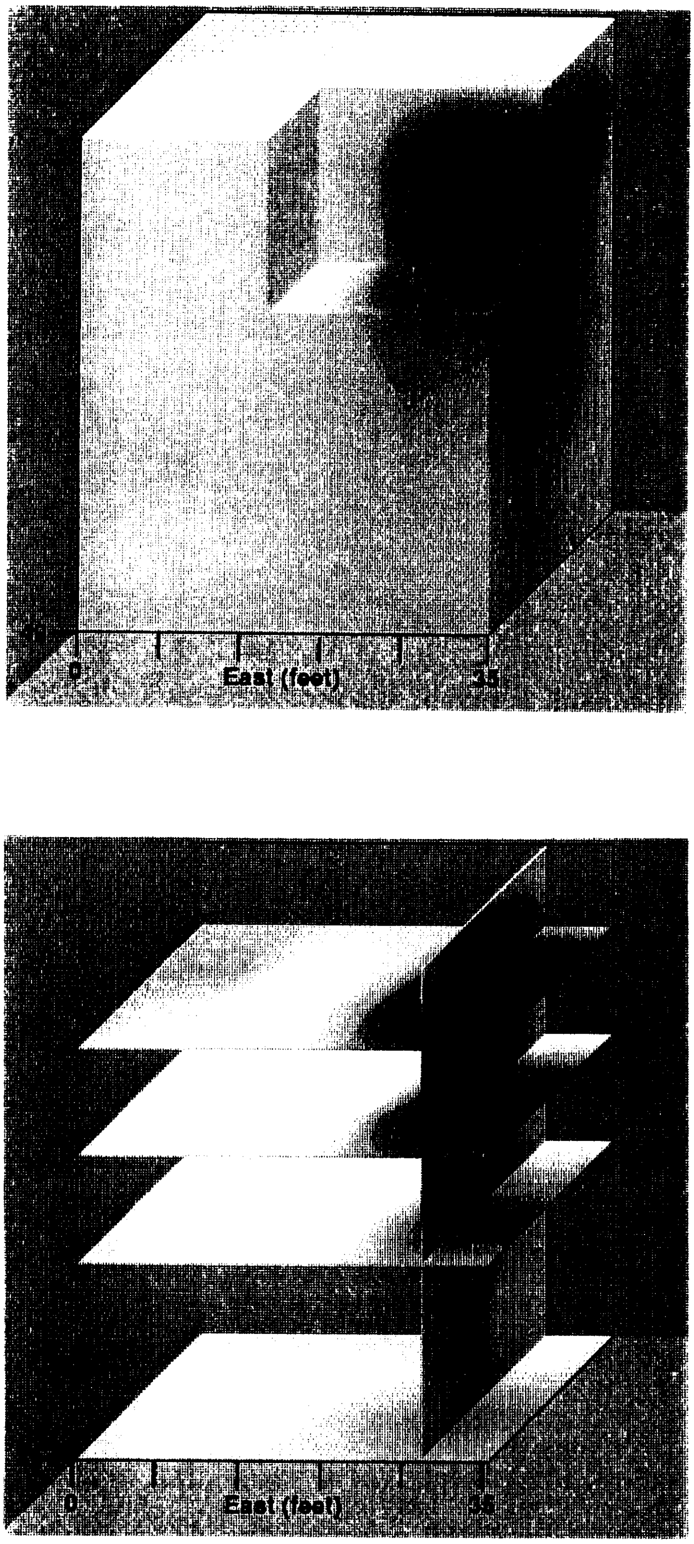
The trench samples collected at the SWMU 10-003(h) location during the 1977 FUSRAP survey indicated background levels of gross-alpha and gross-beta activity. Concentrations of ^{90}Sr were well below background levels.

3.1.4.5 SWMUs 10-003(i-l)

3.1.4.5.1 SWMU Description and Historical Operation

SWMUs 10-003(i-1) were part of the liquid waste disposal complex for the radiochemistry laboratory. SWMU 10-003(i) was an industrial waste (acid waste) septic tank (TA-10-39) (Figure 3.1-2c; Figures A-10-8 and A-10-10, Appendix A). Engineering drawing ENG-C 13943 (LASL 1955, 06-0014) indicates that this was a holding tank with an additional set of three metal tanks. The three metal tanks are thought to be SWMUs 10-003(j-l).

SWMUs 10-003(j-l) were three stainless steel tanks with no identified structure numbers and are thought to be part of SWMU 10-003(i). Each tank had a capacity of 200 gal. (LANL 1990, 0145).



3.1-21. 3-dimensional views of gross-beta activity at the TA-10-48 Area (modified from Mayfield et al. 1979, 06-0041).

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3.1.4.5.2 SWMU Investigations and Remediation

SWMUs 10-003(i-l) were removed during the 1963 D&D of TA-10.

During the 1977 FUSRAP survey, sampling was performed in 120 cm deep trenches that crossed the location of SWMUs 10-003(i-l).

3.1.4.5.3 Nature and Extent of Existing Contamination

The trench samples collected at the location of SWMUs 10-003(i-l) during the 1977 FUSRAP survey indicated background levels of gross-alpha and gross-beta activity. However, ^{90}Sr levels were nearly 6 pCi/g, which was approximately 15 times the background level.

3.1.4.6 SWMUs 10-003(n-o)

3.1.4.6.1 SWMU Description and Historical Operation

SWMU 10-003(h) was a leach field for the liquid waste disposal complex that served the radiochemistry laboratory (TA-10). It is likely that this was also a leach field for the septic system [SWMU 10-004(b)] that served the radiochemistry laboratory. This leach field was located in the stream bed north of TA-10 (Figure 3.1-2c). The dimensions and description of the leach field are unknown.

A chemist who worked at the radiochemistry laboratory remembers decontamination holes [SWMU 10-003(o)] located near the stream bed leach field. It is possible that the decontamination holes were part of the stream bed leach field [SWMU 10-003(n)] (LANL 1990, 0145).

3.1.4.6.2 SWMU Investigations and Remediation

During the 1963 D&D of TA-10, the highest levels of radioactivity encountered were associated with the liquid waste disposal complex that served the radiochemistry laboratory. The entire complex of tanks, lines, manholes etc. was excavated to a depth of approximately 6 m. During the excavation, radiation levels ranged as high as 35 mrad/hr, and the bottom of this excavation had readings of 1.5 mrad/hr. This large excavation was then backfilled with dirt from other parts of the canyon and building debris from the D&D of the Bayo site (see Subsection 3.1.4.1.1) (Blackwell and Babich 1963, 06-0009). It is unknown whether the leach field and decontamination holes were excavated during this effort.

During the 1977 FUSRAP survey, three core samples (to 30cm) were taken near the location of SWMUs 10-003(n-o). In addition, samples were taken near the stream bed along a trench which was dug from the former outfall of SWMU 10-004(b) to the stream bed.

3.1.4.6.3 Nature and Extent of Existing Contamination

The three core samples taken during the 1977 FUSRAP survey in the location of SWMUs 10-003(n-o) indicated gross-alpha and gross-beta activity at, or below, background levels. The concentration of ^{90}Sr was slightly above background.

Results were much higher in the samples taken near the stream bed from the trench. In the 60-120 cm layer, these samples indicated no gross-alpha activity, but maximum gross-beta activity was 48 pCi/g and the maximum ^{90}Sr activity was 67.2 pCi/g.

3.1.4.7 SWMU 10-004(a)

3.1.4.7.1 SWMU Description and Historical Operation

SWMU 10-004(a) is a septic tank (structure TA-10-40) which served the Personnel Building (TA-10-21) at TA-10 from 1949 through 1963 (Figure 3.1-2b; Figure A-10-13, Appendix A). The tank had a capacity of 1060 gal., and discharged to a pit measuring 8 ft wide, 8 ft long, and 12 ft deep (AEC 1954, 06-0002). Engineering drawing ENG R-637 (LASL 1958, 06-0026) indicates that this septic system discharged to a drainline and outfall located in a stream channel approximately 200 ft north-northeast of SWMU 10-002(a) (Figure 3.1-2c).

3.1.4.7.2 SWMU Investigations and Remediation

SWMU 10-004(a) was removed during the 1963 decontamination and decommissioning of TA-10 and taken to MDA-G at TA-54. No information is available concerning the fate of the disposal pit associated with this SWMU. It is not clear whether or not the 4-in. diameter tile drain to this outfall or soil around the outfall was removed during decommissioning (LANL 1990, 0145).

During the 1977 FUSRAP survey, several holes were drilled and trenches were dug around SWMU 10-004(a). One trench was dug across the area where the line led from the personnel building (TA-10-21). Another was dug across the septic tank location (TA-10-40), and two more were dug across the location of the line leading from the tank to the pit. Two holes were augered in and near the pit location (Mayfield et al. 1979, 06-0041).

3.1.4.7.3 Nature and Extent of Existing Contamination

The auger holes and trenches dug around SWMU 10-004(a) during the 1977 FUSRAP survey indicated background, or below background levels, of gross-alpha and gross-beta activity. Gross-alpha activity ranged from 4 to 44 pCi/g and gross-beta activity ranged from 2 to 4 pCi/g.

3.1.4.8 SWMU 10-004(b)

3.1.4.8.1 SWMU Description and Historical Operation

SWMU 10-004(b) (TA-10-38) was a 540-gal. capacity sanitary septic tank that served the radiochemistry laboratory (Figure 3.1-2c). It was constructed of reinforced concrete and measured 4 ft wide, 10 ft long, and 4 ft deep. This tank handled sanitary waste, but is suspected to have also received liquid wastes from the radiochemistry laboratory (TA-10-1). The overflow from SWMU 10-004(b) drained through a 4-in. diameter vitrified clay open-joint drain pipe to the stream channel. SWMU 10-004(b) was used from 1944 to 1963 (LANL 1990, 0145).

3.1.4.8.2 SWMU Investigations and Remediation

SWMU 10-004(b) was removed during the 1963 D&D and taken to TA-54 for disposal. It is likely that the line and soil surrounding the tank were also removed during the liquid waste disposal system excavation. Readings from the tank prior to its removal were less than 5.0 mrad/hr (LANL 1990, 0145).

In 1973, a test hole designated as M-2 was drilled to a depth of 6.1 m near the outfall of SWMU 10-004(b). Sample analyses indicated ^{90}Sr surface and subsurface contamination, while plutonium levels were at background. Five additional test holes were drilled near the M-2 hole in 1974. These holes indicated above background gross-beta activity (Mayfield et al. 1979, 06-0041).

During the FUSRAP survey, trenching was performed along the line leading from the radiochemistry laboratory (TA-10-1) to SWMU 10-004(b), and then along the outfall line leading from 10-004(b) to the stream bed leach field.

3.1.4.8.3 Nature and Extent of Existing Contamination

Many samples were taken during the 1977 FUSRAP survey along the trench leading to and from SWMU 10-004(b). These samples indicated gross-beta activity to 48 pCi/g and gross-alpha activity to 62 pCi/g (Mayfield et al. 1979, 06-0041).

3.1.4.9 SWMU 10-005

3.1.4.9.1 SWMU Description and Historical Operation

An open pit about 30 m west of the northwest firing point (Figure 3.1-1) was used during the 1940s and 1950s to contain shot debris swept from the firing sites and adjacent area. The dimensions of this pit are unknown as are the quantities and type of materials that were placed into it. The debris may have contained small quantities of uranium, ^{90}Sr, lead, HE residues, and possibly beryllium (LANL 1990, 0145).

In 1957, the pit debris was excavated, the wastes burned, and the ash taken to MDA-C at TA-50. The specifics on how this operation was conducted (i.e., whether uranium was burned), including pre- and post-burning monitoring activities are unknown (LANL 1990, 0145).

3.1.4.9.2 SWMU Investigations and Remediation

Dose estimates from residual surface radioactivity at the firing sites were measured in 1961 with field instruments, and ranged from background (approximately 0-0.02 mR/hr) to about 0.6 mR/hr. None of the previous site investigations from 1961 to 1977 specifically targeted the surface disposal area for evaluation of soil contamination concentrations. However, the extensive TA-10 FUSRAP survey in 1977 (Mayfield et al. 1979, 06-0041), described in Subsection 3.1.3, encompassed this disposal area. Results of that survey demonstrated that the highest surface gross-alpha and gross-beta activity were measured in the firing sites that encompassed this disposal area. However, the proximity of the firing sites to this disposal area lead to ambiguity about the surface disposal area contributions to the measured soil radioactivity.

During the 1986 CEARP field survey, the extent of this disposal area (observed as a depression) was found, as well as the presence of residual metal debris within the depression (DOE 1987, 0264).

3.1.4.9.3 Nature and Extent of Existing Contamination

Due to the proximity of SWMU 10-005 to the firing sites [SWMUs 10-001(a-d)], there is no current documentation of potential residual contamination at SWMU 10-005 that is attributable only to this former disposal pit.

3.2 Technical Area 31 (TA-31) - East Receiving Yard

3.2.1 Overview of Historical Operations

Technical Area 31 (TA-31), known as the east receiving yard, was constructed west of the Laboratory Airport in the summer of 1945 for deliveries from the Navajo Van Line (Figure A-31-1, Appendix A). TA-31 originally consisted of five warehouses (TA-31-2, -3, -4, -5, and -6), a roofed receiving dock (TA-31-1), and an oil drum storage area (TA-31-9). Several upgrades were made to the site prior to 1950. A memo from L. G. Huhr to the Black and Veatch Engineering firm discusses a paving project that was to take place at TA-31 covering 250,000 ft^2 and would be sufficient to provide parking for "50 unloaded trucks and other vehicles" (Huhr 1946, 06-0022). Engineering drawing ENG.4 C-275 (LASL 1949, 06-0023) establishes that the paving project was completed. In 1949, six hutments that made up warehouse TA-31-2 were removed to make room for a more permanent warehouse, TA-31-7. This new warehouse was constructed on the former TA-31-2 location in August 1949, and included a sanitary septic system that consisted of two manholes designated as TA-0-41 and -42 (or ULR-41 and -42), a septic tank designated as TA-0-7 (ULR-7), and an associated sewer line. A transformer station (TA-31-8) was also added to the site prior to 1950 (LASL no date, 0402). Figure 3.2-1 illustrates the TA-31 site after 1950.

TA-31 was operated by Group A-4, which was responsible for the procurement of all items required by the Laboratory, from office stationary and supplies to technical apparatus. Group A-4 also maintained all stock rooms and warehouses, and kept all property records. It is not documented which chemicals and oils were received and stored at the site; however, it is unlikely that large quantities of bulk chemicals were stored at TA-31 because Group A-4 maintained five hutments for chemical storage at Technical Area 21 (TA-21) (LASL 1947, 0461).

TA-31 was eventually abandoned, and the buildings in the former east receiving yard were removed in August 1954. There is no documentation of decontamination and decommissioning of the site at that time. The septic tank remained in place until its removal in 1988. No surrounding soil was removed during the tank removal; however, some excavation was required to remove the tank. No septic lines were connected to the tank at the time of removal. Upon removal, samples were collected from the tank; the samples reportedly contained no detectable concentrations of hazardous constituents. Following the sampling, the tank was taken to the county landfill for disposal. The original document referring to this removal effort and sampling and analysis results has not been located.

The only listed SWMU at TA-31 is the sanitary septic system (SWMU 31-001). The storage yard and associated warehouses are listed as a potential area of concern (AOC C-31-001). Table 3.2-1 lists the TA-31 SWMUs and associated structures.

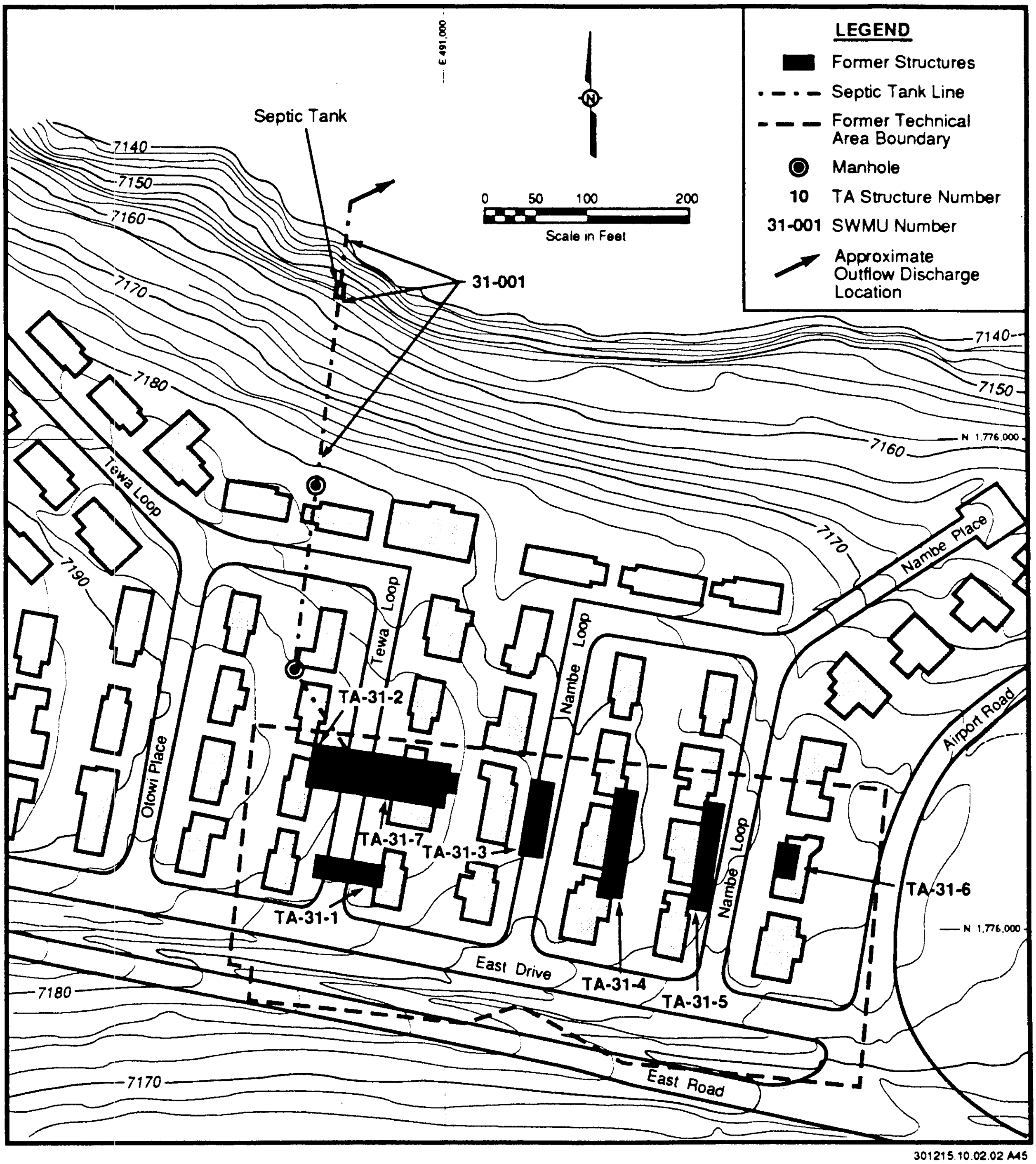

Figure 3.2-1. TA-31 site map and associated SWMU locations (modified from LANL 1990, 0145; AEC 1963, 06-0016; AEC 1963, 06-0030; Los Alamos County 1986, 06-0061; LASL 1950, 06-0054).

TABLE 3.2-1 TA-31 SWMUs AND ASSOCIATED STRUCTURES

SWMU Number	SWMU Description	Known Associated Structures	Structure Description
31-001	Septic System	TA-0-7	Septic Tank
		TA-0-41	Sanitary Sewer Manhole
		TA-0-42	Sanitary Sewer Manhole
		TA-31-7	Main Warehouse
C-31-001	Potential Soil Contamination Beneath Structures	TA-31-1	Receiving Dock
		TA-31-2	Warehouse
		TA-31-3	Warehouse
		TA-31-4	Warehouse
		TA-31-5	Warehouse
		TA-31-6	Office and Warehouse
		TA-31-7	Warehouse
		TA-31-8	Transformer Station
		TA-31-9	Drum Storage Area

3.2.2 Summary of Previous Investigations

The only known site investigation of the former east receiving yard (TA-31) was a site reconnaissance survey by the 1986 CEARP Survey team. During the survey, the septic tank was identified on a bench above the rim of Pueblo Canyon and was observed full of water and soil (DOE 1987, 0264).

3.2.3 East Receiving Yard SWMU Aggregate

This aggregate consists of SWMU 31-001, a sanitary septic system.

3.2.3.1 Septic System [SWMU 31-001]

3.2.3.1.1 SWMU Description and Historical Operation

The sanitary septic tank system, SWMU 31-001 (structure ULR-7 or TA-0-37), served the main warehouse building (TA-31-7) at TA-31 from 1949 to 1954. The septic line ran north from building TA-31-7 to a septic tank (TA-0-7) located on a small bench above the mesa rim of Pueblo Canyon (Figure 3.2-1) (DOE 1987, 0264). The tank, constructed of reinforced concrete, was 4 ft long, 3 ft wide, and several feet deep (LANL 1990, 0145). The tank drained directly into Pueblo Canyon from a 4-in. diameter pipe outfall. The exact date of construction of the tank is unknown, but it is assumed to have been installed in August 1949, when building TA-31-7 was constructed. The septic tank was located above-ground and was removed in 1988 (LANL 1990, 0145). There is no documentation of accidental spills having occurred at building TA-31-7, but it is possible that any chemicals stored in the warehouse may have entered the septic system.

3.2.3.1.2 SWMU Investigations and Remediation

See Subsection 3.2.2.

3.2.3.1.3 Nature and Extent of Existing Contamination

No documentation is available regarding the removal and closure of SWMU 31-001 (septic tank system). The nature and extent of potential residual contamination in the surrounding soil and sediment are not known at this time.

3.3 Technical Area 32 (TA-32) - Medical Research Facility

3.3.1 Overview of Historical Operations

The medical research and training facilities for the Laboratory were located at Technical Area 32 (TA-32) between the years 1944 and 1954 (Figure A-32-1, Appendix A). TA-32 was operated by H-Division under Dr. L. H. Hempelmann. TA-32 was located south of Trinity Drive behind the Zia Supply Building (now the Los Alamos County Roads Division) near the north edge of Los Alamos Canyon (Figure 3.3-1). The area consisted of four laboratories (TA-32-1, -2, -5, and -11), an office building (TA-32-3), three warehouses (TA-32-4, -12, and -13), an incinerator (TA-32-9), two septic tanks (TA-32-7 and -8), a valve house that contained the access points to the piping at the site (TA-32-6), and a transformer station (TA-32-10). Most of the structures were reconstructed barracks. All of the structures at TA-32 were removed, but the removal date is not known. Only the incinerator and the septic tanks are listed SWMUs (SWMUs 32-001 and 32-002(a-b), respectively). The soil beneath former structure locations is listed as an AOC (C-32-001). The SWMUs and associated structures are listed in Table 3.3-1 (LASL no date, 0402; LASL 1947, 0641; LANL 1990, 0145).

In 1944, after several Laboratory personnel had been diagnosed as having been exposed to plutonium, the Laboratory determined the need to develop a urinalysis method to monitor radionuclide accumulation in Laboratory personnel. A small staff was hired, and an existing military police barracks at the site was converted to a laboratory. The research group expanded and performed research investigations into the metabolism of plutonium in animals (LASL 1950, 0682). The research group activities comprised three areas: organic chemistry, radiobiology, and biochemistry.

The Organic Chemistry Section was primarily concerned with labeling biologically and medically-important substances with isotopes. These included iodine-131, sulfur-35, carbon-14, hydrogen-3, and nitrogen-15. However, the research activities of this section were not confined to those mentioned. Other activities included organic analyses, preparation and purification of special organic compounds, and the production of large organic crystals.

The Radiobiology Section was primarily concerned with studying the biological effects of radiation on normal and cancerous tissue; biological methods of measuring radiation dosage and possible applications to future atomic bomb tests; and the relative biological effectiveness of beta and gamma rays and neutrons of various energies on the organ weights of mice and on mitotic activity of tissues. This research section also addressed radioautographic methods of determining where radioactive material localizes in various tissues of the body (LASL 1950, 0682).

The Biochemistry Section was primarily concerned with the toxicology of plutonium and americium; the metabolism of carbon-14 and sulfur-35 labeled materials; the effect of radiation on nucleic acid systems; and methods of measuring tritium in biological systems (LASL 1950, 0682).

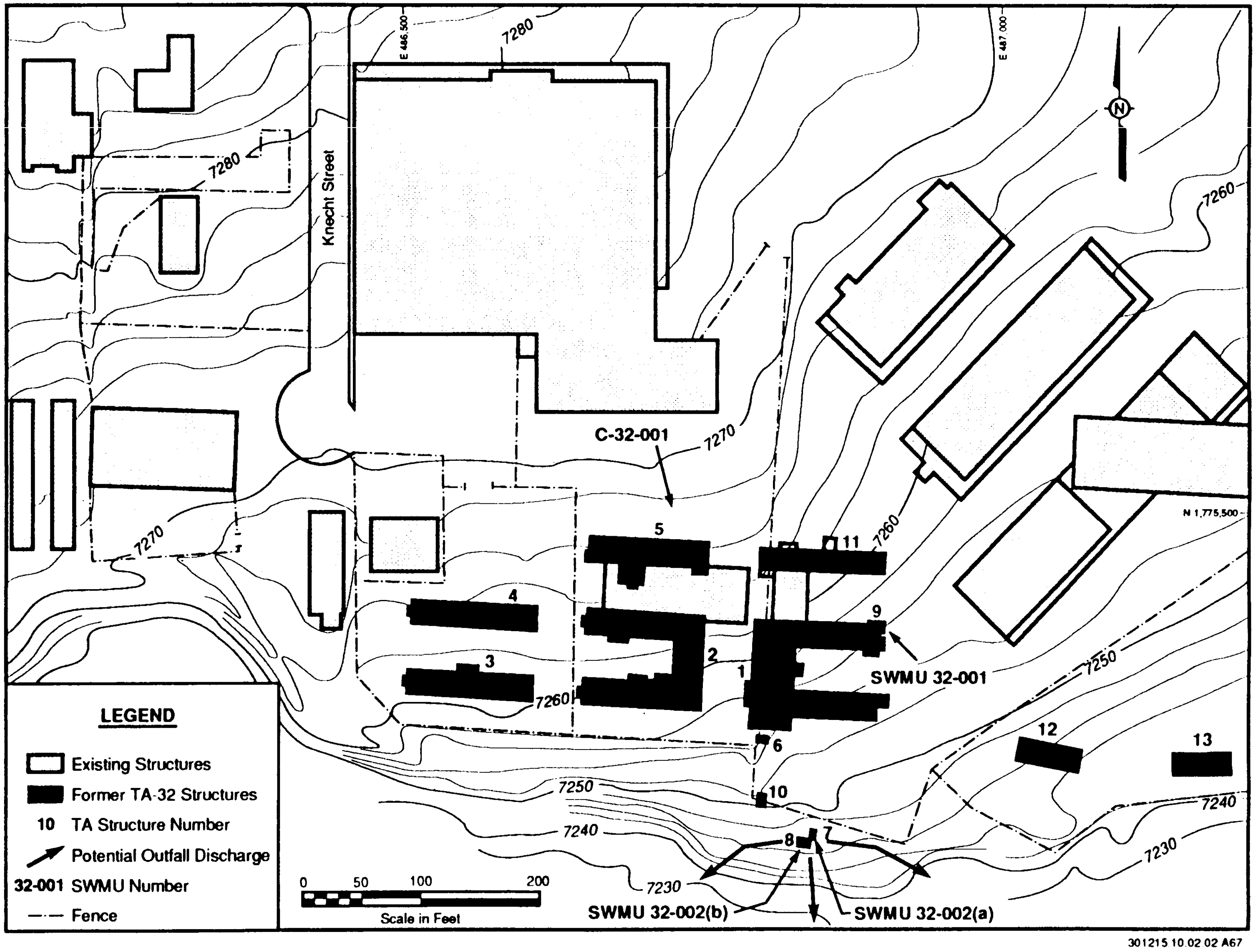

Figure 3.3-1. TA-32 site map and associated SWMU locations (modified from LANL 1990, 0145; AEC 1963, 06-0032; AEC 1963, 06-0031; Los Alamos County 1986, 06-0062; Los Alamos County 1986, 06-0063; LASL 1953, 06-0055).

TABLE 3.3-1 TA-32 SWMUs AND ASSOCIATED STRUCTURES

SWMU Number	SWMU Description	Known Associated Structures	Structure Description
32-001	Incinerator	TA-32-9	Incinerator
		TA-32-1	Main Laboratory
32-002 (a)	Septic Tank	TA-32-7	Wood Septic Tank
32-002 (b)	Septic Tank	TA-32-8	Concrete Septic Tank
C-32-001	Potential soil contamination beneath former structures	TA-32-1	Main Laboratory
		TA-32-2	Laboratory
		TA-32-3	Office
		TA-32-5	Laboratory
		TA-32-12	Warehouse
		TA-32-13	Warehouse

Besides radionuclide and chemical wastes from research activities, other potential waste streams include animal carcasses and their excrement after they were used in experiments. It is possible that both waste streams were incinerated at the on-site incinerator (TA-32-9). In addition, electronic and radiation survey equipment was calibrated at TA-32 in the late 1940s (LANL 1989, 0682).

Contaminated waste was picked up from TA-32 on an "on call" basis by Group H-1. Types of waste picked up included animal carcasses and lab pack material. The standard waste container for disposal was a cardboard box sealed with 2-in. masking tape. Between the years 1948 and 1953, waste from TA-32 was taken to pits 1, 2, and 3 in MDA-C at TA-50. Because the Laboratory did not identify radioactive isotopes associated with waste disposal activities until approximately 1954, radioactive isotopes associated with these wastes were not identified (IT Corporation 1991, 06-0001).

TA-32 was abandoned in 1954. All structures were razed, but the exact date is unknown. SWMU 32-002(a) (structure TA-32-7) was thought to have been left at the site following decommissioning in 1954 (LANL 1990, 0145). SWMU 32-002(b) (structure TA-32-8) was removed in 1988. Prior to its removal, samples of sludge in the tank were collected and analyzed. While the sample analyses indicated no radioactive contamination, the analyses did detect parts per billion (ppb) concentrations of volatile organics, with the exception of parts per million (ppm) concentrations of methylene chloride and chloroform. The analyses also indicated ppb concentrations of semivolatiles (phenols). Results of the EP Toxicity tests indicated high levels of lead and chromium. The septic tank and sludge contents were disposed of in MDA-L at TA-54.

3.3.2 Summary of Previous Investigations

The only documented site investigation of TA-32 was performed by the 1987 CEARP Survey, Phase I. This survey included only a visual inspection which indicated that both septic tanks were near the edge of the mesa top (DOE 1987, 0264).

3.3.3 Medical Research Facility SWMU Aggregate

This aggregate consists of SWMUs 32-001 and 32-002(a-b): an incinerator and two septic tank systems.

3.3.3.1 Incinerator [SWMU 32-001]

3.3.3.1.1 SWMU Description and Historical Operation

TA-32 had an incinerator (TA-32-9), designated as SWMU 32-001, located on the northeast corner of the main laboratory building (TA-32-1) (Figure 3.3-1). It was constructed of brick and was 2.5 ft wide, 2.5 ft long, and 10 ft high (LANL 1990, 0145). The incinerator probably received any combustible waste from the medical research facilities. Disposition of the ash from the incinerator is unknown (LANL 1990, 0145).

3.3.3.1.2 SWMU Investigations and Remediation

The incinerator was removed, but the exact date is unknown. No formal investigations of this SWMU have been documented.

3.3.3.1.3 Nature and Extent of Existing Contamination

The nature and extent of potential residual contamination in the surrounding soil and sediment is not known at this time.

3.3.3.2 Septic Tank - [SWMU 32-002(a)]

3.3.3.2.1 SWMU Description and Historical Operation

Two septic tank systems (structures TA-32-7 and -8) served TA-32 (Figure 3.3-1). While there are no drawings that indicate exactly which buildings these tanks served, it is assumed that they served laboratory buildings where there were probably many sinks, toilets, and drains. SWMU 32-002(a) (TA-32-7) was of wood frame construction, and was 4 ft wide, 8 ft long, and 4 ft deep. Since radionuclides were used for experiments in these laboratories, and no industrial waste line served TA-32, it is possible that contaminants were disposed of through this septic system. The septic tank was connected to an outfall over the edge of Los Alamos Canyon. SWMU 32-002(a) is thought to have been abandoned in place. Wood debris remaining at the site is assumed to be the remains of SWMU 32-002(a) (LANL 1990, 0145).

3.3.3.2.2 SWMU Investigations and Remediation

No documentation is available regarding the removal and closure of SWMU 32-001(a). The 1987 CEARP Survey, Phase I, indicated that the tank was observed near the edge of the mesa top (DOE 1987, 0264).

3.3.3.2.3 Nature and Extent of Existing Contamination

The nature and extent of contamination in the surrounding soil and sediment is not known at this time.

3.3.3.3 Septic Tank [SWMU 32-002(b)]

3.3.3.3.1 SWMU Description and Historical Operation

Two septic tank systems (structures TA-32-7 and -8) served TA-32 (Figure 3.3-1). While there are no drawings that indicate exactly which buildings these tanks served, it is assumed that they served laboratory buildings where there were probably many sinks, toilets, and drains. SWMU 32-002(b) (TA-32-8) was constructed of reinforced concrete and was 9 ft wide, 5 ft long, and 6 ft deep. Because radionuclides were used for experiments in these laboratories, and no industrial waste line served TA-32, it is possible that contaminants were disposed of through this septic system. The septic tank was connected to an outfall at the edge of Los Alamos Canyon. The tank was decommissioned in 1954 and was removed in 1988 (LANL 1990, 0145).

3.3.3.3.2 SWMU Investigations and Remediation

SWMU 32-002(b) was left in place when TA-32 was decommissioned. The tank was removed in 1988 and sludge samples were taken from the tank prior to its removal.

3.3.3.3.3 Nature and Extent of Existing Contamination

The samples of the septic tank sludge from 32-002(b) collected in 1988 during the tank removal contained part per billion concentrations of volatile organic and semivolatile organic compounds, and lead and chromium in excess of the EP-Toxicity maximum concentrations (see Subsection 3.3.1). The nature and extent of potential residual contamination in the surrounding soil and sediment is not known at this time.

3.4 Technical Area 45 (TA-45) - WD Site Waste Treatment Facility

3.4.1 Overview of Historical Operations

Technical Area 45 (TA-45), released to Los Alamos County in 1967, was the site of the first radioactive liquid waste treatment facility at the Laboratory. TA-45 was located northwest of the intersection of Canyon Road and Central Avenue (Figure 3.4-1) and was operated from April 1951 through June 1964. The structures associated with the technical area included a waste treatment facility and laboratory (TA-45-2), a vehicle decontamination facility (TA-45-1), a sewage lift station (TA-45-3), and a transformer station (TA-45-4). Other ancillary equipment included two sanitary sewer manholes (TA-45-5 and TA-45-6), four industrial waste (acid waste) manholes (TA-45-7, TA-45-8, TA-45-9, and TA-45-10), and all associated piping (LASL no date, 0402). The operational history of TA-45 is summarized in Table 3.4-1.

After the treatment plant ceased to operate in 1964, several radiation surveys of the TA-45 structures were completed before decontamination and decommissioning activities began (LASL 1965, 06-0027; Mitchell 1965, 06-0029; Buckland 1965, 06-0010). The vehicle decontamination facility (SWMU 45-002) and the waste treatment plant (SWMU 45-001) were radioactively contaminated. Additionally, all industrial waste (acid waste) manholes at the site (TA-45-7 through 10) and the entire industrial waste (acid waste) line (SWMU 45-003) between TA-1 and TA-45 were radioactively contaminated. No radioactivity was detected at the transformer station (TA-45-4), the sewage lift station (TA-45-3), or the sanitary manholes (TA-45-5 and 6). Alpha activity was monitored in the Acid Canyon area in August 1965, and "nuisance levels" of contamination were found. Laboratory Group H-6 recommended that 3 ft of clean soil be placed over both outfall areas (SWMUs 45-001 and 1-002) and upper Acid Canyon after the TA-45 buildings were removed (Barnett 1965, 06-0003; Kennedy 1965, 06-0033). This was never done.

An additional radiation survey (unspecified type) of Acid Canyon was completed by Group H-1 in August and September 1965. Activity measurements on the dry cliff portion of the treated outfall location below the waste treatment plant (SWMU 45-001) registered 10,000 counts per minute alpha and 0.5 mr/hr beta-gamma activity. Alpha activity below the untreated outfall (SWMU 1-002) from TA-1 was 8,000 counts per minute (Buckland 1965, 06-0011; Buckland 1965, 06-0012).

Decontamination and decommissioning of the TA-45 liquid waste treatment plant (SWMU 45-001) began in October 1966 (Figure A-45-2, Appendix A). All radioactively contaminated equipment, plumbing, and removable fixtures were removed. The structures for the waste treatment plant (SWMU 45-001) and the vehicle decontamination facility (SWMU 45-002) were demolished, and all debris was removed. Buried industrial waste (acid waste) lines (SWMU 45-003), industrial waste (acid waste) manholes, and a significant amount of contaminated soil in the vicinity of the radioactively contaminated structures were excavated. All debris was transported to the solid radioactive waste disposal area at TA-54, MDA-G. A total of 516 dump-truck loads of debris were removed during the

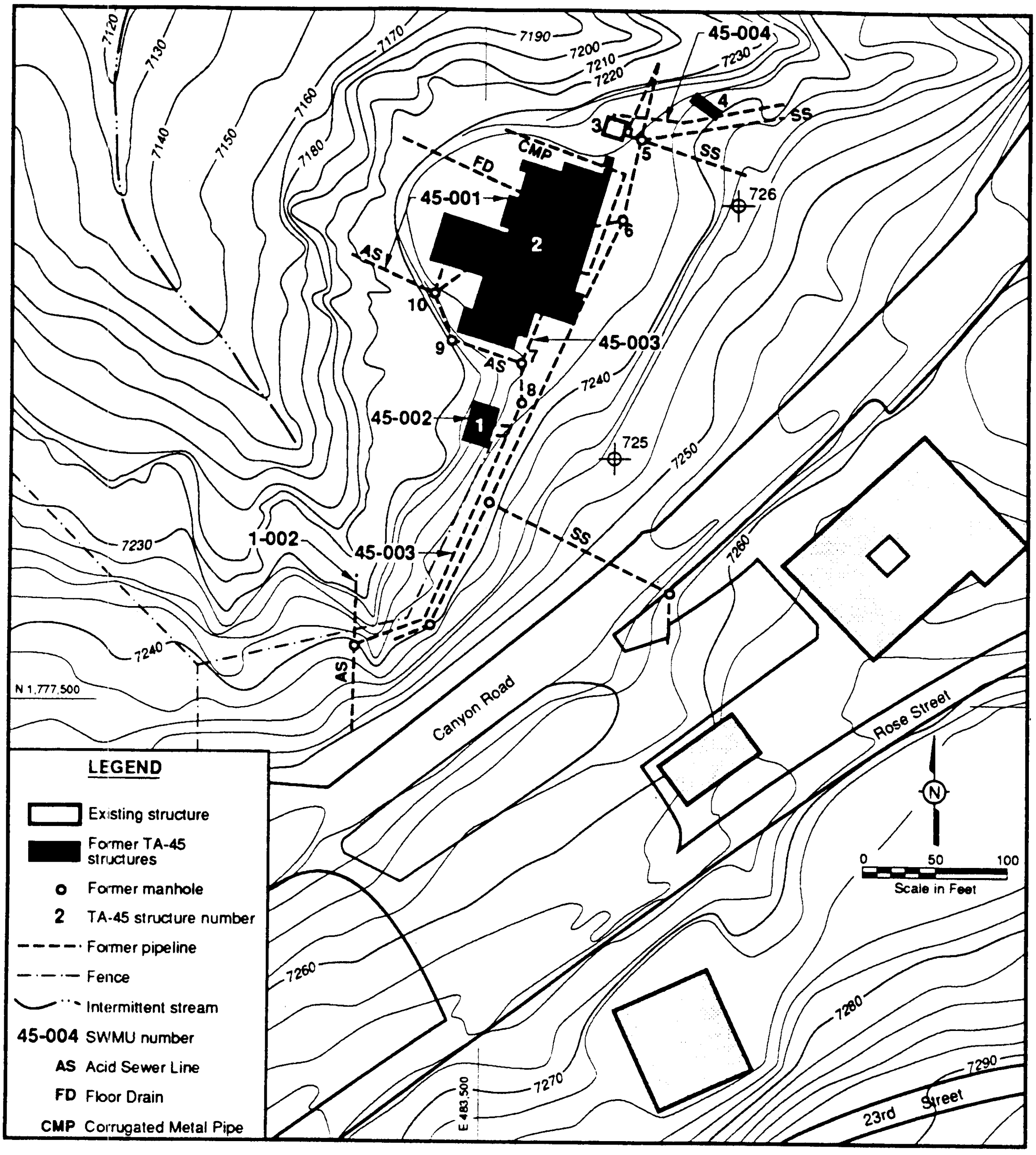

Figure 3.4-1. TA-45 site map and associated SWMU locations (modified from LANL 1990, 0145; AEC 1963, 06-0036; Los Alamos County 1986, 06-0059; Los Alamos County 1986, 06-0060; LASL 1961, 06-0051; LASL 1955, 06-0052; LASL 1962, 06-0053).

TABLE 3.4-1 HISTORICAL OPERATION AT TECHNICAL AREA 45

Date	Description
1943 -1951	Untreated liquid radioactive waste discharged to Acid Canyon.
1947	Sewage lift station and transformer station constructed at the site for community services.
1948-1951	Joint effort between U.S. Public Health Service and Lab to develop method of removing plutonium and other radionuclides from liquid waste.
? - 1951	Treatment Plant (TA-45-2) designed and constructed. Vehicle decontamination facility also constructed.
June 1951 - June 1953	Only liquid waste from TA-1 processed at TA-45.
June 1953	Liquid wastes from TA-3 added to TA-45 waste stream.
September 1953	Liquid waste from TA-43 added to TA-45 waste stream.
January 23, 1955	A section of the industrial waste (acid waste)line between the neutralization tank at TA-3 and TA-45 plant froze up resulting in several hundred gallons of waste discharging into Los Alamos Canyon beneath Omega Bridge; no significant contamination was found in affected soils.
1955	Wastewater from vehicle decontamination facility diverted to the treatment plant instead of discharging into Acid Canyon untreated.
November 1957	Modifications to the waste treatment plant result in increased treatment capacity from 90 to 145 gallons/minute.
January 21, 1957	Plutonium spill occurred in parking lot south of TA-45-2; the contaminated soil was removed to an unspecified contaminated dump.
1958	Liquid wastes from TA-48 were added to the line coming from TA-3.
July 1963	Liquid wastes from TA-3 and TA-48 redirected to the new Central Waste Treatment Plant (TA-50).
July 1963	Low level liquid waste from TA-43 redirected to sanitary sewer system.
July 1963 - May 1964	Only liquid wastes from TA-1 processed at TA-45.
July 1964 - June 1964	Untreated low level liquid wastes released from decommissioning of Sigma Building at TA-1. May contain some fission products.
June 1964	No further effluents released from TA-45 into Acid Canyon.
October 1966	Beginning of decommissioning at TA-45, including outfall locations.
January 1967	Decommissioning and decontamination put on hold for weather reasons.

TABLE 3.4-1 HISTORICAL OPERATION AT TECHNICAL AREA 45 (CONTINUED)

Date	Description
Spring 1967	Further decommissioning and decontamination.
July 1967	TA-45 and Acid Canyon and part of Pueblo Canyon transferred to Los Alamos County. This includes transfer of sewage lift station (TA-45-3) and concrete plugged sanitary manholes (TA-45-5 and -6).
1977 - 1981	FUSRAP Survey Completed at Site.
May 1986	Radiological survey directly southeast of TA-45 site found no above background radioactivity.
1986 - 1987	Los Alamos County natatorium constructed southeast of the site.

operations (Blackwell 1967, 06-0006; LANL 1981, 0141). During the same time, decontamination of portions of Acid Canyon was accomplished (Figure A-45-3, Appendix A). Contaminated tuff was removed from the cliff face in the outfall locations (SWMUs 45-001 and 1-002). Workers using jackhammers and axes were suspended over the cliff edge on ropes with safety harnesses to remove contaminated rock (LANL 1981, 0141). An estimated 94 dump-truck loads were removed through these operations and placed in Pit #4 in MDA-C at TA-50 (Blackwell 1967, 06-0007). In January 1967, the operations were suspended due to cold weather. Additional decontamination was undertaken in the spring, including removal of more contaminated rock, the flow-measuring weir from Acid Canyon, and other portions of the buried industrial waste (acid waste) lines (SWMU 45-003). The TA-45 site and Acid Canyon were considered free of radioactive contamination by July 1967, and the posted signs were removed to allow unrestricted access (Blackwell 1967, 06-0006; Blackwell 1967, 06-0008). Some residual radioactivity was left in the inaccessible areas of the canyon (less than 500 counts per minute alpha activity), but the area was not considered a public health hazard at that time (Blackwell 1967, 06-0008).

The TA-45 site, Acid Canyon, and a portion of Pueblo Canyon were transferred to the County of Los Alamos by Quit Claim Deed on July 1, 1967, pursuant to the Community Disposal Act. The transfer allowed for an easement for continued access for maintenance of sampling locations and test wells in, and adjacent to, the channel in Acid and Pueblo Canyons (LANL 1981, 0141).

The five identified SWMUs at TA-45 include the radioactive waste treatment plant and outfalls (SWMU 45-001), the former vehicle decontamination facility (SWMU 45-002), the decommissioned industrial waste (acid waste) lines (SWMU 45-003), an untreated industrial waste (acid waste) outfall (SWMU 1-002), and a sanitary sewer outfall (SWMU 45-004). Due to a plutonium sludge spill at TA-45 (H-Division 1957, 0675, see Subsection 3.4.3.2.1), the former parking lot area is listed as an area of concern (AOC C-45-001). The SWMUs and associated structures at TA-45 are listed in Table 3.4-2.

3.4.2 Summary of Previous Investigations

3.4.2.1 Investigations Prior to 1977

The Laboratory has monitored the soil, water, and air at the TA-45 site and adjacent canyons affected by the waste treatment operations since 1945 (LANL 1981, 0141). The U.S. Geological Survey (USGS), Water Resource Division, studied the water quality and geohydrology in the area from 1949 to 1971 to determine the effects of release of industrial effluent. In addition, the environmental monitoring staff at the Laboratory has continued routine surveillance of the affected areas. A series of reports including documentation and interpretation of the monitoring data have been published annually since 1970 by the Laboratory. The reports include soil, air, water, and external penetrating radiation monitoring data and dose estimates.

TABLE 3.4-2 TA-45 SWMUs AND ASSOCIATED STRUCTURES

SWMU Number	SWMU Description	Known Associated Structures	Structure Description
45-001	Treatment Facility	TA-45-2	Radioactive Waste Treatment Facility and Associated Outfalls
45-002	Decontamination Facility	TA-45-1	Vehicle Decontamination Facility and Outfall
45-003	Decommissioned Waste Lines	TA-45-8	Manhole in industrial waste (acid waste) line connecting TA-45-1 to TA-45-2.
45-004	Sanitary Sewer Outfall	TA-45-3	Sanitary Sewer Lift Station
		TA-45-5	Sanitary Sewer Manhole
		TA-45-6	Sanitary Sewer Manhole
1-002	Untreated Waste Outfall	Many TA-1 Structures	See OU 1078 Work Plan for details
C-45-001	Potential Soil Contamination in parking lot	TA-45-2	Radioactive Waste Treatment Facility

The historical data indicate a distinct distribution pattern of radioactivity. The majority of residual activity remains attached to bank soils or more stable inactive channel sediments. As expected, the radioactivity is greatest near the waste discharge points and generally decreases with distance from the source area. However, the levels and distribution of radioactivity can vary considerably in the canyon stream channels due to the intermittent major flow events (LANL 1981, 0141).

3.4.2.2 Formerly Utilized MED/AEC Sites Remedial Action Program (FUSRAP) - 1977

An investigation of TA-45 was conducted in the late 1970s under the auspices of the Formerly Utilized Sites Remedial Action Program (FUSRAP) sponsored by the US Department of Energy (DOE). A comprehensive report describing these activities was issued in May 1981, entitled "Radiological Survey of the Site of a Former Radioactive Liquid Waste Treatment Plant (TA-45) and the Effluent Receiving Areas of Acid, Pueblo, and Los Alamos Canyons, Los Alamos, New Mexico" (LANL 1981, 0141). The FUSRAP investigation was designed to provide a basis for estimating potential exposures to the public based on land use at the time of the FUSRAP survey as well as possible future uses. Historical data from previous investigations were used to guide the FUSRAP sampling program (LANL 1981, 0141).

The FUSRAP survey consisted of soil and sediment sampling, analysis of airborne radioactivity measurements through the Laboratory's environmental surveillance program, and measurement and analysis of external penetrating radiation (LANL 1981, 0141). Each of these field efforts is described in the following subsections.

3.4.2.2.1 FUSRAP Soil and Sediment Sampling

The area designated for soil and sediment sampling included the former liquid waste treatment plant site (SWMU 45-001), including the treated and untreated outfall locations, and the receiving canyons: Acid, Pueblo, and Los Alamos (Figures 3.4-2a-b). The portable field instruments used for radioactivity detection in the survey included a phoswich and a micro-R meter (LANL 1981, 0141).

All of the soil and sediment samples were analyzed for gross-alpha and gross-beta activity by ZnS and plastic scintillator detectors, respectively. Subsets of these samples, selected by random choice or identified by prior monitoring data, were submitted for various radiochemical analyses. The largest number of radiochemical analyses were performed for ^{238}Pu and ^{239}Pu, followed closely by uranium, then ^{90}Sr, ^{137}Cs, ^{232}Th, ^{226}Ra, ^{241}Pu, and ^{241}Am (LANL 1981, 0141). A summary of the soil sampling plan is provided in Table 3.4-3. Complete results are provided in the FUSRAP Report (LANL 1981, 0141).

TABLE 3.4-3 RESURVEY SAMPLING AND ANALYSIS SUMMARY

Strata	Sample Type	No. of Locations	Analysis Type	Comment
Treatment Plant Site	surface (0-5 cm)	15	gross α,β	positive survey meter response and pattern around untreated discharge
		12	radiochemical	positive gross α,β result; positive survey meter response; expected contamination
	core (0-25 cm)	22	gross α,β	rectangular gridpoints, H_4
		11	radiochemical	positive gross α,β result; expected contamination
	trench	24	gross α,β	6.1-m increments of industrial waste (acid waste) alignment
		12	radiochemical	positive gross α,β result; positive survey meter response; expected contamination
	auger (60-900 cm)	111	gross α,β	potential structural leakage
		26	radiochemical	positive gross α,β result; potential contamination
Acid Canyon	surface (0-5 cm)	12	gross α,β	positive survey meter response
		5	radiochemical	positive gross α result
	core (0-25 cm)	6	gross α,β	positive survey meter response; potential contamination
		3	radiochemical	clarification
Pueblo and Los Alamos Canyons	surface (0-5 cm)	26	gross α,β	unusual accumulation or depletion feature
		2	radiochemical	positive gross α result
	core (0-25 cm)	148	gross, α,β	transect points; background clarification
		91	radiochemical	positive gross α,β result; background; clarification; random selection.

(Modified from LANL 1981, 0141)

The treatment plant site was divided into four general sampling locations corresponding to operational uses within the site (Figure 3.4-2a-b). These sampling locations included

- the former untreated outfall location (SWMU 1-002);
- the locations of the former industrial waste (acid waste) lines (SWMU 45-003);
- the location of the former vehicle decontamination facility (SWMU 45-002); and
- the location of the former waste treatment plant (SWMU 45-001).

Soil sampling point locations in Acid Canyon below the former untreated outfall (SWMU 1-002) were determined by historical data or positive field instrument response (Figure 3.4-2a-b). The majority of the soil samples in this location were taken at a depth of 5 cm; however, a few cores were collected at depths to 25 cm. The surface soil samples were collected with a 9-cm-diameter ring, and the near surface samples were collected with 2.5-cm-diameter plastic pipe sections (LANL 1981, 0141). The highest Laboratory-analyzed concentration of ^{239}Pu in surface soil for the entire survey area, 163,000 pCi/g, was encountered in the untreated outfall location. The area of surface activity was approximately 30 m long, 5 m wide, and 30 cm deep. The maximum ^{239}Pu concentrations detected by laboratory analyses were within a 30 to 75 cm wide band in the drainage channel into Acid Canyon (LANL 1981, 0141).

Trenching was performed to collect soil samples in the locations of the former industrial waste (acid waste) line feeding into the TA-45 waste treatment plant, the former effluent discharge line and outfall, and the former utility room floor drainline and outfall. Trenches were dug perpendicular and parallel to the former line locations with a backhoe. The trenches were excavated at 6.1 m intervals across the line, at locations of former manholes, and at connections in the waste lines. Soil samples were scooped near the bottom of the trenches, at depths of about 120 cm. Concentrations of ^{239}Pu contamination were detected in the subsurface where the industrial waste (acid waste) line approached the treatment plant, to a maximum of 4 pCi/g. The ^{239}Pu concentrations extended over an area approximately 40 m long, 3 m wide, and 1.5 m deep (LANL 1981, 0141).

Soil sampling locations in the vicinity of the former vehicle decontamination facility (SWMU 45-002) and its drainage to Acid Canyon were determined by positive field survey instrument response. Surface soil samples were collected with a 9-cm-diameter ring, to a depth of 5 cm. (LANL 1981, 0141). These soil samples indicated surface ^{239}Pu contamination in the drainage area leading from the former vehicle decontamination facility, but at considerably lower activity levels than detected in the untreated outfall area. The ^{239}Pu concentration, to a maximum of 42 pCi/g, extended over an area approximately 10 m wide by 30 m long. The depth of ^{239}Pu activity was not determined (LANL 1981, 0141).

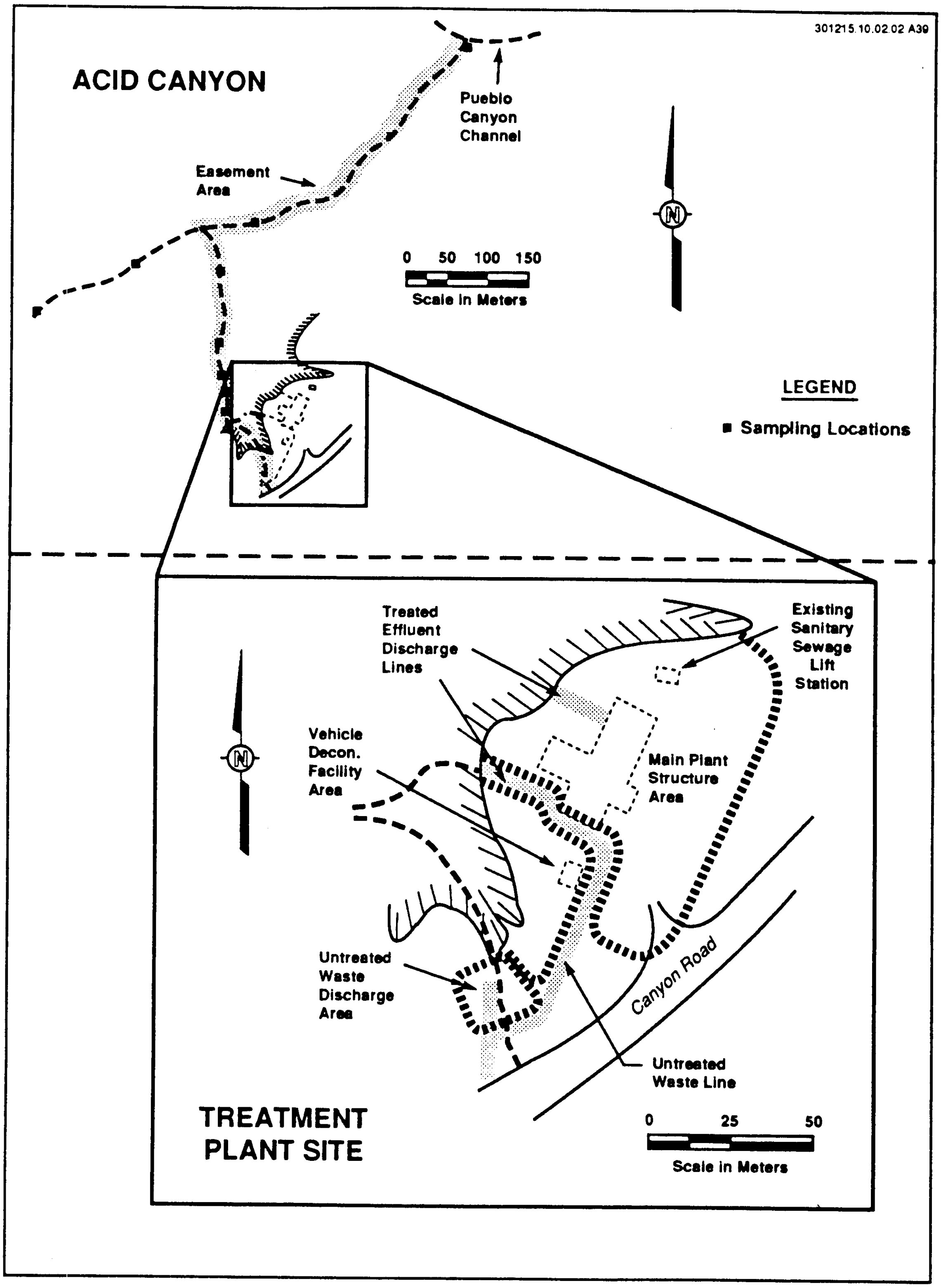

Figure 3.4-2a. General sampling locations at TA-45 (modified from LANL 1981, 0141).

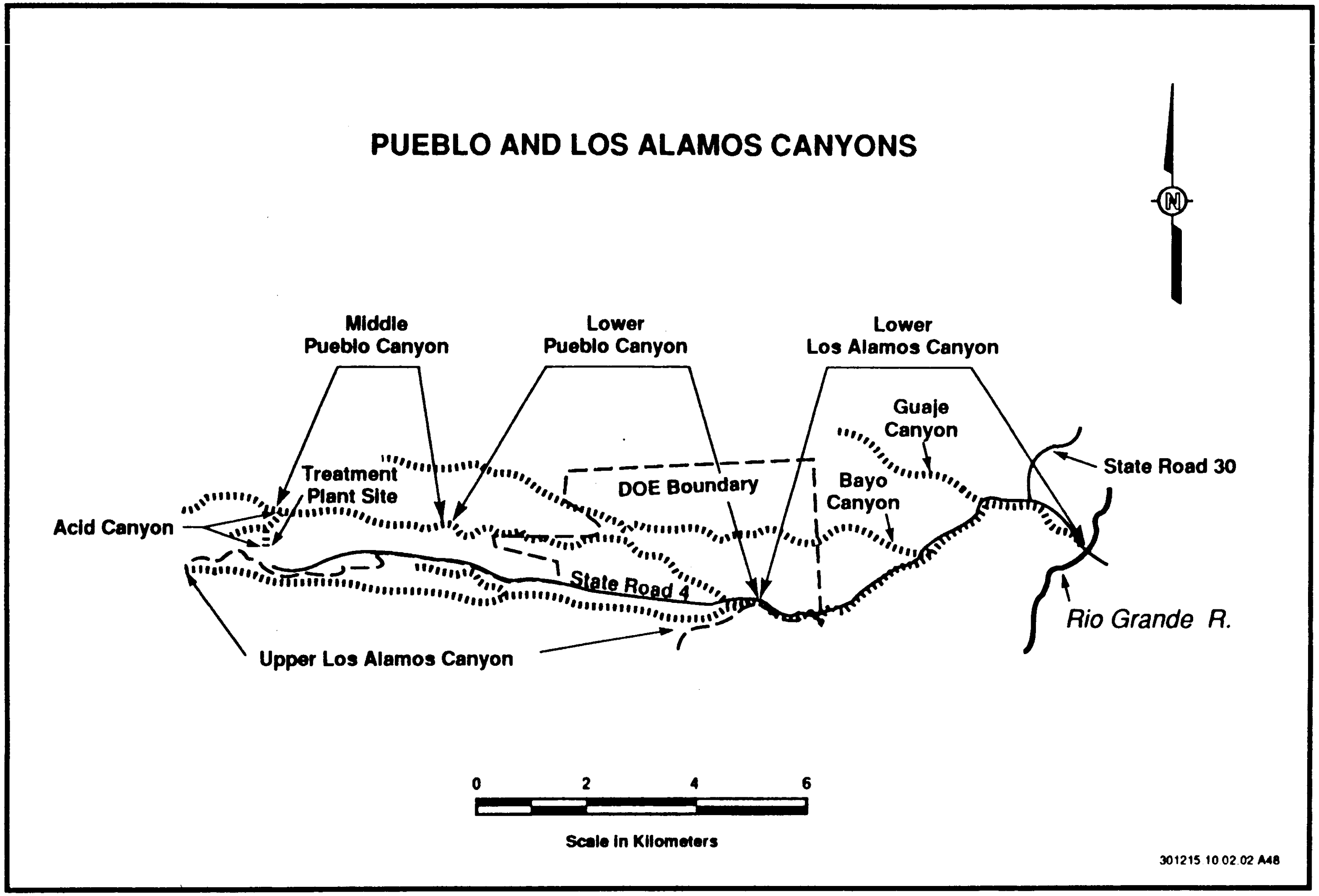

Figure 3.4-2b. General canyon sampling locations downstream from TA-45 (modified from LANL 1981, 0141).

Due to the varying depths of fill that was placed in this area during the original decontamination and decommissioning in the 1960s, soil sampling in the location of the former waste treatment plant (SWMU 45-001) was performed by auger drilling. Soil samples (cuttings) were collected with a truck-mounted auger to a minimum drilling depth of 240 cm. A solid-stem, 4-in. diameter auger was used for the drilling. Soil samples collected inside the perimeter of the former treatment facility were collected from depths ranging from 120 to 900 cm, sometimes penetrating unidentified bedrock. These soil samples were collected from former locations of the holding and settling tanks, sumps, and near corners of the former waste treatment facility. Soil samples were also collected at locations of related plant structures such as manholes. Outside the perimeter of the waste treatment plant, a rectangular grid of unspecified dimensions and sampling intervals was established, and soil samples were collected to depths of 240 cm (LANL 1981, 0141). Laboratory sampling results indicated that concentrations of ^{239}Pu were present in the subsurface inside the perimeter of the former waste treatment facility and its vicinity to a depth of 1.5 m. The area of ^{239}Pu concentrations, to a maximum of 35 pCi/g, extended over an area about 55 m wide by 60 m long (LANL 1981, 0141).

The cliff face extending from the TA-45 site into the headwaters of Acid Canyon, where the former effluent had flowed, was surveyed separately using a portable phoswich and micro-R meter. A total of eleven vertical transect lines were surveyed; eight of them on the cliff face that had been extensively decontaminated by chipping (during the 1960s decontamination and decommissioning); one parallel to the flow path for the untreated waste outfall (SWMU 1-002); one parallel to the drainage for the vehicle decontamination facility (SWMU 45-002); and one parallel to the smaller 6-in. diameter utility room floor drain outfall from the treatment plant (LANL 1981, 0141). No significant levels of activity were detected on the cliff face.

Two different methods were utilized for sampling within Acid Canyon. Soil samples at the headwaters of the canyon near the former effluent outfalls were collected in locations registering a positive activity response on the field survey instruments. The soil samples were collected at depths of 5 cm. Additional soil samples were collected in the stream channel to correspond with sample locations in previous studies (LANL 1981, 0141). The soil samples were collected at a depth of 25 cm and were collected with either a 9-cm-diameter ring or 2.5-cm-diameter plastic pipe sections (LANL 1981, 0141). Concentration levels of ^{239}Pu, to a maximum of 629 pCi/g, were above background levels in all channels and banks of Acid Canyon, to depths of 30 cm. The higher activity levels detected in the channel banks decreased with increasing distance from the discharge points (LANL 1981, 0141). The concentrations of ^{239}Pu extended over an area approximately 2 m wide and 750 m long (Table 3.4-4).

The stream channel sediments in Pueblo and Los Alamos Canyons were sampled by establishing 100 m segments down the channel and randomly selecting one out of every five segments (500 m). In each selected segment, samples were collected in the active and inactive stream channel and on each bank. In the lower reaches of the canyons, additional soil samples were collected as the channels widened. Areas near a meander or sand bar also warranted additional

TABLE 3.4-4 SUMMARY OF RADIOLOGICAL ANALYSES OF SOILS AND SEDIMENTS ASSOCIATED WITH THE TA-45 WASTE TREATMENT PLANT AND OUTFALL

	Treatment Plant Site						
STRATUM:	Subsurface	Surface	Acid Canyon	Mid-Pueblo Canyon	Lower Pueblo Canyon	Lower Los Alamos Canyon	Northern N.M. Background Concentrations
Radioactivity Concentrations ($\bar{x} \pm s$)[a]							
^{239}Plutonium (pCi/g)							0.008 ± 0.010
Maximum in Stratum	35	163 000	630	88	15.5	9.3	
Average in Active Channel	6.3 ± 10.6		31 ± 29	1.1 ± 1.1	0.9 ± 0.5	0.24 ± 0.26	
Average in Inactive Channel			---	---	5.1 ± 3.6	0.15 ± 0.18	
Average in Banks		21 000 ± 49 000	110 ± 75	3.5 ± 4.0	6.4 ± 5.8	2.3 ± 3.0	
Other Isotopes							
Concentration Increment Above Background							
^{90}Sr (pCi/g)	0.1 - 10 (Range)	0.5 - 230 (Range)	1.0 ± 1.4	N.S.[b]	N.S.	N.S.	0.25 ± 0.27
^{137}Cs(pCi/g)	0 - 3 (Range)	0.1 - 180 (Range)	1.9 ± 4	N.S.	N.S.	0.27 ± 0.18	0.32 ± 0.30
Uranium (μg/g)	1 - 36 (Range)	1 - 600 (Range)	1.3 ± 1	N.S.	1.1 ± 0.6	2.0 ± 0.6	1.8 ± 1.3

TABLE 3.4-4 SUMMARY OF RADIOLOGICAL ANALYSES OF SOILS AND SEDIMENTS ASSOCIATED WITH THE TA-45 WASTE TREATMENT PLANT AND OUTFALL (CONTINUED)

STRATUM:	**Treatment Plant Site**		**Acid Canyon**	**Mid-Pueblo Canyon**	**Lower Pueblo Canyon**	**Lower Los Alamos Canyon**	**Northern N.M. Background Concentrations**
	Subsurface	**Surface**					
^{239}Plutonium Inventory Estimate							
Stratum Inventory (mCi, $\bar{x} \pm 2s_{\bar{x}}$)[c]			98.9 ± 52	74.6 ± 83.4	422 ± 281	34.8 ± 19.9	
Percent of Total (%)			15.7	11.8	66.8	5.7	
Distribution in Stratum							
Active Channel (%)			9	5	4	32	
Inactive Channel (%)			----	----	70	29	
Bank (%)			91	95	26	39	
Physical Characteristics							
Channel Length (m)			750	3250	6050	7400	
Average Width (m)			2.3	15	33	35	
Area with Greater than Background Concentration (m^2)	~3500	~500	~1750	~50 000	~200 000	~260 000	

[a] s denotes the standard deviation of the data population; in this particular table, the numerical value of $\bar{x} \pm s$ may be taken to represent the upper limit of the confidence interval on the mean with at least 95% confidence.

[b] N.S. means "no significant difference".

[c] $s_{\bar{x}}$ denotes the standard error of the calculated estimate; in this line $\bar{x} \pm 2s_{\bar{x}}$ may be taken as an approximate 95% confidence interval of the estimate.

(Modified from LANL 1981, 0141)

soil samples. Most soil samples were collected at a depth of 20 to 25 cm using a 2.5 cm diameter plastic pipe section; however, some scoop samples were collected at a depth of about 5 cm to provide verification of historical data (LANL 1981, 0141). The soil samples contained concentrations of ^{239}Pu above background levels in the stream channels and banks of both canyons, to a maximum of 88 pCi/g. As expected, the ^{239}Pu concentrations decreased with distance from the discharge points, and the channel banks contained higher concentrations of ^{239}Pu than the channels. The area of ^{239}Pu concentration extended over an area ranging from 15 to 35 m wide and 3,250 to 7,400 m long, and to a depth of about 30 cm (Table 3.4-4) (LANL 1981, 0141).

Other radioactive isotopes that were detected above background concentrations were ^{90}Sr, ^{137}Cs, and uranium. Table 3.4-4 summarizes data for these isotopes. The distribution of these isotopes was similar to the ^{239}Pu distribution; however the majority of these contaminants remained in the immediate area of the waste treatment plant and Acid Canyon (LANL 1981, 0141).

From the FUSRAP soil sampling data, estimates were made of the amount of ^{239}Pu in the affected canyons. The ^{239}Pu inventory pattern indicates that most of the plutonium is associated with the channel banks and inactive channels because these receive less intermittent stream flow. The majority of the plutonium, about 67%, was found in lower Pueblo Canyon (LANL 1981, 0141).

The FUSRAP survey estimated that the ^{239}Pu inventory in Acid Canyon was about 630 ± 300 mCi, or 7.9 ± 3.8 g, based on arithmetic means with an approximate 95% confidence interval. No inventory estimate was made for the treatment plant site upstream of Acid Canyon due to the erratic distribution of the ^{239}Pu concentrations and the small volume of potentially affected material relative to the canyon areas (LANL 1981, 0141).

3.4.2.2.2 FUSRAP Air Quality Sampling

To determine the potential for airborne radioactivity from resuspension of ^{239}Pu in Acid and Pueblo Canyons, data from the Laboratory's environmental surveillance program from 1974 through 1978 were compiled and reviewed from several monitoring stations. The stations selected included four on the mesa tops at various distances from Pueblo Canyon and other Laboratory facilities, one at the County-operated sewage treatment plant near the midpoint of lower Pueblo Canyon, and one in Santa Fe. New York City measurements were also included as an indicator of worldwide fallout (LANL 1981, 0141). A summary of ^{239}Pu airborne radioactivity potential is provided in Table 3.4-5. Conclusions from the data analysis were as follows:

1. Measurements of annual average ^{239}Pu concentrations found in Pueblo Canyon followed the same pattern as worldwide fallout.

TABLE 3.4-5 POTENTIAL CONTRIBUTIONS OF RESUSPENSION TO ^{239}Pu AIRBORNE RADIOACTIVITY

	^{239}Pu Concentration (aCi/m^3)[a]	Percent of DOE Concentration Guide (%)	Percent of Proposed EPA Derived Limit (%)
Analysis of Measured Airborne ^{239}Pu Concentrations (Lower Pueblo Canyon)			
Likely Maximum Annual Increment from Resuspension	3	0.005	0.3
Likely Maximum Short-Term Increment from Resuspension	170	0.3	17
Theoretical Contributions of Resuspension to ^{239}Pu Airborne Concentrations			
Acid Canyon	71	0.1	7
Middle Pueblo Canyon	25	0.04	2.5
Lower Pueblo Canyon	36	0.06	3.6
Lower Los Alamos Canyon	2.9	0.005	0.3
Range of ^{239}Pu from Worldwide Fallout 1974-1978 at Santa Fe, NM			
Low (1976)	3.8	0.006	0.4
5-year average	16	0.03	1.6
High (1978)	24	0.04	2.4

[a] aCi/m^3 is 1 x 10^{-18} curies/m^3; where "aCi" is "attocurie."

(Modified from LANL 1981, 0141)

2. The estimated airborne concentration of ^{239}Pu due to resuspension was 3 pCi/m^3, which was about 0.0005% of DOE guidelines or 0.3% of proposed EPA guidelines at that time.

3.4.2.2.3 FUSRAP Dosimetry Measurements

The potential for external penetrating radiation due to the presence of radioactive contaminants above background levels was addressed in the FUSRAP survey by actual measurements and theoretical calculation. Actual measurements were made during the first quarter of 1978 with thermoluminescent dosimeters (TLDs) placed at 20 locations in the vicinity of the former waste treatment plant site and along the various canyon bottoms. Measurements within the waste treatment plant site averaged 12 µrem/h. The measurements in the canyons averaged 12 to 19 µrem/h. Dose rates from above background concentrations were calculated for ^{137}Cs, uranium, ^{239}Pu and ^{241}Pu, and ^{241}Am. The estimated total contributions to doses from these isotopes are presented in Table 3.4-6 (LANL 1981, 0141).

3.4.2.3 FUSRAP - 1982 Remediation and Post-Remediation Survey

The FUSRAP survey determined that Lower Pueblo Canyon, on DOE-owned property, retained the largest inventory of radioactive material. Because the area was DOE property, corrective action in the lower Pueblo and lower Los Alamos Canyons was to be addressed at a later date. No further corrective action has been taken in the canyons to date. Corrective action alternatives were developed for the former TA-45 site and Acid Canyon because they were no longer under DOE control (Ferenbaugh et al. 1982, 0668). The Laboratory determined that the only areas at the TA-45 site where residual radioactivity exceeded the proposed FUSRAP soil cleanup criteria (Table 3.4-7) were the former vehicle decontamination facility (SWMU 45-002), the former untreated waste outfall (SWMU 1-002) and two small areas down gradient in Acid Canyon (Figure 3.4-3). The proposed action alternatives were to take no action; to fence the areas of residual contamination; or to clean up the areas around the former vehicle decontamination facility and the untreated waste outfall location. The Laboratory elected to perform additional removal of residual radioactivity (Ferenbaugh et al. 1982, 0668). The removal activities were calculated to have minimal effects on the public; FUSRAP calculations indicated that the annual dose having the greatest residual radioactivity would be about 12% of the applicable guideline at that time (Ferenbaugh et al. 1982, 0668).

Bechtel National Inc. (Bechtel) was retained to perform the remedial action at the former TA-45 site. Bechtel's scope of work included the construction of a temporary vehicle decontamination pad, the excavation and subsequent disposal of the contaminated material, and the sampling to verify that the site was within acceptable levels of radioactivity for unrestricted use (Bechtel National Inc. 1983, 06-0037).

TABLE 3.4-6 EXTERNAL PENETRATING RADIATION MEASUREMENTS AND ESTIMATES OF CONTAMINANT CONTRIBUTIONS (μrem/h)

Location	Measurement by TLD First Quarter 1978 $(\bar{X} \pm \sigma)$	Theoretical Contribution from Above Background Contaminants
Lower Los Alamos Canyon	12 ± 1	0.2[a]
Lower Pueblo Canyon	13 ± 1	<0.03
Middle Pueblo Canyon	16 ± 1	<0.01
Acid Canyon	19 ± 3	1.1[a]
TA-45 Site	19 ± 3	
Untreated Waste Outfall	16 - 18	50[b] (maximum)
Vehicle Decontamination Facility	22 - 26	40[a] (maximum)
LASL Surveillance Program Perimeter Group[c]		
First Quarter 1978	12 ± 1	
Four-Year Group Average	13.4 ± 1	
Range of Separate Station Values	9.4 - 17.4	

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[a] ^{137}Cs main contributor.

[b] ^{241}Am and ^{137}Cs main contributors.

[c] Not affected by Los Alamos operations.

(Modified from LANL 1981, 0141)

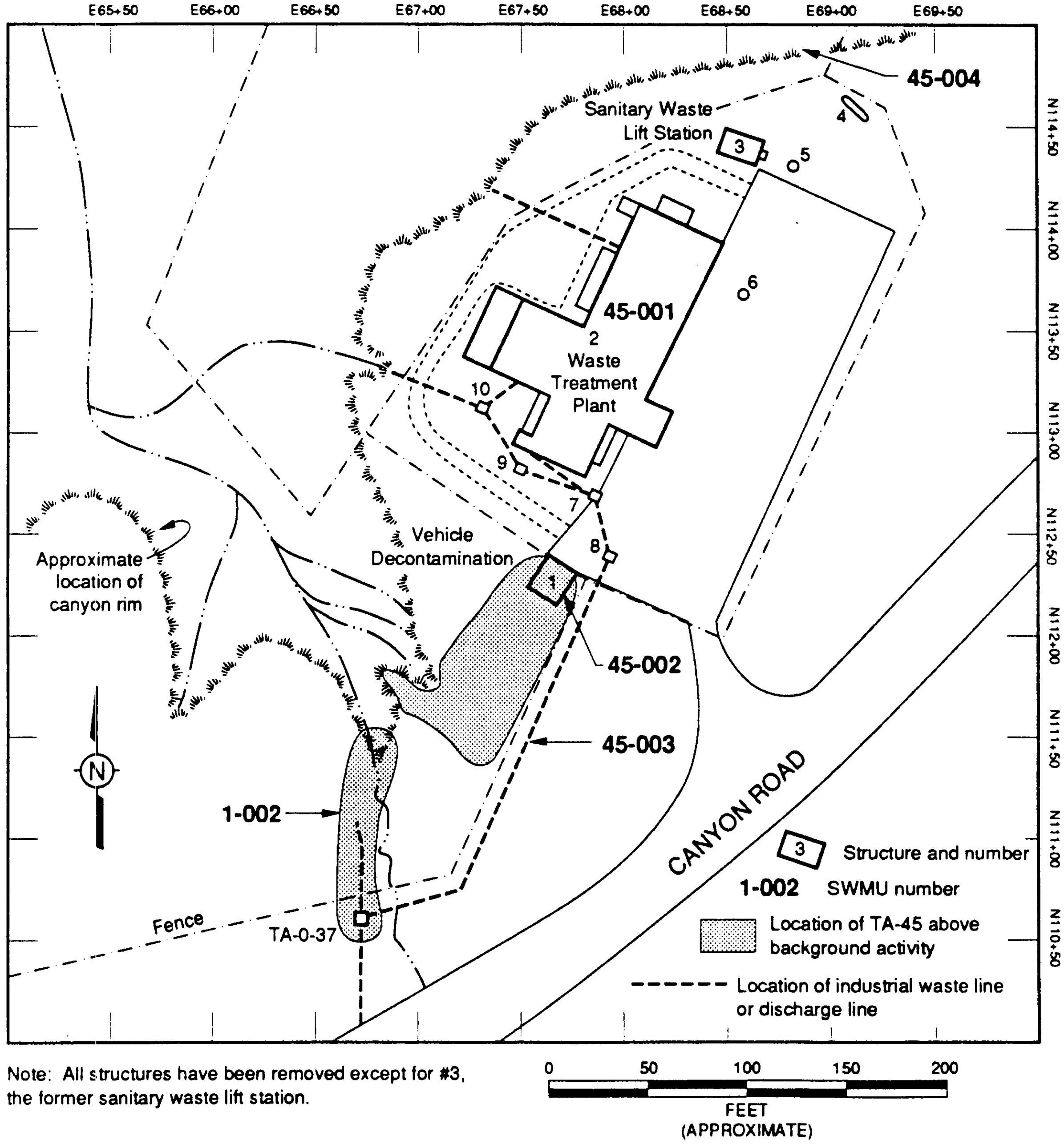
TABLE 3.4-7 SURFACE SOIL FUSRAP GUIDELINES

Radionuclide	Radionuclide Soil Guideline (RSG) (pCi/g above background)
^{241}Am[a]	20
^{241}Pu[a]	800
^{239,240}Pu[a]	100
^{238}Pu[a]	100
Natural uranium[b]	75
^{238}U[b]	75
^{230}Th[b]	300
^{226}Ra[b]	15
^{137}Cs[a]	80
^{90}Sr[a]	100
^{3}H (pCi/ml) soil moisture[a]	5200

[a] These guidelines are based on radiation exposure from a 100- by 100-m contamination area. The guidelines are the average radionuclide concentrations from the 100- by 100-m area.

[b] Guidelines for the radionuclides in the ^{238}U decay series are based on the assumption that a 140 by 140 by 1.5-m homogeneous waste field is exposed at the ground surface. The guidelines are the average radionuclide concentrations from the 140 by 140 by 1.5-m area.

(Modified from Gunderson et al. 1983, 0671)



Note: All structures have been removed except for #3, the former sanitary waste lift station.

Figure 3.4-3. Location of former structures, SWMUs, and areas of above background surface activity at TA-45 (modified from Bechtel National, Inc. 1983, 06-0037; LANL 1981, 0141).

At the time of the cleanup (1982), guidelines for soil decontamination at FUSRAP sites had not been issued. Soil guidelines developed in 1982 for a possible Acid and Pueblo Canyons cleanup project were used (Ferenbaugh et al. 1982, 0668). These guidelines are shown in Table 3.4-8. After the remedial action was completed, guidelines covering above-background concentrations of radionuclides in soils at FUSRAP sites were published by the DOE. These guidelines are shown in Table 3.4-7 (Gunderson et al. 1983, 0668). Both sets of guidelines were comparable with the exception of uranium concentrations, which allowed for approximately twice the concentration under the FUSRAP guidelines (75 versus 40 pCi/g). The actual FUSRAP guidelines were eventually adopted for the radiological survey report of the TA-45 site cleanup that the Laboratory issued in 1983 (Gunderson et al. 1983, 0671).

Bechtel began cleanup actions in August 1982. The corrective action area covered approximately 100 m^2. Pre-corrective action survey data that Bechtel extrapolated from Laboratory data in the FUSRAP survey is shown in Figure 3.4-4 and Table 3.4-9 (Bechtel National Inc. 1983, 06-0037). Radioactive contaminated material was removed by backhoe and placed in plastic-lined dump trucks and taken to Material Disposal Area G in TA-54. Hot spot excavation was completed manually and placed into 55-gal. drums with spades or shovels. The drums were also removed to the same disposal area. Initial soil sampling results indicated several small areas which required additional removal. This cleanup was performed during September 1982. A total of 390 yd^3 of contaminated material was excavated in both phases. Backfilling of the site was not performed because most of the material removed was barren sandstone and tuff and any backfill placed at the site might have washed away with subsequent precipitation events (Bechtel National Inc. 1983, 06-0037).

Following the first phase of remediation in August 1982, Laboratory Group H-8 conducted a radiological surface survey in the area where excavation had occurred. The results of this survey are shown in Figure 3.4-5 and Table 3.4-10 (Gunderson et al. 1983, 0671). The second remediation phase in September 1982 was performed to further remove isolated radioactivity due to elevated ^{239}Pu levels in the untreated waste outfall area (SWMU 1-002). Post-remedial sampling was completed by both Bechtel and Group H-8. The Bechtel results are shown in Figure 3.4-6 and Table 3.4-11 (Bechtel National Inc. 1983, 06-0037). Group H-8 results are shown in Figure 3.4-7 and Table 3.4-12 (Gunderson et al. 1983, 0671). Both surveys indicated that the additional removals placed the area within all FUSRAP guidelines.

The corrective action by Bechtel addressed only the former site of the TA-45 waste treatment plant (SWMU 45-001), and a small area at the headwaters of Acid Canyon (SWMU 1-002) (Figure 3.4-3). Data from the FUSRAP survey and current environmental surveillance data indicated that there is residual radioactivity still in Acid Canyon. The estimated ^{239}Pu concentration in the first 100 m of the active channel below the rim of Acid Canyon is 154 pCi/g. The maximum concentration measured was 629 pCi/g. The average concentration of ^{239}Pu in the active channel over the 750 m length of Acid Canyon is 30.6 pCi/g and the concentration in the banks of the active channel is 110 pCi/g (LANL 1981, 0141).

TABLE 3.4-8 PROPOSED CRITERIA FOR SOIL CLEANUP ACTION

Radionuclide	Concentration (pCi/g above background)
^{241}Am	20
^{239}Pu	100
^{238}Pu	100
^{238}U/^{239}U	40
^{232}Th	20
^{230}Th	280
^{228}Th	50
^{137}Cs	80
^{90}Sr	100

(Modified from Gunderson et al. 1983, 0671)

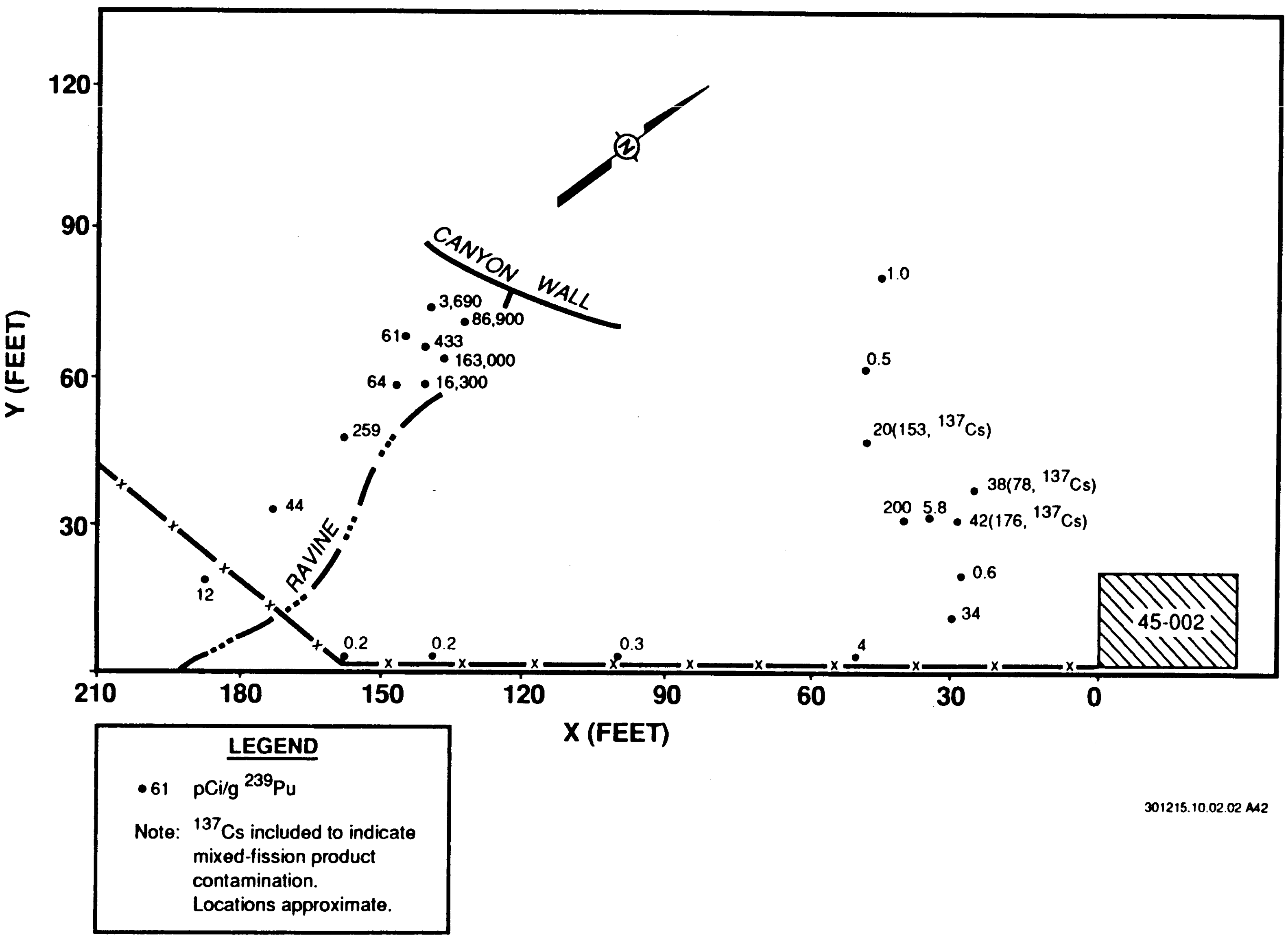


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Figure 3.4-4. Pre-remedial action concentration of ^{239}Pu in soil at TA-45 (modified From Bechtel National Inc. 1983, 06-0037).

TABLE 3.4-9 PRE-REMEDIAL ACTION RADIOLOGICAL SURVEY DATA-ACID CANYON[a]

COORDINATES[b]						
X	Y	^{239}Pu	^{238}Pu	^{241}Am	^{137}Cs	^{90}Sr
25	35	38.0	0.3	N/A	78	183.0
27	17	0.6	0.0	N/A	1.8	1.5
30	10	34.0	0.3	N/A	0.3	0.6
30	30	42.0	0.3	N/A	176.0	229.0
35	30	5.8	0.3	4.0	2.9	N/A
50	60	0.5	0.1	3.0	39.0	N/A
40	30	200.0	1.8	32.0	47.0	N/A
45	80	1.0	0.1	0.1	2.4	N/A
50	0	4.0	0.1	N/A	1.0	1.1
50	45	20.0	0.2	4.0	153.0	N/A
100	0	0.3	0.01	N/A	0.3	0.49
133	68	86,900.0	326.0	55.0	10.7	1.0
136	62	163,000.0	696.0	1,200.0	1.1	0.9
139	0	0.2	0.0	N/A	1.8	2.6
139	72	3,690.0	26.4	106.0	36.0	5.1
140	65	433.0	2.7	10.0	25.1	1.8
141	57	16,300.0	70.4	126.0	2.3	2.4
145	67	61.0	0.08	1.5	2.2	0.5
146	57	64.0	0.26	0.9	1.9	0.9
157	0	0.2	0.01	N/A	0.7	0.5
157	48	259.0	1.1	N/A	0.1	0.2
172	33	44.0	0.3	N/A	0.3	0.5
187	20	12.0	0.1	N/A	2.2	2.9

[a] Gunderson et al. 1983, 0671

[b] Coordinates based on extrapolation of data presented in Gunderson et al. 1983, 0671

N/A Not analyzed

(Modified from Bechtel National Inc. 1983, 06-0037)

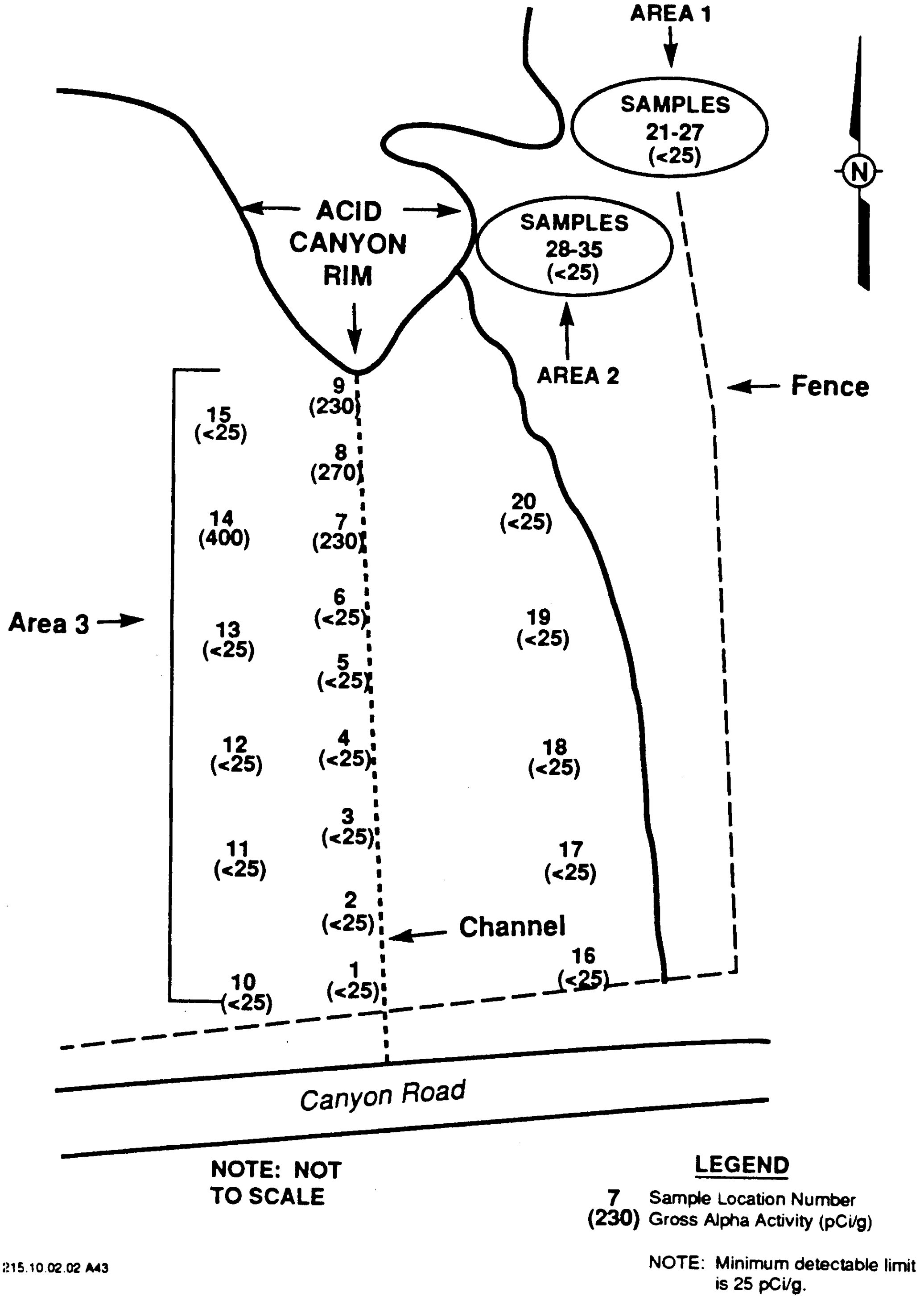

Figure 3.4-5. Gross-alpha activity (pCi/g) for surface soil samples from the radiological survey, August 16, 1982 (modified from Gunderson et al. 1983, 0671).

TABLE 3.4-10 RESULTS OF RADIOLOGICAL SURFACE SOIL SURVEY DONE ON AUGUST 16, 1982

Sample Number (Fig. 3.5-5)	Gross Alpha (pCi/g)	Gross Beta (pCi/g)	^{238}Pu (pCi/g)	^{239,240}Pu (pCi/g)	^{241}Am (pCi/g)	^{90}Sr (pCi/g)	^{137}Cs (pCi/g)
Minimum Detectable Limit	25	8	0.002	0.002	0.01	0.01	0.01
AREA 3							
Typical Background[a]	10±13		0.003±0.007	0.028±0.058	—	0.29±0.33	0.44±0.89
1	—	—					
2	—	—	0.001±0.002	0.23±0.02	0.5±0.2		0.003±0.001
3	—	—	0.004±0.004	0.48±0.04	0.7±0.2		0.003±0.001
4	—	—					
5	—	—					
6	—	—					
7	230±40	—	0.51±0.06	133±12	8.2±0.4		0.04±0.009
8	270±60	—	0.47±0.04	130±6	4.5±0.3		0.004±0.001
9	230±60	—	0.52±0.04	120±6	2.8±0.2		0.002±0.001
10	—	—					
11	—	—					
12	—	—					
13	—	—					
14	400±70	—	0.32±0.03	77±4	2.2 ± 0.2		0.004 ± 0.001
15	—	—					
16	—	—					
17	—	—					
18	—	—					
19	—	—					
20	—	—					
AREA 1							
21	—	—					
22	—	—					
23	—	—					
24	—	—					
25	—	—					
26	—	—					
27	—	—					

TABLE 3.4-10 RESULTS OF RADIOLOGICAL SURFACE SOIL SURVEY DONE ON AUGUST 16, 1982 (CONTINUED)

Sample Number (Fig. 3.5-5)	Gross Alpha (pCi/g)	Gross Beta (pCi/g)	^{238}Pu (pCi/g)	^{239,240}Pu (pCi/g)	^{241}Am (pCi/g)	^{90}Sr (pCi/g)	^{137}Cs (pCi/g)
			AREA 2				
28	—	212±12				88±6	17±1
29	—	258±14				101±8	5.3±0.5
30	—	106±10				46±4	5.5±0.4
31	—	106±10				59±4	3.5±0.3
32	—	60±10				26±1	2.0±0.3
33	—	212±12					
34	—	—					
35	—	—					

[a] ESG 1982, 0620. Typical background radionuclide concentrations in soils are averages of samples taken at six regional sampling locations in northern and central New Mexico during 1981.

Notes: (1) Gross-beta counting system was only calibrated for ^{90}Sr.
(2) Results reported with ± two standard deviations.
(3) — means sample activity was less than the minimum detectable limit. No entry means no analysis was made on the sample.
(4) The ^{238}Pu, ^{239,240}Pu, ^{241}Am, ^{90}Sr, and ^{137}Cs analyses were done using chemical dissolution and instrumental counting techniques. The gross-alpha and gross-beta analyses were counted with ZnS and plastic scintillator counting systems, respectively, on dried soil samples.

(Modified from Gunderson et al. 1983, 0671)

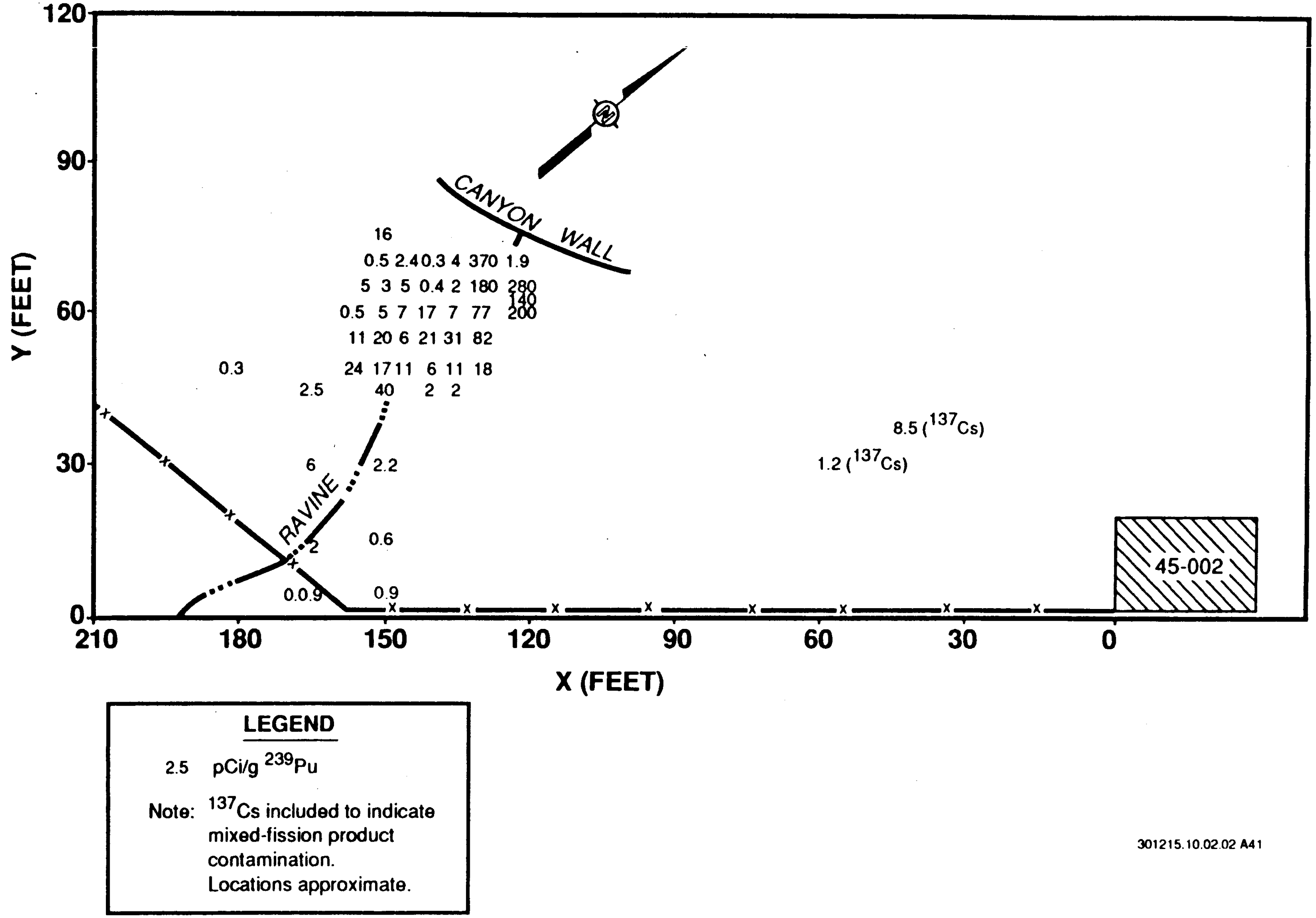

Figure 3.4-6. Post-remedial action concentration of ^{239}Pu in soil at TA-45 (modified from Bechtel National Inc. 1983, 06-0037).

TABLE 3.4-11 POST-REMEDIAL ACTION RADIOLOGICAL SURVEY DATA-ACID CANYON

COORDINATES		pCi/gram				
X	Y	^{239}Pu	^{238}Pu	^{241}Am	^{137}Cs	^{90}Sr
40	35	N/A	N/A	5.4±0.5	8.5±0.9	N/A
60	30	N/A	N/A	0.4±0.1	1.2±0.1	N/A
123	63	140±10	0.7±0.6	N/A	N/A	N/A
125	60	200±10	2±1	N/A	N/A	N/A
125	65	230±10	1.2±0.6	N/A	N/A	N/A
125	70	1.9±0.6	0.3±0.3	N/A	N/A	N/A
130	50	18±2	0.2±0.3	N/A	N/A	N/A
130	55	82±3	0.5±0.2	N/A	N/A	N/A
130	60	77±4	0.2±0.3	N/A	N/A	N/A
130	65	190±30	0.5±0.5	N/A	N/A	N/A
130	70	370±10	1.4±0.6	N/A	N/A	N/A
135	45	2±1	0.1±0.1	N/A	N/A	N/A
135	50	11±2	0.1±0.3	N/A	N/A	N/A
135	55	31±3	0.2±0.3	N/A	N/A	N/A
135	60	7±1	0.2±0.4	N/A	N/A	N/A
135	65	2±1	0.1±0.2	N/A	N/A	N/A
135	70	4±1	0.0±0.1	N/A	N/A	N/A
140	45	2±1	0.0±0.3	N/A	N/A	N/A
140	50	6±1	0.1±0.2	N/A	N/A	N/A
140	55	21±3	0.2±0.3	N/A	N/A	N/A
140	60	17±2	0.4±0.3	N/A	N/A	N/A
140	65	0.4±0.3	0.1±0.1	N/A	N/A	N/A
140	70	0.3±0.3	0.0±0.1	N/A	N/A	N/A
145	50	11±1	0.1	N/A	N/A	N/A
145	55	6±1	0.5±0.5	N/A	N/A	N/A
145	60	7±1	0.1±0.1	N/A	N/A	N/A

TABLE 3.4-11 POST-REMEDIAL ACTION RADIOLOGICAL SURVEY DATA-ACID CANYON (CONTINUED)

COORDINATES		pCi/gram				
X	Y	^{239}Pu	^{238}Pu	^{241}Am	^{137}Cs	^{90}Sr
145	65	5±1	0.4±0.4	N/A	N/A	N/A
145	70	2.4±0.4	0.1±0.1	N/A	N/A	N/A
150	45	40±2	0.8±0.3	1	1	0.9
150	50	17±2	0.2	N/A	N/A	N/A
150	55	20±3	0.6±0.5	N/A	N/A	N/A
150	60	5±1	0.0±0.1	N/A	N/A	N/A
150	65	3±1	0.2±0.3	N/A	N/A	N/A
150	70	0.5±0.2	0.0±0.1	N/A	N/A	N/A
150	75	16±1.5	0.07±0.15	1	2.3±0.2	1.2±0.5
150	0	0.9±0.3	0.06±0.08	1	1	1
150	15	0.6±0.3	0.003±0.009	1	0.1±0.1	0.6
150	30	2.2±0.5	0.4±0.2	0.3±0.3	0.6±0.1	0.6
155	50	24±1	0.1±0.1	N/A	N/A	N/A
155	55	11±1	0.1±0.1	N/A	N/A	N/A
155	60	0.5±0.2	0.0±0.1	N/A	N/A	N/A
155	65	5±1	0.1±0.2	N/A	N/A	N/A
165	0	0.09±0.13	0.05±0.09	1	0.1±0.1	0.7
165	15	2±0.5	0.08±0.13	1	0.3±0.1	0.9
165	30	6±0.8	0.4±0.2	1	1	0.6
165	45	2.5±0.5	0.3±0.2	0.3±0.1	0.3±0.1	0.6
180	50	0.3±0.2	0.2±0.2	1	1	0.7

N/A - Not Analyzed

(Modified from Bechtel National Inc. 1983, 06-0037)

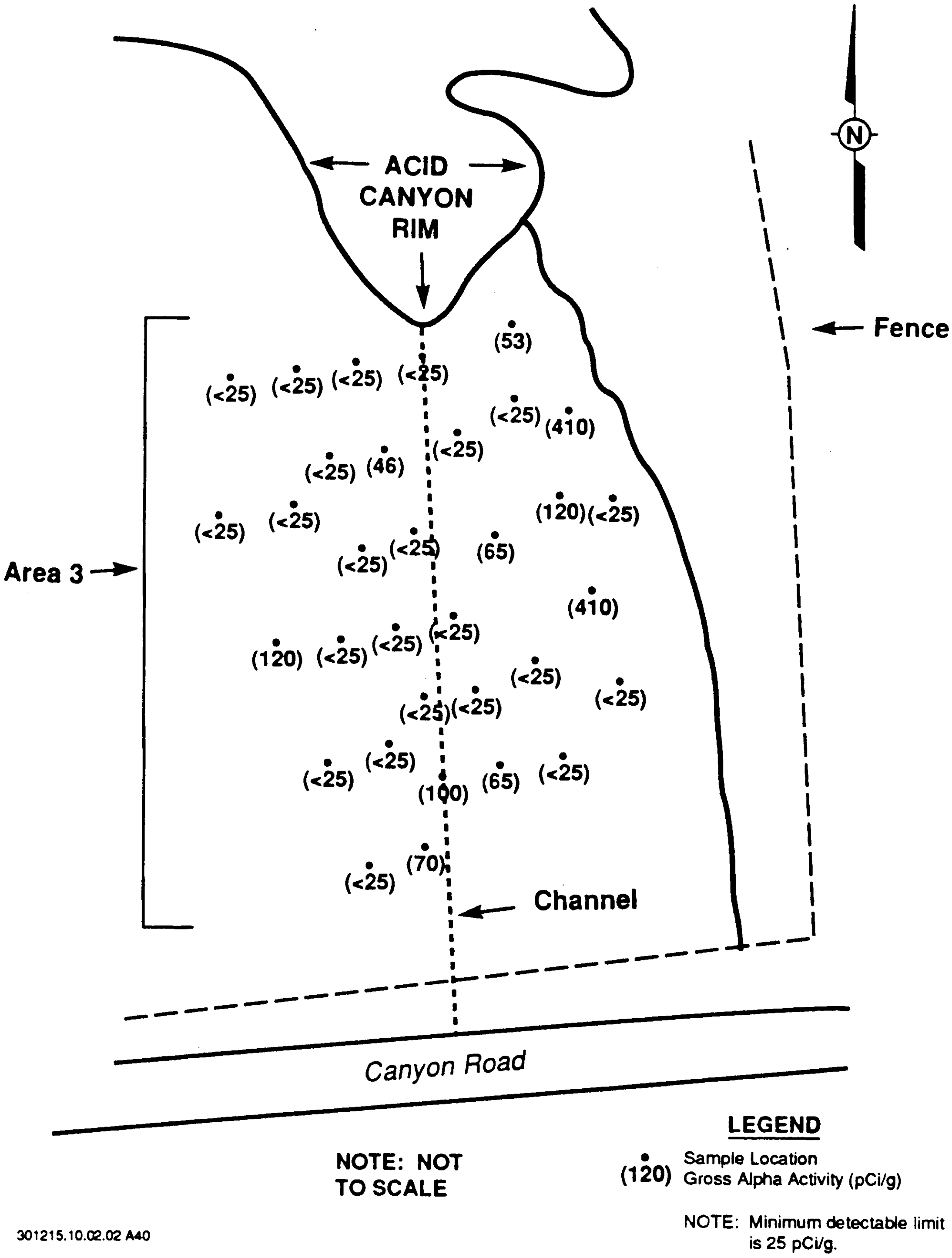

Figure 3.4-7. Gross-alpha activity (pCi/g) for surface soil samples from the radiological survey, November 1, 1982 (modified from Gunderson et al. 1983, 0671).

TABLE 3.4-12 RESULTS OF RADIOLOGICAL SURFACE SOIL SURVEY DONE ON NOVEMBER 1, 1982

Untreated Waste Line Discharge Area	
Sample Number	Gross Alpha (pCi/g)
1	a
2	a
3	120±40[b]
4	a
5	—
6	70±50
7	a
8	a
9	a
10	a
11	100±50
12	a
13	a
14	a
15	a
16	a
17	65±38
18	a
19	a
20	a
21	46±48
22	a
23	a
24	a
25	65±38
26	a
27	a
28	a
29	410±60
30	120±60
31	a
32	a
33	410±60
34	53±49
35	a

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[a] Sample activity is less than the minimum detectable limit of about 25 pCi/g.

[b] All results reported as X ± 2s.

NOTE: All Samples analyzed for gross-beta activity were less than minimum detectable limit, except for Sample Number 33, which had a gross beta concentration of 23 ± 2 pCi/g.

(Modified from Gunderson et al.1983, 0671)

No further corrective action was performed in Acid Canyon by Bechtel because of the rough terrain and limited contamination migration pathways. Pathways included resuspension/inhalation and erosion into Lower Pueblo Canyon where possible gardening could occur. Post-corrective action external exposure rates are shown in Table 3.4-13 and within FUSRAP guidelines (Bechtel National Inc. 1983, 06-0037).

3.4.3 Treatment Plant SWMU Aggregate

This aggregate consists of SWMUs 1-002, 45-001, 45-003 and AOC C-45-001: the untreated industrial waste (acid waste) outfall, the radioactive waste water treatment plant, associated industrial waste (acid waste) lines, and the former parking lot area. The geographic areas describing these SWMUs are depicted as areas 1, 2, and 4 in Figure 3.4-8.

3.4.3.1 Untreated Outfall (SWMU 1-002)

3.4.3.1.1 SWMU Description and Historical Operation

Prior to construction and operation of the TA-45 waste treatment facility in 1951, the radioactive liquid wastes generated from nuclear research conducted in the Main Technical Area (TA-1) were discharged untreated to an outfall (SWMU 1-002) at the edge of Acid Canyon (Figure 3.4-1; Figure A-01-1, Appendix A). The outfall was subsequently incorporated into TA-45. The radioactive liquid waste was routed through TA-1 to the outfall by an industrial waste line system referred to as the industrial waste (acid waste) sewer system. The untreated radioactive liquid waste contained a variety of radioactive isotopes resulting from research and processing operations associated with nuclear weapons development. Records describing the exact nature and quantity of the untreated waste discharged during the period 1943 through 1951 are not available; however, it is reported that isotopes of strontium, cesium, plutonium, uranium, americium, and tritium were part of the waste stream (LANL 1981, 0141). Estimates of the quantities of major isotopes released in the untreated liquid waste are summarized in Table 3.4-14 (LANL 1981, 0141). Approximately 18 x 10^3 m^3 of untreated radioactive liquid waste was released annually into Acid Canyon between the years 1943 and 1951, with average concentrations of total plutonium (predominantly ^{239}Pu) ranging from 1,000 pCi/l to approximately 10,000 pCi/l. Based on effluent information/estimates, approximately 1.9 g of plutonium was released to Acid Canyon in the untreated liquid waste between 1943 and 1951; however, the total estimated ^{239}Pu inventory in Acid Canyon is 7.9 ± 3.8 g (LANL 1981, 0141).

TABLE 3.4-13 POST-REMEDIAL ACTION EXTERNAL EXPOSURE RATES (INCLUDING BACKGROUND)[a]

Coordinates X	Y		Exposure Rate (µR/hr)
FORMER VEHICLE DECONTAMINATION FACILTY			
35	30		31.7
40	30		22.3
45	40		22.1
45	45		19.3
50	45		21.3
		AVERAGE	23.3
UNTREATED WASTE OUTFALL			
135	60		18.0
140	50		18.5
140	55		19.0
140	60		16.8
145	45		17.2
150	0		14.4
150	5		16.0
150	10		16.7
150	15		17.0
150	20		17.1
150	25		16.9
150	30		17.6
150	35		17.6
150	40		16.8
150	45		16.9
150	50		16.9
150	55		17.3
150	60		17.4
150	65		16.8
150	70		17.5
150	75		17.4
155	0		14.6
155	5		14.8
155	10		16.7
155	15		16.6
155	20		16.6
155	25		17.5
155	30		16.8
155	35		16.8
155	40		17.1
155	45		16.6
155	50		17.7

TABLE 3.4-13 POST-REMEDIAL ACTION EXTERNAL EXPOSURE RATES (CONTINUED) (INCLUDING BACKGROUND)[a]

Coordinates X	Y	Exposure Rate (μR/hr)
155	60	17.2
160	0	15.1
160	5	14.7
160	10	15.3
160	15	16.0
160	20	15.9
160	25	17.8
160	30	17.1
160	35	16.6
160	40	16.4
160	45	17.3
160	50	17.6
160	55	17.7
160	60	17.4
160	75	16.2
165	0	14.5
165	5	16.3
165	10	15.4
165	15	16.2
165	20	15.6
165	25	16.9
165	30	16.5
165	35	16.3
165	40	17.0
165	45	17.0
165	50	17.6
165	55	17.7
165	60	17.4
170	0	15.9
170	30	16.2
170	40	16.7
170	45	16.7
175	50	16.6
180	50	16.6
185	50	15.5
	AVERAGE	16.7

[a] Background exposure rates in the Los Alamos Area range from 9.4 to 17.4 μR/hr

(Modified from Bechtel National Inc.1983, 06-0037)

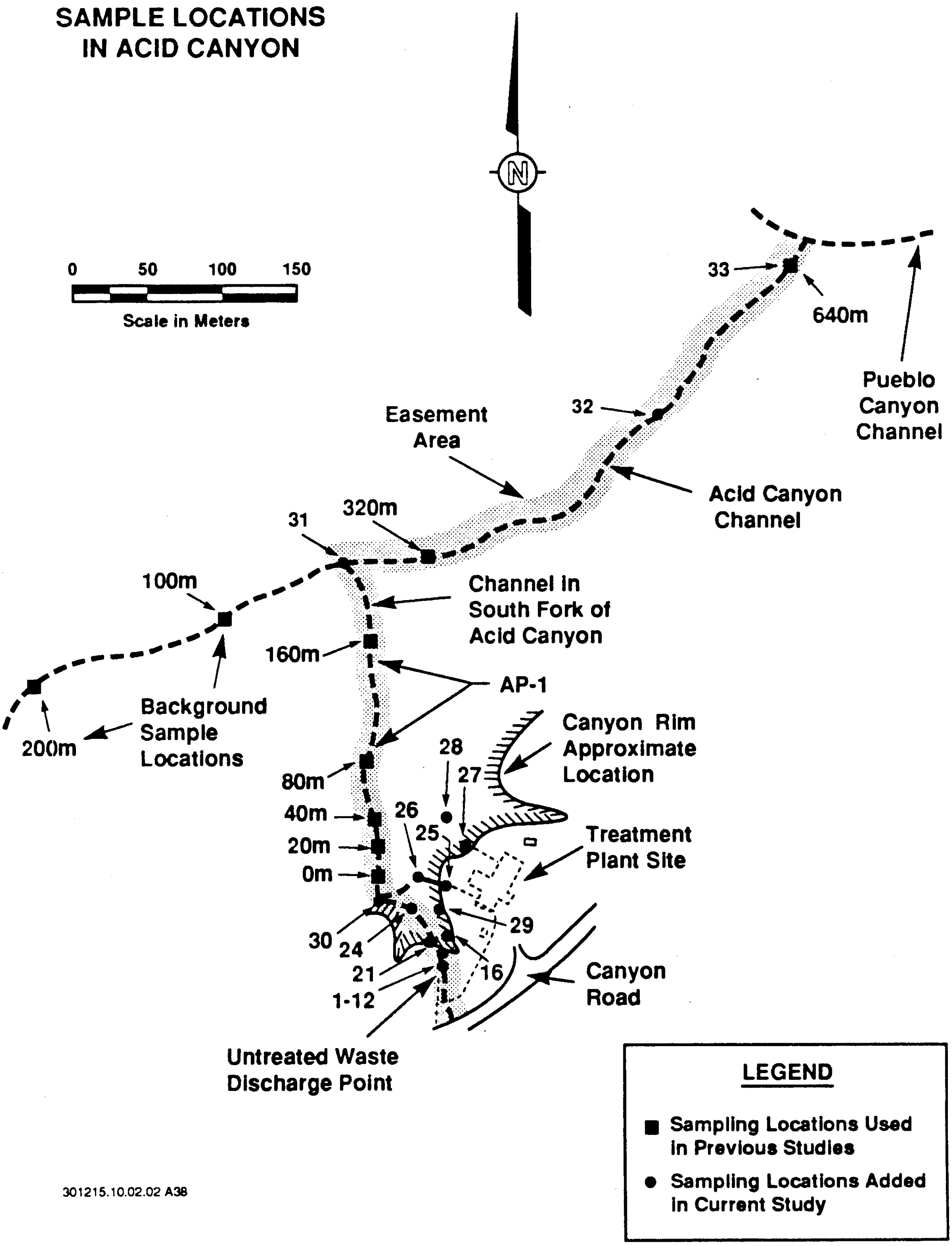

Figure 3.4-8. Sampling locations in Acid Canyon (modified from LANL, 1981, 0141).

TABLE 3.4-14 RADIOACTIVITY CONTENT OF EFFLUENTS RELEASED TO ACID CANYON[a]

Untreated Effluents, 1943 - April 1951

	Isotope (curies)			
	^{3}H[b]	^{89}Sr	^{90}Sr	Pu[c]
Estimated Total Releases	18.25	0.25	0.94	0.15
Activity Decayed to Dec. 1977[e]	3.4	0	0.046	0.15

Treated Effluents, April 1951 - June 1964

	Isotope (curies)			
Annual Release	^{3}H[c]	**Unidentified Gross α**	**Unidentified Gross β & γ**	**Pu[b]**
1951	3	0.0024		0.0013
1952	3	0.0041		0.0011
1953	3	0.0038		0.0012
1954	3	0.0044		0.0022
1955	3	0.0041		0.0022
1956	3	0.0060		0.0011
1957	3	0.0087		0.0009
1958	3	0.0038		0.0009
1959	3	0.0018		0.0012
1960	3	0.0035	1.251	0.0026
1961	3	0.0093	0.505	0.0053
1962	3	0.0074	1.222	0.0039
1963	3	0.0072	0.804	0.0030
1964	1.2	0.0001	0.0001	0.00004
Total Release	40.2	0.0666	3.78	0.0269
Activity Decayed to Dec. 1977[e]	13.1	d	d	0.0269

[a] Measured and estimated data as compiled for and summarized in the U.S. DOE Onsite Discharge Information System (ODIS).

[b] All tritium values estimated.

[c] Total plutonium, predominantly ^{239}Pu, but includes small amounts of other isotopes. Reported in ODIS as ^{239}Pu.

[d] No estimate of decayed value made because data on isotopic mixtures are not available. The gross α is assumed to be predominantly plutonium and uranium; therefore, little decay would have occurred. If the gross β and γ is assumed to be largely ^{90}Sr and ^{137}Cs, then decayed value would be about 70% of total released.

[e] Decay based on year of release and appropriate half-life.

(Modified from LANL 1981, 0141)

3.4.3.1.2 SWMU Investigations and Remediation

Soil and water samples were collected from industrial waste (acid waste) and sanitary sewer outfall locations between 1945 and 1947 to determine levels of radioactivity associated with discharges of industrial and sanitary wastes from Laboratory operations. Results of the sample analyses confirmed the presence of radioactivity in the vicinity of the main industrial waste (acid waste) sewer outfall (SWMU 1-002), the canyon walls, and stream channels (Kingsley 1947, 0680; Tribby and Kingsley 1947, 0686; LANL 1981, 0141). Plutonium concentrations in the vicinity of the industrial waste (acid waste) outfall were detected up to 10,700 pCi/l in surface water samples (LANL 1981, 0141).

Prior to the initiation of the decontamination activities at TA-45, alpha activity was measured with field instruments. The outlet pipe for the untreated outfall, the mesa top weir box, and the area downgradient from the outlet pipe were found to be contaminated. During the decontamination and decommissioning, the outlet pipe was removed to the north side of Canyon Road. The weir box, soil, and tuff were removed from the mesa top and down the untreated outfall cliff face. All this contaminated material was taken to MDA-G at TA-54.

Many soil samples were taken in the area of SWMU 1-002 (Figure A-01-3, Appendix A) and its corresponding drainage during the FUSRAP survey (Figure 3.4-9). The highest concentrations of ^{239}Pu in surface soil for the entire TA-45 area was encountered in the untreated outfall location, to a maximum of 163,000 pCi/g (location 9 on Figure 3.4-9). The area of surface activity was approximately 30 m wide, 5 m long, and 30 cm deep. One vertical transect line down the cliff face where the untreated effluent had flowed was surveyed for radioactivity using portable field instruments. No significant levels of activity were found (LANL 1981, 0141).

Based on the FUSRAP survey results, Bechtel performed additional remediation at the TA-45 site in 1982. During this remedial effort, additional soil and tuff were removed along the drainage of the untreated outfall and its drainage channel. This remediation effort placed the site of SWMU 1-002 within established FUSRAP guidelines (Bechtel National Inc. 1983, 06-0037).

3.4.3.1.3 Nature and Extent of Existing Contamination

The 1977 FUSRAP investigation report (LANL 1981, 0141), the Bechtel remediation report (Bechtel National Inc. 1983, 06-0037), and a post-remediation monitoring report prepared by Laboratory personnel (Gunderson et al. 1983, 0671) document the radiological sampling and subsequent remediation efforts for the TA-45 site (see Subsections 3.4.2.2 and 3.4.2.3). These reports represent the most current data available to characterize the site.

To establish current site conditions, a composite data set was prepared by merging data from the FUSRAP report (LANL 1981, 0141) with post-remediation

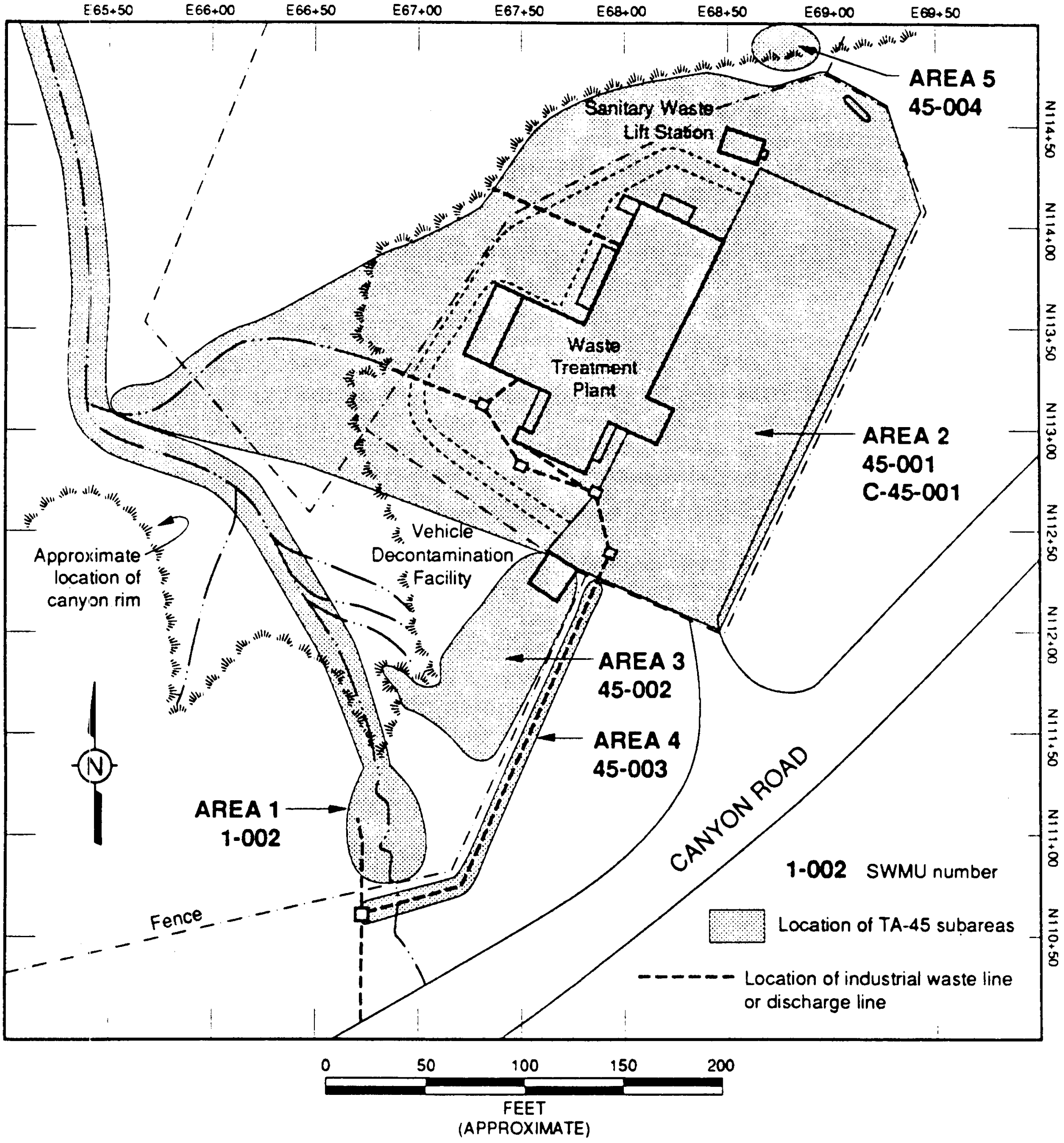

Figure 3.4-9. Location of five geographic areas and related SWMUs at TA-45 (modified from LANL 1981, 0141).

data from the Bechtel remediation report (Bechtel National Inc. 1983, 06-0037). This composite data set is provided in Appendix B of this work plan and contains 123 locations comprised of surface (0-5 cm), core (0-25 cm), and trench (0-120 cm) samples. For most of these locations, gross-alpha activity levels were reported, and for a number of sample locations, radiological analyses results for ^{239}Pu, ^{90}Sr, and ^{137}Cs were also reported. Strontium-90 and ^{137}Cs were not considered to be a problem at the site because most of the ^{90}Sr and ^{137}Cs levels were below 1.0 pCi/g, well below the FUSRAP action levels for ^{90}Sr and ^{137}Cs of 100 pCi/g and 80 pCi/g, respectively (Table 3.4-8). However, some of the gross-alpha and plutonium levels exceeded 100 pCi/g, which was the FUSRAP action level for plutonium. Analyses showed that ^{239}Pu was the main contributor to the gross-alpha readings (Gunderson et al. 1983, 0671). Consequently, the data for plutonium and gross-alpha have been used to establish current radiological site conditions. Figure 3.4-10 provides the sampling locations and results for the composite data set. No current data on chemical contamination exists for the TA-45 site.

Bubble plots of the gross-alpha and plutonium levels for the composite data set are shown in Figures 3.4-11 and 3.4-12. The area of a bubble is proportional to the gross-alpha activity or the ^{239}Pu concentration. The shading of a bubble indicates whether the sample was a surface (open), core (hatched), or trench sample (solid).

In addition to the composite data set, the post-remediation report prepared by the Laboratory (Gunderson et al. 1983, 0671) provides gross-alpha activity data for the remediated area near the untreated waste outfall (SWMU 1-002). These data were collected after the site was remediated twice by Bechtel in 1982. The exact locations of these samples were unavailable, however, the approximate locations and the gross-alpha levels are shown in Figure 3.4-7. This data set is also provided in Appendix B of this work plan.

Gross-alpha Activity

For the area that comprises SWMU 1-002, shown as area 1 in Figure 3.4-8, the highest gross-alpha activity levels occur near the headwaters of Acid Canyon, below the outfall of the untreated industrial waste (acid waste) line. The maximum gross-alpha activity measured at this location is 580 pCi/g. The canyon channel was not reported to have been remediated during the 1982 remediation effort (Bechtel National Inc. 1983, 06-0037).

^{239}Pu Activity

The ^{239}Pu activity for the area that comprises SWMU 1-002 is elevated near the untreated waste outfall (Figure 3.4-12). There are seven values of ^{239}Pu activity above 100 pCi/g and their locations generally correspond to the elevated values for gross-alpha activity. The highest value (629 pCi/g) is directly below the outfall and coincides with the location of the greatest measured gross-alpha activity.

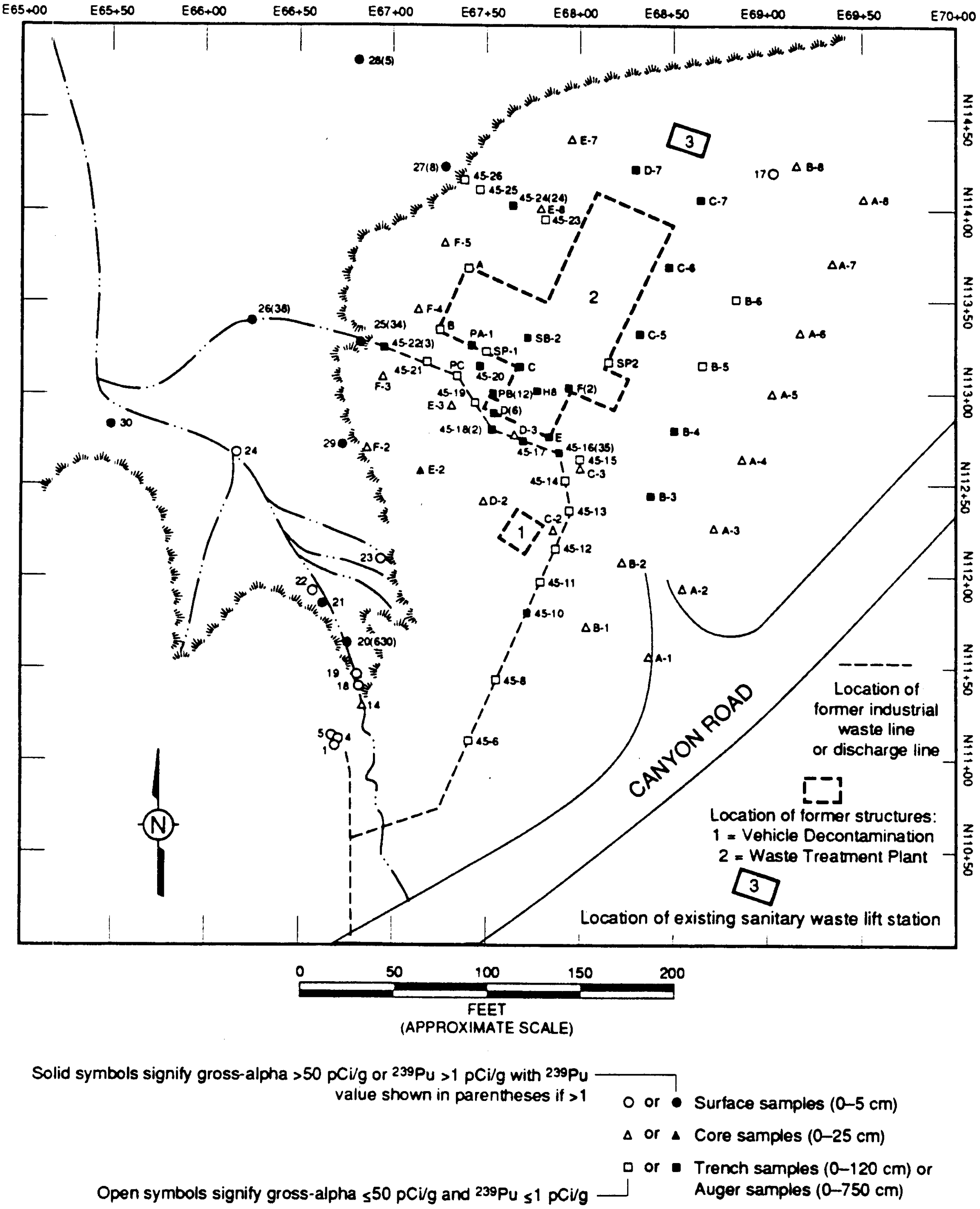

Figure 3.4-10. Sampling locations and composite data set summary results, TA-45 treatment plant site and part of Acid Canyon (modified from LANL 1981, 0141; Bechtel National Inc. 1983, 06-0037).

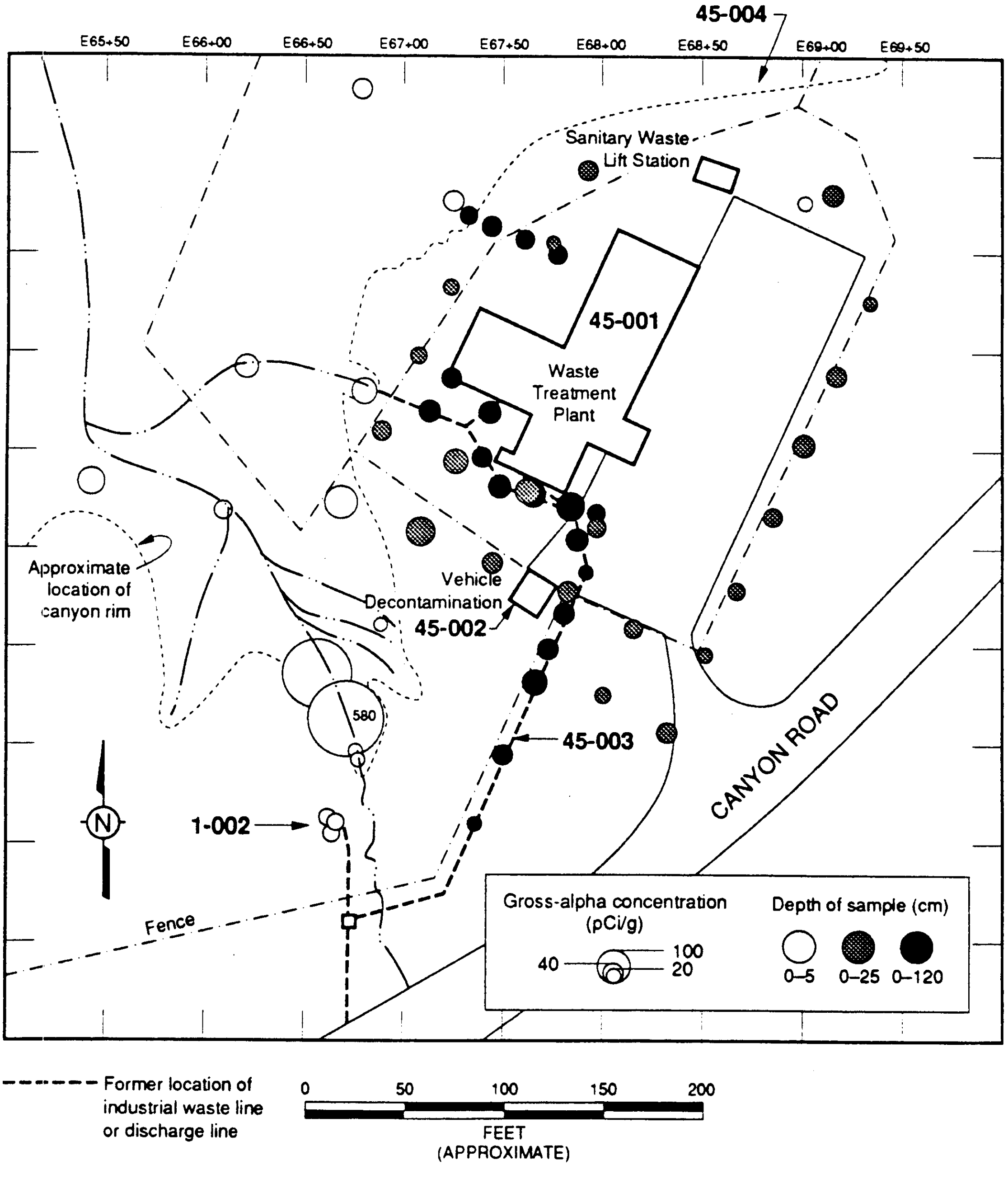

Figure 3.4-11. Post-remediation gross-alpha activity (pCi/g) at sample locations in TA-45 (modified from LANL 1981, 0141; Bechtel National Inc. 1983, 06-0037).

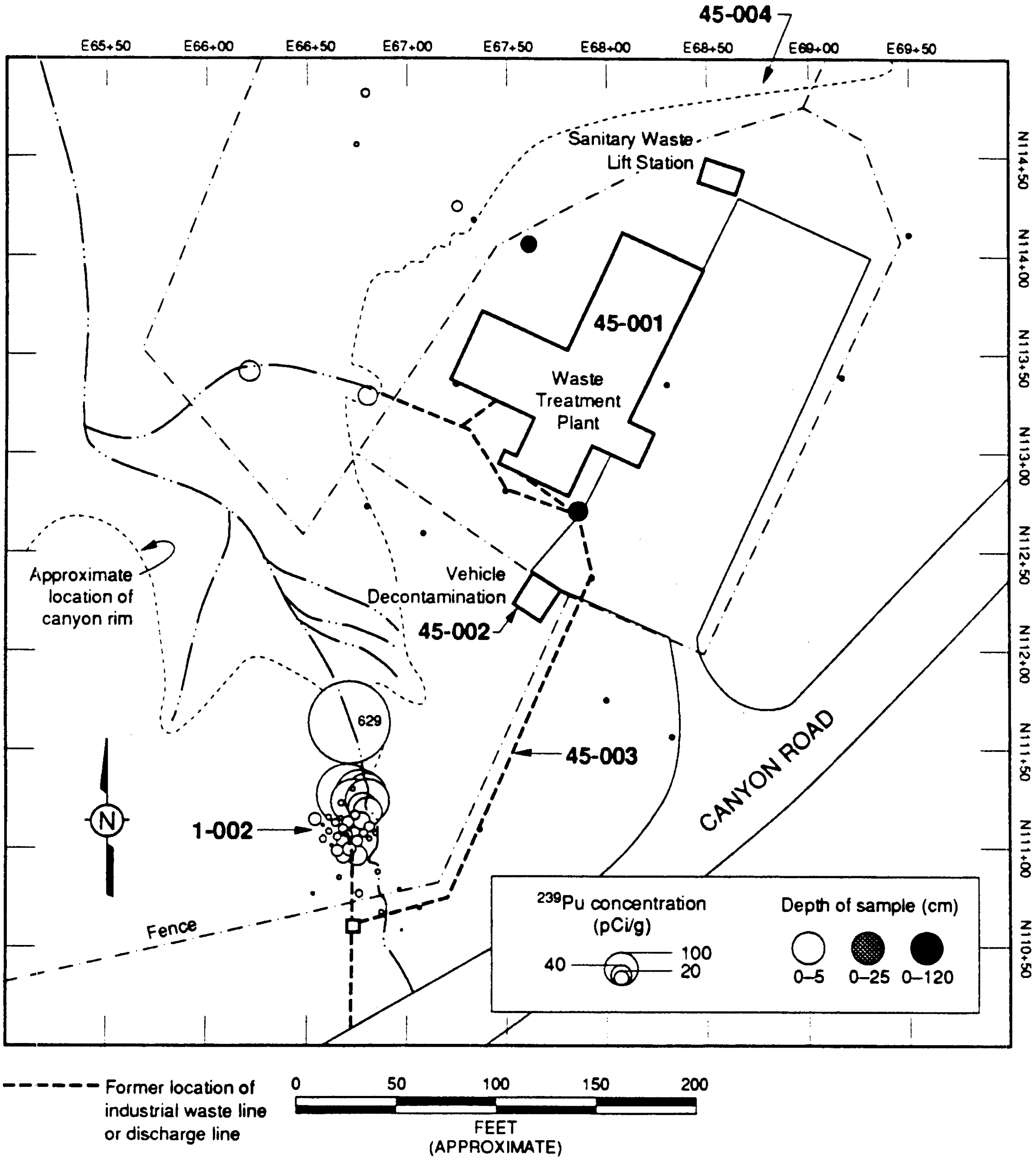

Figure 3.4-12. Post-remediation ^{239}Pu sample locations at TA-45 (modified from LANL 1981, 0141; Bechtel National Inc. 1983, 06-0037).

At some point after the TA-45 site was decontaminated and decommissioned, a storm sewer was installed that discharges into the same drainage as the former untreated wasted line. This installation changed the topography above the outfall and could produce intermittent dispersal of any residual contamination in the drainage.

Very low levels of ^{137}Cs (145 10^{-9} µCi/mL) and ^{239,240}Pu (0.082 10^{-9} µCi/mL) were found in surface water samples collected in Acid Canyon at Acid Weir in a study of radiochemical quality of surface and ground waters from effluent release areas described in the 1989 Environmental Surveillance report (Environmental Protection Group 1990, 0497). Sediment (and other water) samples collected over the years from 1978 to 1990 at Acid Weir also indicate levels of ^{137}Cs and ^{239,240}Pu as well as ^{238}Pu, ^{241}Am, gross-alpha and gross-beta activity less than 20 pCi/g. A summary of all environmental surveillance data collected from Acid and Pueblo Canyons is contained in Appendix C of this work plan.

3.4.3.2 Treatment Plant, Industrial Waste (Acid Waste) Lines, and the Former Parking Lot Area [SWMUs 45-001,45-003, and AOC C-45-001]

3.4.3.2.1 SWMU Description and Historical Operation

In 1948, the Laboratory and the U.S. Public Health Service developed a method for removing plutonium and other radionuclides from radioactive liquid waste (LANL 1981, 0141). The design and eventual construction of the TA-45 waste treatment plant followed (SWMU 45-001), and by June 1951, the TA-45 plant began treating radioactive liquid wastes from TA-1 (Figure A-45-1, Appendix A). The wastes were treated by a flocculation-sedimentation-filtration process. "Alpha activity was concentrated into the ferric hydroxide floc at high pH by the addition of calcium hydroxide, sodium carbonate, ferric sulfate, and a nonionic coagulant to the influent. Coarse floc was settled out in sedimentation tanks, collected for vacuum filtration, and placed in drums for burial in a solid radioactive waste disposal area within the present Los Alamos Laboratory site. Finer floc was removed in sand or anthrafilt filters. The final effluent, containing about 1% of the influent plutonium concentration, was sampled prior to release into Acid Canyon" (LANL 1981, 0141). During the plant's operations, plutonium concentrations in the final effluent ranged from approximately 20 to 150 pCi/l. A summary of the amount of radioactive material released annually in the treated effluent is shown in Table 3.4-14. Influent liquid waste characteristics are presented in Table 3.4-15. Approximately 0.34 g of plutonium were released in the treated effluent during the 14 years the TA-45 treatment plant operated (LANL 1981, 0141).

In 1953, the main Laboratory facilities were relocated to the South Mesa site (TA-3). Radioactive liquid wastes from TA-3 were piped to the TA-45 waste treatment plant. To accommodate the additional waste handling, a 40,000 gal. tank (designated as TA-3-700 or SM-700) was constructed near TA-3 for neutralization and storage of waste prior to treatment at TA-45. The tank was equipped with automatic pH sensing equipment and was connected to the TA-45 plant by

TABLE 3.4-15 WASTE CHARACTERISTICS (RADIOACTIVITY) 1954-1963

		TA 1/3/43/48 Gross-Alpha (1,000 d/m-l)			
Year	**TA 3/43/48 Flow (10^4 Liters)**	**Monthly Average**	**Monthly Maximum**	**Monthly Minimum**	**Pu (mg)**
1954	12.7	9.8	20.8	2.5	2604
1955	13.6	4.8	8.8	2.0	1032
1956	14.3	4.2	7.4	1.2	794
1957	17.0	7.2	21.0	3.4	1429
1958	16.9	9.4	17.5	3.6	1567
1959	26.7[a]	14.2	26.0	7.0	3577
1960	41.1[b]	13.3	71.6	9.2	5296
1961	52.9	9.8	31.4	10.8	5686
1962	64.1	7.4	26.4	7.8	4906
1963	29.7[c]	14.7	19.6	11.4	2142

[a] Transfer of operations from TA-1 to TA-3 resulted in a marked decrease in flow from TA-1 and increase from TA-3 for July and following. For December, TA-1 was 340,000 liters and further recording of separate TA-1/TA-3 influent flows was discontinued.

[b] For 1960 and beyond, the flow indicated is a total of that from TA-1, TA-3, TA-43, and TA-48.

[c] After June 27, 1963, all TA-3 and TA-48 waste was pumped to TA-50. This figure is a total of the TA-1, TA-3, TA-43, and TA-48 Waste to TA-45 from January 1 to June 27, 1963. Activity figures are also confined to the first 6 months of the year.

(Modified from LANL 1981, 0141)

approximately 1-1/4 miles of 3- to 4-in.-diameter cast iron pipe (AEC 1954, 06-0035). The tank was valved to automatically discharge liquid wastes from TA-3 to TA-45 if treatment was required to maintain the two-week effluent average for radioactivity adopted from the National Bureau of Standards Handbook 52. The guideline average was 165 cpm/l or 330 dis/min/l. If the radioactive liquid wastes were below this activity level, wastes were discharged untreated to Los Alamos Canyon. In July 1953, only 3% of the radioactive liquid wastes from TA-3 were discharged to the TA-45 waste treatment plant. By December of 1953, more than 70% of the TA-3 radioactive liquid wastes warranted treatment at TA-45. Additionally, flow from the original Laboratory site (TA-1) had increased rather than decreased and liquid wastes from the Health Research Laboratory (TA-43) were routed to TA-45 for treatment. Between January and December of 1953, the flow rate to the plant had increased from 16,000 to nearly 30,000 gal./day (AEC 1954, 06-0035). In 1957, the Radiochemistry Building was completed (TA-48) and radioactive liquid wastes from that operation were connected to the industrial waste (acid waste) sewer line connecting TA-3 to the TA-45 waste treatment plant (SWMU 45-003) (LASL 1958, 0683). TA-48 radioactive liquid wastes included fission products which resulted in higher gross-beta and gross-gamma activity in the TA-45 effluent (LANL 1981, 0141).

The TA-45 waste treatment plant (SWMU 45-001) also received some special wastes which required pretreatment. These wastes included cyanide plating solutions from electroplating shops, which were treated with caustic and chlorine prior to discharge into the plant influent, and acid pickling solutions which may have been from the Sigma Building (H-Division 1955, 0673; H-Division 1956, 0674; H-Division 1958, 0490). Additionally, approximately 10 g of trinitrotoluene (TNT) may have entered the industrial waste (acid waste) sewer system during the TA-45 operating period. Approximately 90 to 95% of the TNT degraded in the waste treatment process (LASL 1965, 06-0028).

In 1957, the waste treatment plant was modified to accommodate the increased monthly flow. The modifications included an increase in diameter of the effluent lines from the flocculation tanks to the settling basins, replacement and/or overhaul of the rate-of-flow controller, and installation of a circulating pump in the settling basin effluent line. The liquid waste treatment rate was increased from 90 to 145 gal./min without adverse effect on effluent quality (H-Division 1957, 0474; LASL 1958, 0683).

Throughout the TA-45 plant operation, several unplanned releases occurred:

- In January 1957, a release of plutonium-contaminated sludge occurred in the parking area south of the TA-45 treatment plant (AOC C-45-001). An area of the parking lot and a layer of soil near the treatment plant was excavated to a depth of one and one-half ft. No information on post excavation activity levels was available (H-Division 1957, 0675).
- In May 1957, a droplet of ^{90}Sr solution was dropped on the floor of the laboratory at the TA-45 waste treatment plant. Before the incident was discovered, the radioactivity had been inadvertently transported to

private homes and cars by employees. The laboratory floor, homes, and cars were subsequently decontaminated (LASL 1957, 06-0025).

- An accidental discharge of plutonium-contaminated sludge occurred in November 1958, and reportedly increased the gross alpha levels in the soil of the Acid Canyon stream channel for several months (Abrahams 1962, 0230).
- In 1960, contamination was detected in the basement of the waste treatment facility. Alpha readings were 5,000 counts/min. The radioactivity resulted from a hose leak in the vicinity of the sludge pumps. A daily survey of radioactivity in the release area was initiated for an unknown length of time (H-Division 1960, 0678).

In July 1963, the radioactive liquid wastes from TA-3 and TA-48 were piped to a new Central Waste Treatment Plant (TA-50) located south of Los Alamos Canyon within the present Laboratory site. Additionally, the liquid wastes from TA-43 were piped to the sanitary sewer due to the small volumes of very low activity wastes being generated at that time. Between July 1963 and May 1964, only radioactive liquid wastes from TA-1 were processed at the TA-45 waste treatment plant. Some untreated radioactive liquid wastes (low level), containing fission products from decommissioning of Sigma Building at TA-1, were released until June 1964 (LANL 1981, 0141). The small amount of untreated radioactive liquid waste from TA-1 was discharged into Acid Canyon in May 1964, so that decontamination and decommissioning operations of the TA-45 site could proceed at a faster rate (Fowler 1964, 06-0021).

3.4.3.2.2 SWMU Investigations and Remediation

The TA-45 treatment plant (SWMU 45-001) and associated industrial waste (acid waste) sewer lines (SWMU 45-003) were decontaminated and decommissioned in the fall of 1966 and the spring of 1967 (Figures A-45-2, A-45-3, and A-45-4, Appendix A). The treatment plant was first stripped of loose equipment (i.e. ductwork, hoods, etc.). Then the structure framework, concrete basement, concrete supports, and concrete holding tanks were reduced to manageable rubble with a 7800 lb "headache" ball. The industrial waste (acid waste) lines, including the industrial waste (acid waste) manholes, were also removed to the north side of Canyon Road (Figure A-45-7, Appendix A). Workers, suspended over the cliff face, decontaminated the outfall areas by removing tuff with jackhammers and axes. All contaminated material was taken to MDA-G and MDA-C at TA-54. In the summer of 1967, the former TA-45 area was cleared for unrestricted access.

During the FUSRAP survey, soil sampling was performed in the waste treatment plant area, outfall locations, and along the former industrial waste (acid waste) line location. Auger samples to a depth of 900 cm were drilled within the former treatment plant footprint; near building corners, where holding and settling tanks were located, and former sump locations. Trenching was performed to collect soil samples along the two former outfalls from the treatment plant and from the location of the former influent industrial waste (acid waste) line to the treatment plant. These samples indicated that low levels of ^{239}Pu were present in the subsurface where the industrial waste (acid waste) line approached the treatment plant. The area of contamination was approximately 3 m wide, 40 m long, and 1.5 m deep. Concentrations of ^{239}Pu were also detected in the subsurface inside the perimeter of the former waste treatment plant, extending over an area 55 m wide, 60 m long, and 1.5 m deep. In addition, nine vertical transect lines were surveyed on the cliff face of the treatment plant outfalls. No significant levels of contamination were detected on the cliff face. None of these areas were remediated in the Bechtel remediation effort performed in 1982 (LANL 1981, 0141; Bechtel National Inc. 1983, 06-0037).

3.4.3.2.3 Nature and Extent of Existing Contamination

As described in Subsection 3.4.3.1.3, the existing radiological site conditions for TA-45 have been based on a composite data set prepared from the most recent data available. The sampling locations and composite data set results are shown in Figure 3.4-10.

3.4.3.2.3.1 SWMU 45-001

The area that comprises SWMUs 45-001, 45-003, and AOC C-45-001, shown as areas 2 and 4 on Figure 3.4-8, includes the footprint of the former treatment plant, the parking lot, the untreated industrial waste (acid waste) influent line to the treatment plant and the treated industrial waste (acid waste) effluent line that extended from the treatment plant to the canyon rim.

Gross-alpha Activity

The gross-alpha activity data from trenching samples (0-120 cm) (Figure 3.4-11) show elevated levels along the untreated industrial waste (acid waste) influent line. One sample was at 80 pCi/g and eight were in the 50-60 pCi/g range.

^{239}Pu Activity

All ^{239}Pu samples had levels less than 40 pCi/g. The highest levels were from surface samples along the treated industrial waste (acid waste) effluent line, and along the untreated industrial waste (acid waste) influent line near the southwest portion of the treatment plant.

3.4.4 Vehicle Decontamination Facility SWMU Aggregate

This aggregate consists of SWMU 45-002, a vehicle decontamination facility. The geographic area that describes this SWMU is depicted as area 3 in Figure 3.4-8.

3.4.4.1 Vehicle Decontamination Facility [SWMU 45-002]

3.4.4.1.1 SWMU Description and Historical Operation

The Vehicle Decontamination Facility (SWMU 45-002) was constructed between October 1950 and February 1951 (LASL no date, 0402), and was operated by Group H-1 (Figure A-45-5, Appendix A). This facility had steam cleaning capabilities and was used to decontaminate large, radioactively contaminated items such as trucks, filters from the Sigma Building, trash dumpsters, and wing tanks from airplanes used to gather air samples after blasts at firing sites. On at least one occasion, several tons of lead bricks were steam cleaned at the facility. Small equipment was decontaminated at the CMR Building (IT Corporation 1991, 06-0004).

This facility was not utilized until approximately 1952. Prior to its construction, large contaminated equipment was taken to Area G and washed down with fire hoses (IT Corporation 1991, 06-0004). The facility operated on an intermittent basis, approximately one day per month, unless an accident or spill warranted more use. In the early years of operation, waste water from the facility flowed out one end of the building and down a drainage into Acid Canyon. Later, waste water flowed into the floor pit which contained a sump pump. The sump sent the water to a holding tank or seepage pit, which then flowed into a manhole which fed into the liquid radioactive waste treatment facility (IT Corporation 1991, 06-0004).

3.4.4.1.2 SWMU Investigations and Remediation

This entire structure, including the concrete slab, was taken to MDA-G at TA-54 during the fall of 1966 (Figure A-45-6, Appendix A). Additionally, soil from the drainage into Acid Canyon was removed because untreated waste water had flowed there during the early years of operation.

In the FUSRAP survey, soil sampling locations in the vicinity of SWMU 45-002 were determined by positive field instrument response. The soil samples indicated surface ^{239}Pu contamination in the drainage outfall from the vehicle decontamination facility. The contamination extended over an area 10 m wide, 30 m long, and an undetermined depth. A vertical transect line was also surveyed on the cliff face below the vehicle decontamination facility outfall. No significant contamination was detected on the cliff face (LANL 1981, 0141).

The soil in the drainage outfall area that was determined to be contaminated with ^{239}Pu during the FUSRAP survey was removed during the 1982 Bechtel remediation. Levels after remediation were within FUSRAP guidelines (Bechtel National Inc. 1983, 06-0037).

3.4.4.1.3 Nature and Extent of Existing Contamination

After the TA-45 site was released to Los Alamos County for road maintenance equipment storage, large amounts of fill were deposited on this site, substantially changing the topography. This fill included blocks of concrete, asphalt, and rebar. The gradient and drainage that existed at the time the facility was in use have been substantially altered or covered up. The former vehicle decontamination facility and adjacent areas were remediated in 1982 as described in Bechtel National Inc. (1983, 06-0037) and Gunderson et al. (1983, 0671). The only current data available for this SWMU are two post-remediation surface (0-5 cm) ^{137}Cs measurements with values of 8.5 and 1.2 pCi/g (Figure 3.4-6). These values are well below the DOE action level of 80 pCi/g.

3.4.5 Sanitary Sewer Outfall SWMU Aggregate

This aggregate consists of SWMU 45-004, a sanitary sewer outfall. The geographic area that describes this SWMU is depicted as area 5 in Figure 3.4-8.

3.4.5.1 Sanitary Sewer Outfall [SWMU 45-004]

3.4.5.1.1 SWMU Description and Historical Operation

The sanitary sewer system was constructed at the TA-45 site prior to the construction of the waste treatment plant. The sewer system was constructed in 1947 for community service and included a lift station (TA-45-3), one manhole (TA-45-5), and associated piping. An additional manhole (TA-45-6) was added to the system when the treatment plant was built. There was a sanitary sewer outfall (SWMU 45-004) located on the north side of the lift station for overflow (LASL no date, 0402).

3.4.5.1.2 SWMU Investigations and Remediation

The sanitary sewage lift station was transferred to Los Alamos County in 1967. There have been no formal remediation or investigative efforts concerning SWMU 45-004.

3.4.5.1.3 Nature and Extent of Existing Contamination

The nature and extent of potential residual contamination in the surrounding soils and sediment is not known at this time.

3.5 Current Site Conditions

3.5.1 Environmental Setting

All of the technical areas comprising OU 1079 are situated on the Pajarito Plateau, which overlooks the Rio Grande valley to the east. The morphology of the Plateau is dominated by a relatively flat, gently eastward-sloping surface, dissected by numerous, steep-sided canyons (LANL 1991, Chapter 2, 0553).

Technical areas of OU 1079 include sites within canyons and on mesa tops. The facilities at the former TA-10 were located at an elevation of 6,800 ft entirely within Bayo Canyon, between Kwage Mesa to the south and Otowi Mesa to the north.

The site of former TA-31 is located on the north side of East Mesa at an elevation of 7,270 ft. The ground slopes gently toward the rim of Pueblo Canyon from approximately the center of the site.

The site of former TA-32 is located on the south side of East Mesa at an elevation of 7,260 ft. The ground slopes gently toward the rim of Los Alamos Canyon. The canyon side below the site has a gently-sloping bench located about 100 ft below the top of the escarpment. Surface runoff from the main part of the property currently exits at the southern edge of the yard and flows down the canyon wall by way of a natural drainage, which has caused marked discoloration on the cliff face. Runoff from this drainage makes its way fairly directly down over the bench and subsequently to the bottom of Los Alamos Canyon. Runoff from the western portion of the site may flow down to the bench and then west along the bench for approximately 100 ft before flowing south down to the bottom of the canyon.

The site of former TA-45 is located on the north side of East Mesa at an elevation of 7,230 ft. The site, which is on the down-dropped (western) side of the Rendija Canyon fault, slopes gently to the edge of Acid Canyon. The current surface of the area where TA-45 was located has been filled and regraded by Los Alamos County for use as a storage yard, with fill pushed into adjacent vegetation, minor drainages, and down the slope north of the site. Because of the extensive filling and regrading, the present surface of this site is as much as 25 ft higher than the original surface, especially at the northwestern edge (canyon rim) of the site. The floor of adjacent Acid Canyon lies about 150 ft below the TA-45 site.

At all sites, canyon walls adjacent to mesa tops consist of steep slopes and alternating cliffs. Erosion of canyon rims takes place primarily as undercutting and subsequent breaking away of blocks of volcanic tuff (see below) along natural joints and fractures. The local climate does not promote rapid weathering of this material. Vegetation on north-facing canyon slopes consists of fairly mature Ponderosa pine, juniper, and scrub oak in a thin sandy soil, indicating long-term stability of the slope. Vegetation on the steeper south-facing canyon slopes consist of very scant Piñon pine, juniper, and scrub oak. Erosion of exposed south-facing slopes may proceed at a faster rate than north-facing slopes, but there has probably been little or no significant change in the past 50 years. Canyon floors support Ponderosa pine, grass, and Rabbit Brush (Chamisa).

Tertiary stratigraphic units exposed on, or directly underlying, the Pajarito Plateau in the vicinity of OU 1079 consist of (from oldest to youngest) (1) tuffaceous sandstones and volcaniclastic conglomerates of the Abiquiu Formation; (2) terrestrial conglomerates, sandstones, and mudstones, with minor limestones, evaporites, volcanic tuffs, and intercalated basalts of the Santa Fe Group; (3) alluvial fan gravels and interstratified fluvial gravels and lacustrine sediments of the Puye Formation; and (4) rhyolitic tephra of the Bandelier Tuff. Bandelier Tuff underlies the surface of the Pajarito Plateau. Bayo, Acid, and Pueblo Canyons are cut entirely in the Bandelier Tuff.

The Bandelier Tuff erupted during formation of the Valles and Toledo calderas in the Jemez volcanic field. It is divided into lower (Otowi) and upper (Tshirege) members. The basal unit of the Otowi Member is a fallout pumice, the Guaje Pumice Bed, which consists of massive to poorly bedded, unconsolidated, silicic, lapilli-tuff. The Guaje Pumice Bed is overlain by a thick sequence of ash-flow deposits comprising the majority of the Otowi Member. It consists of a massive to poorly bedded, poorly sorted, tuff to lapilli-tuff. In all exposures on the Pajarito Plateau, the Otowi ash flow sequence is unwelded. The upper contact of the Otowi Member is an erosional surface marked by a horizon up to 3.3 ft in thickness of epiblastic deposits and partial soil development (Crowe et al. 1978, 0041). The Otowi Member is not exposed in OU 1079.

The Tshirege Member is divided into a lower sequence of Plinian fallout deposits (Tsankawi Pumice Bed), and an overlying sequence of ash flow deposits. The Tsankawi Pumice Bed consists of tuff to lapilli-tuff airfall deposits. In lower Los Alamos, Pueblo, Bayo, and Sandia Canyons the unit can be divided into three to five sequences separated by reworked deposits. The Tsankawi Pumice Bed is overlain by complex and laterally variable ash-flow deposits. The Tshirege ash-flow sheet consists of numerous individual ash-flows, ranging up to 82.5 ft in thickness. Ash-flow deposits of the Tshirege Member underlie the major part of the surface of the Pajarito Plateau, including TA-31 and TA-32, and form the bulk of exposures of Bandelier Tuff in canyons which dissect the Plateau. In Bayo Canyon, Bandelier Tuff may be exposed at the ground surface and in Test Hole TH-1 extended to a maximum depth of 25.7 m below the surface of the canyon (Test Hole TH-1), where it is underlain by conglomerates of the Puye Formation (Table 3.5-1).

Stratigraphically overlying the Bandelier Tuff, occurring both as thin deposits (typically <5 m thick) on mesa tops and as deposits inset along canyons, are discontinuous Quaternary alluvial units. Those units lowest in the drainages grade into the active alluvium along canyon bottoms. Well- to poorly-sorted clay-rich to sandy alluvium occurs in major drainages of the Pajarito Plateau. At TA-10 in Bayo Canyon, alluvial fill ranges from 0 to at least 47 ft thick (depth of test holes) near the subsurface disposal SWMU aggregate. Depth of alluvial fill in Acid Canyon (TA-45) and upper Pueblo Canyon is not well constrained, but at some localities, bedrock of Bandelier Tuff is exposed in the channels of the ephemeral

TABLE 3.5-1 LOG OF TEST HOLES DRILLED AT BAYO SITE

	Log (m)		
Hole No.	Alluvium	Tuff	Conglomerate
TH-1 (1961)	—	0 - 25.7	25.7 - 27.1
TH-2 (1961)	0 - 1.5	1.5 - 7.6	—
TH-3 (1961)	0 - 3.6	3.6 - 19.8	19.8 - 21.3
TH-4 (1961)	0 - 3.1	3.1 - 23.3	23.0 - 24.1
M-1 (1973)	0 - 7.9[a]	7.9 - 12.2	—
M-2 (1973)	0 - 4.6[a]	4.6 - 6.1	—
M-3 (1973)	0 - 2.4[a]	—	—

[a] Fill or reworked tuff

Remarks: All holes were dry

(Modified from Mayfield et al. 1979, 06-0041)

streams. Thickness of alluvium in the canyons is a function of the subsurface geometry and of the detailed erosional and sedimentation cycles for each canyon.

Soils on the Pajarito Plateau are derived primarily from the underlying Bandelier Tuff, and consist mainly of shallow, well-drained sandy loams of the Hackroy series (Nyhan et al. 1978, 0162). The Hackroy soils comprise about 10 cm of brown sandy loam, or loam overlying about 20 cm of reddish brown clay, gravelly clay, or clay loam subsoil. Depth to bedrock and the effective rooting depth are 20-50 cm. Intermixed with the Hackroy soils on mesa tops are small areas of deeper loams of the Nyjack series. Nyjack soils are distinguished from Hackroy soils by thicknesses of 50-102 cm and by the common presence of pumice fragments in the lower soil (Nyhan et al. 1978, 0162). Areas of exposed bedrock are common towards the edges of mesa, such as at TA-31 and -32. Slopes between mesa tops and canyon bottoms consist of steep rock outcrops and patches of shallow, undeveloped colluvial soils. Canyon bottoms are underlain by deep, poorly developed, well drained soils of the Totavi series formed in alluvium. These soils are present in Bayo Canyon (TA-10), and Acid and Pueblo Canyons (TA-45).

The main aquifer beneath the Pajarito Plateau is located chiefly within sediments of the lower Puyé Formation and Santa Fe Group. The potentiometric surface of the main aquifer beneath OU 1079 lies at about 6,000 ft in elevation, which at Bayo Canyon (TA-10) is about 800 ft beneath the surface. For mesa-top sites in OU 1079, over 1,000 ft of unsaturated tuff and other volcanic rock separate the surface from the main aquifer. None of the canyons in OU 1079 have perennial streams: rather, flow occurs only in response to precipitation events or snow-melt runoff. Therefore, they are not thought to have alluvial aquifers. A perched water body is located at a depth of up to 60 m downstream of Bayo Canyon near the confluence of Pueblo and Los Alamos Canyons.

Prevailing winds in OU 1079 on the Pajarito Plateau are generally from the west-southwest to south-southwest, averaging about 12 mph (Environmental Protection Group 1990, 0497). This pattern dominates the mesa-top sites such as TA-31, -32, and -45. Winds in the canyons, such as Bayo and Acid Canyons (TA-10 and -45, respectively), reflect the diurnal, thermally-controlled pattern seen elsewhere in Los Alamos County, with low-velocity (generally less than 10 mph) down-canyon winds at night and up-canyon winds during the day.

Detailed descriptions of the geology, hydrology, and soils of the Los Alamos area are found in Sections 2.6.1 and 2.6.2 of the 1991 IWP (LANL 1991, 0553).

3.5.2 Biological Resources

During 1991, field surveys were conducted in OU 1079 for compliance with the Federal Endangered Species Act of 1973, New Mexico's Wildlife Conservation Act, New Mexico Endangered Plant Species Act, Executive Order 11990, "Protection of Wetlands," and Executive Order 11988, "Floodplain Management," 10 CFR 1022, and DOE Order 5400.1. As a result of habitat evaluation and previous information on the OU, only one endangered species, the peregrine falcon (Falco peregrinus), may inhabit the areas near TA-10 and TA-31. All RFI activities within the critical habitat will be scheduled to insure no adverse impact to the peregrine falcon (i.e., nesting season). There are no wetlands or floodplains located within the former TA-10, TA-31, TA-32 or TA-45 sites of OU 1079. Best management practices will be implemented to minimize impacts on native vegetation.

3.5.3 Cultural Resources

As required by the National Historic Preservation Act of 1966 (as amended), a cultural resource survey was conducted during the summer of 1991 at OU 1079. The methods and techniques used for this survey conform to those specified in the Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation.

Twenty archaeological sites eligible for inclusion on the National Register of Historic Places under Criterion D are located within the survey area: Laboratory of Anthropology (LA) site numbers LA 21480, LA 21493 through LA 21495, LA 21602, LA 35003, LA 86526 through LA 86531, and LA 86556 through LA 86563.

The attributes of these sites that make them eligible for inclusion on the National Register will not be affected by any ER sampling activities proposed at OU 1079. A report documenting the survey area, methods, results, and monitoring recommendations, if any, will be transmitted to the New Mexico State Historic Preservation Office (SHPO) for its concurrence in a "Determination of No Effect." As specified in 36 CFR 800.5(b), and following the intent of the American Indican Religious Freedom Act, a copy of this report will also be sent to the Govemor of San Ildefonso Pueblo for comments on any possible impacts to sacred and traditional places.

All monitoring and avoidance recommendations contained in this report must be followed by all personnel involved in ER sampling activities (Hoagland in preparation, 06-0064).

3.5.4 Land Use

3.5.4.1 TA-10

The only remaining physical structures at the Bayo Canyon site (as described in Ford, Bacon, and Davis Utah Inc. 1981, 06-0039) were a number of asphalt-paved areas and roads, and a concrete pad from a former warehouse (Figure A-10-6, Appendix A). The site is currently under institutional controls, with concrete monuments installed in 1983 to delineate an area where excavation is prohibited until 2142 A.D. This controlled area is where the former subsurface disposal SWMU aggregate is located.

Bayo Canyon is used strictly for recreational purposes - picnicking, trail riding, jogging, hiking, firearms practice, and possibly wood cutting and piñon nut gathering.

3.5.4.2 TA-31

The East Receiving Yard was located on the mesa bounded by Los Alamos Canyon on the south, and Pueblo Canyon on the north, in the area north of East Road and west of the air strip. The area is approximately bounded to the east by Nambe Loop and to the west by Tewa Loop. The site is now occupied by a residential area (Figure A-31-2, Appendix A). County land between the residences and the north edge of the mesa contains the utility right-of-way for buried natural gas lines and sanitary and storm sewers. This strip of land has been extensively regraded to slope gently to the canyon rim, probably incorporating any remaining sand and gravel from the concrete block plant that was adjacent to the former TA-31, as well as excavation debris and original surface materials. Some of this material has been pushed into the vegetation rimming the canyon, indicating that the surface has been raised in some locations above the original level along the canyon rim.

3.5.4.3 TA-32

The Medical Research Facility was located on the top of East Mesa in the area south of Trinity Drive behind the Zia Supply Building near the rim of Los Alamos Canyon. The area is bounded approximately by Ninth Street to the east, Knecht Street to the west, and the rim of Los Alamos Canyon to the south. The site is now used by the Los Alamos County Roads Division to store and maintain road working equipment, materials for road construction, and salted sand for winter road treatment. The latter is currently stored in open sheds and uncovered on the surface of the yard.

The area formerly occupied by TA-32 was located south of Trinity Drive and is currently used by the Los Alamos County Roads Division (Figure A-32-2, Appendix A). The property is used to store and maintain road working equipment and road construction materials. Maintenance activities may include use of solvents, lubricants, and fuels.

3.5.4.4 TA-45

Currently, the former TA-45 site is undeveloped. The former untreated outfall area (SWMU 1-002) associated with former TA-1 operations is partly fenced at or near the canyon edge. The former sanitary sewage lift station structure is still located at the site; however, the 1986 CEARP field survey confirmed that the lift station had been decommissioned and the basement area filled with soil (DOE 1987, 0264).

The industrial waste (acid waste) lines on the site were removed during the period of 1965 through 1967 (Gunderson and Ahlquist 1979, 0670). At that time, the portions of the industrial waste (acid waste) lines which flowed from TA-1 and TA-3 were plugged with concrete and left in place. They have since been removed, and were reported to have posed no public health hazard (Gunderson and Ahlquist 1979, 0670).

Sanitary sewer drainlines from the treatment plant and the vehicle decontamination facility were reported to have been removed to manholes TA-45-5 and TA-45-6 in 1968. However, other sanitary lines crossed the site to the lift station, and their status is unknown.

It was reported that the County has used the site as a landfill (Ferenbaugh et al. 1982, 0668). The 1987 CEARP field survey confirmed that debris was in the area, including building debris disposed of in Acid Canyon behind the former TA-45 site (DOE 1987, 0264).

3.6 Operable Unit 1079 Conceptual Models

3.6.1 Contaminants of Concern

The following sections identify the contaminants of concern (COCs), those contaminants which might present a human health risk.

3.6.1.1 TA-10

3.6.1.1.1 Firing Sites SWMU Aggregate

The possible contaminants from the firing site SWMU aggregate include ^{90}Sr, total uranium, Ba, Be, Pb, and high explosives (HE) residues. These contaminants were widely distributed across the canyon bottom, hillslopes, and adjacent mesa tops during the explosives testing. A summary of the COCs and present characteristics of the Firing Sites SWMU Aggregate is given in Table 3.6-1. Sampling plans that focus on characterizing the nature and extent of the COCs will result in cost-effective sampling efforts and ultimately lead to more timely and effective remediation.

HE and Metals

Pieces of HE debris are not considered a COC, because of the extensive surface sweeps and debris removal at the site (see Subsection 3.1.1). Residual pieces of HE that might remain in Bayo Canyon are lacking appropriate mass and trigger mechanisms to pose a health risk to the public. Organic contaminants that resulted from the utilization of HE will be determined utilizing the standard EPA method for HE, USATHAMA (see Appendix C). This method determines the amount of the following HE compounds: HMX, RDX, NB, 1,3-DNB, 1,3,5-TNB, 2,4-DNT, 2,6-DNT, 2,4,6-TNT, and TETRYL. This list includes all organic explosives likely to have been used at TA-10. BARATOL, which is composed of $Ba(NO_3)_2$ and TNT, was likely to have been used as an initiator at TA-10; consequently, Ba is a contaminant of concern at the firing sites. However, any initiators would exist in very small amounts and it is unlikely that they would represent significant levels of contamination. Beryllium, lead, aluminum, and iron could have been dispersed as a result of HE testing; however, aluminum and iron are not hazardous constituents. The majority of the shrapnel-sized pieces of uranium created during the firing tests has been retrieved during the many extensive surface sweeps of the area (1963, 1966, 1967, 1969, 1971, 1973, 1975, and 1976).

3.6.1.1.2 Subsurface Disposal SWMU Aggregate

Suspected contaminants from the Subsurface Disposal SWMU Aggregate are ^{90}Sr, total uranium, TAL metals, and organic compounds. ^{140}La used at the site has since decayed to below detection levels due to its short half-life (40.3 hours). No information on nonradiological contaminants is available. Sanitary wastes were handled by two septic systems, which may also have received hazardous

TABLE 3.6-1. CHARACTERISTICS OF SWMUs AND ASSOCIATED STRUCTURES IN TA-10

SWMU	DESCRIPTION	CONTAMINANTS OF CONCERN	TRIGGER LEVELS[a]	RANGE OF EXISTING DATA[c]	ADDITIONAL DATA REQUIRED
10-001(a-e)	Firing Sites and Sand Pile Detonation Area	^{90}Sr	TBD[b]	0-132 pCi/g	^{90}Sr Concentration (to confirm existing data)
		Natural and Depleted Uranium	TBD[b]	0.54-19.0 µg/g	Natural and Depleted U (to confirm existing data)
		Lead	TBD[b]	None	Pb concentration
		Beryllium	0.2 mg/kg	None	Be concentration
		High Explosives	Dependent upon composition TBD[b]	None	Explosives concentration
		Barium	4,000 mg/kg	None	Ba concentration

[a] Trigger levels for nonradionuclides are the proposed RCRA Subpart S action levels (EPA 1990,0432). Trigger levels for radionuclides and nonradioactive hazardous constituents not listed in Subpart S will be provided in the LANL 1992 Installation Work Plan.

[b] TBD: To Be Determined

[c] Mayfield et al. 1979, 06-004i

TABLE 3.6-1. CHARACTERISTICS OF SWMUs AND ASSOCIATED STRUCTURES IN TA-10 (CONT'D)

SWMU	DESCRIPTION	CONTAMINANTS OF CONCERN	TRIGGER LEVELS [a]	RANGE OF EXISTING DATA [c]	ADDITIONAL DATA REQUIRED
10-002(a-b)	Solid Disposal Pits	^{90}Sr	TBD[b]	0.5-810 pCi/g	^{90}Sr Concentration (to confirm existing data)
		Natural and Depleted Uranium	TBD[b]	1.9-5.6 µg/g	Natural and Depleted U (to confirm existing data)
		Barium	4,000 mg/kg	None	Ba concentration
		Cadmium	40 mg/kg	None	Cd concentration
		TAL Metals	Dependent on contaminant TBD[b]	None	TAL Metals analyses
		Organic Compounds	Dependent on contaminant TBD[b]	None	Organic Compounds analyses

a Trigger levels for nonradionuclides are the proposed RCRA Subpart S action levels (EPA 1990,0432). Trigger levels for radionuclides and nonradioactive hazardous constituents not listed in Subpart S will be provided in the LANL 1992 Installation Work Plan.
b Mayfield et al. 1979, 06-0041
c TBD: To Be Determined

TABLE 3.6-1. CHARACTERISTICS OF SWMUs AND ASSOCIATED STRUCTURES IN TA-10 (CONT'D)

SWMU	DESCRIPTION	CONTAMINANTS OF CONCERN	TRIGGER LEVELS [a]	RANGE OF EXISTING DATA [c]	ADDITIONAL DATA REQUIRED
10-003(a-o)	Liquid Disposal System	^{90}Sr	TBD[b]	0-4310 pCi/g	^{90}Sr Concentration (to confirm existing data)
		Natural and Depleted Uranium	TBD[b]	1.1-50 μg/g	Natural and Depleted U (to confirm existing data)
		Barium	4,000 mg/kg	None	Ba concentration
		Cadmium	40 mg/kg	None	Cd concentration
		Beryllium	0.2 mg/kg	None	Be concentration
		Lead	TBD[b]	None	Pb concentration
		Organic Compounds	Dependent on contaminant TBD[b]	None	Organic Compounds analyses

a Trigger levels for nonradionuclides are the proposed RCRA Subpart S action levels (EPA 1990,0432). Trigger levels for radionuclides and nonradioactive hazardous constituents not listed in Subpart S will be provided in the LANL 1992 Installation Work Plan.

b TBD: To Be Determined

c Mayfield et al. 1979, 06 0041

TABLE 3.6-1. CHARACTERISTICS OF SWMUs AND ASSOCIATED STRUCTURES IN TA-10 (CONT'D)

SWMU	DESCRIPTION	CONTAMINANTS OF CONCERN	TRIGGER LEVELS [a]	RANGE OF EXISTING DATA [c]	ADDITIONAL DATA REQUIRED
10-004(a-b)	Septic Tanks	^{90}Sr	TBD[b]	1.9-4.2 pCi/g	^{90}Sr Concentration (to confirm existing data)
		Natural and Depleted Uranium	TBD[b]	None	Natural and Depleted U Concentration
		Barium	4,000 mg/kg	None	Ba concentration
		Cadmium	40 mg/kg	None	Cd concentration
		Beryllium	0.2 mg/kg	None	Be concentration
		Lead	TBD[b]	None	Pb concentration
		Organic Compounds	Dependent on contaminant TBD[b]	None	Organic Compounds analyses

[a] Trigger levels for nonradionuclides are the proposed RCRA Subpart S action levels (EPA 1990,0432). Trigger levels for radionuclides and nonradioactive hazardous constituents not listed in Subpart S will be provided in the LANL 1992 Installation Work Plan.

[b] TBD: To Be Determined

[c] Mayfield et al. 1979, 06-0041

TABLE 3.6-1. CHARACTERISTICS OF SWMUs AND ASSOCIATED STRUCTURES IN TA-10 (CONT'D)

SWMU	DESCRIPTION	CONTAMINANTS OF CONCERN	TRIGGER LEVELS[a]	RANGE OF EXISTING DATA[c]	ADDITIONAL DATA REQUIRED
10-005	Surface Disposal	^{90}Sr	TBD[b]	None	^{90}Sr Concentration
		Natural and Depleted Uranium	TBD[b]	None	Natural and Depleted Uranium Concentration
		Lead	TBD[b]	None	Pb concentration
		Beryllium	0.2 mg/kg	None	Be concentration
		High Explosives	Dependent upon composition TBD[b]	None	Explosives concentration
		Barium	4,000 mg/kg	None	Ba concentration

a Trigger levels for nonradionuclides are the proposed RCRA Subpart S action levels (EPA 1990,0432). Trigger levels for radionuclides and nonradioactive hazardous constituents not listed in Subpart S will be provided in the LANL 1992 Installation Work Plan.

b TBD: To Be Determined

c Mayfield et al. 1979, 06-0041

TABLE 3.6-1. CHARACTERISTICS OF SWMUs AND ASSOCIATED STRUCTURES IN TA-10 (CONT'D)

SWMU	DESCRIPTION	CONTAMINANTS OF CONCERN	TRIGGER LEVELS [a]	RANGE OF EXISTING DATA [c]	ADDITIONAL DATA REQUIRED
10-006	Open Burning Area	^{90}Sr	TBD[b]	None	^{90}Sr Concentration
		Natural and Depleted Uranium	TBD[b]	None	Natural and Depleted Uranium Concentration
		Lead	TBD[b]	None	Pb concentration
		Beryllium	0.2 mg/kg	None	Be concentration
		High Explosives	Dependent upon composition TBD[b]	None	Explosives concentration
		Barium	4,000 mg/kg	None	Ba concentration

a Trigger levels for nonradionuclides are the proposed RCRA Subpart S action levels (EPA 1990,0432). Trigger levels for radionuclides and nonradioactive hazardous constituents not listed in Subpart S will be provided in the LANL 1992 Installation Work Plan.
b TBD: To Be Determined
c Mayfield et al. 1979, 06-0041

TABLE 3.6-1. CHARACTERISTICS OF SWMUs AND ASSOCIATED STRUCTURES IN TA-10 (CONT'D)

SWMU	DESCRIPTION	CONTAMINANTS OF CONCERN	TRIGGER LEVELS[a]	RANGE OF EXISTING DATA[c]	ADDITIONAL DATA REQUIRED
10-007	Landfill	^{90}Sr	TBD[b]	None	^{90}Sr Concentration (to confirm existing data)
		Natural and Depleted Uranium	TBD[b]	None	Natural and Depleted U Concentration
		Barium	4,000 mg/kg	None	Ba concentration
		Cadmium	40 mg/kg	None	Cd concentration
		Beryllium	0.2 mg/kg	None	Be concentration
		Lead	TBD[b]	None	Pb concentration
		Organic Compounds	Dependent on contaminant TBD[b]	None	Organic Compounds analyses

[a] Trigger levels for nonradionuclides are the proposed RCRA Subpart S action levels (EPA 1990,0432). Trigger levels for radionuclides and nonradioactive hazardous constituents not listed in Subpart S will be provided in the LANL 1992 Installation Work Plan.

[b] TBD: To Be Determined

[c] Mayfield et al. 1979, 06 0041

laboratory wastes. Buildings, septic systems, solid and liquid disposal pits, and their delivery systems were removed to a large degree during previous decommissioning activities, but some surface and significant subsurface contamination remains. Some broken pieces of the septic systems may remain at depth. Samples of tuff taken at depths of 20 m and just downstream of the former liquid waste pit showed significantly elevated ^{90}Sr concentrations, indicating migration of the more soluble constituents through the alluvium and into the volcanic tuff bedrock. The most probable occurrence of contaminants is as discrete particles adsorbed onto detrital grains; a less probable occurrence is as solutes, dissolved during rain storms, which have mobilized and remained as residue in the sparse interstitial water. A few samples of downstream sediments associated with the intermittent stream channel have been analyzed for gross-gamma activity, with no contamination observed.

A summary of the COCs and the characteristics of the Subsurface Disposal SWMU Aggregate has been given in Table 3.6-1.

3.6.1.2 TA-31

SWMU 31-001 was a septic tank and outfall serving the main TA-31 warehouse (TA-31-7) from 1949 until 1954. The TA-31 storage yard received construction materials, drummed oil, and possibly chemicals (See Subsection 3.2.1). Operational history indicates that no radioactive materials were stored at the site. The septic tank system was designed and installed to provide sanitary waste treatment and disposal. While there is no documentation of spills having occurred at building TA-31-7, it is possible that hazardous materials may have been released into the septic tank system through accidental spills. Organic compounds, TAL metals, and possibly radioactive materials are potential COCs at the site (Table 3.6-2).

3.6.1.3 TA-32

Waste may have been released at the former TA-32 site during two periods of active usage: as a medical research facility between 1944 and 1954, and as the Los Alamos County Roads Division from 1967 to present.

3.6.1.3.1 Medical Research Facility

No records are available of waste disposition from these facilities during operation. Since there was an on-site incinerator (SWMU 32-001), it is assumed that much of the combustible waste was incinerated. No industrial waste line served TA-32, so it is possible that several types of hazardous and radioactive waste were disposed of in laboratory sinks and drains connected to the septic tank systems [SWMUs 32-002(a-b)].

TABLE 3.6-2. CHARACTERISTICS OF SWMUS AND ASSOCIATED STRUCTURES IN TA-31

SWMU	DESCRIPTION	CONTAMINANTS OF CONCERN	TRIGGER LEVELS[a]	EXISTING DATA	ADDITIONAL DATA REQUIRED
31-001	Area of Removed Septic Tank	Radioactive Materials	TBD[b]	None	Gross gamma, beta, and alpha analyses
		TAL Metals	TBD[b]	None	TAL Metals analyses
		Organic Compounds	TBD[b]	None	Organic Compounds analyses
	Area of Inlet Line to Septic Tank	Radioactive Materials	TBD[b]	None	Gross gamma and alpha analyses
		TAL Metals	TBD[b]	None	TAL Metals analyses
		Organic Compounds	TBD[b]	None	Organic Compounds analyses
C-31-001	Areas of removed warehouses and storage yard.	Unknown	TBD[b]	None	None unless SWMU 31-001 shows evidence of contamination

a Trigger levels for nonradionuclides are the proposed RCRA Subpart S action levels (EPA 1990, 0432). Trigger levels for radionuclides and nonradioactive hazardous constituents not listed in Subpart S will be provided in the LANL 1992 Installation Work Plan.

b TBD: To Be Determined

Potential contaminants from the medical research activities include radionuclides such as ^{241}Am, ^{3}H, $^{238,\,239}$Pu, ^{131}I, ^{14}C, and ^{35}S. In addition, it is likely that organic compounds, metal solutions, and inorganic acids may have been disposed of through either the incinerator (SWMU 32-001) or the septic tank systems [SWMUs 32-002(a-b)].

The COCs for TA-32 are provided in Table 3.6-3. Both ^{131}I and ^{35}S have not been included because ^{131}I has a half life of 8.04 days and ^{35}S has a half life of 87.4 days. Additionally, inorganic acids have not been included because they would have been neutralized due to the buffering capacity of the soil; however, metal constituents are still of concern.

3.6.1.3.2 Los Alamos County Maintenance Facility

Currently, the area of former TA-32 is occupied by the Los Alamos County Roads Division. There is the possibility that fuels, lubricants, metals, and other hazardous materials have been released at the site (Table 3.6-3).

3.6.1.4 TA-45

There are three potential waste types associated with the former TA-45 waste treatment plant site sources (Table 3.6-4):

- **Industrial or liquid radioactive waste** as described in Subsections 3.4.2.1 and 3.4.3.2; the untreated liquid radioactive waste discharged at SWMU 1-002 contained isotopes of strontium, cesium, plutonium, uranium, americium, and tritium. Chemical constituents possibly associated with the liquid radioactive waste stream have not been identified. The potential TA-45 source areas for liquid radioactive waste include the former waste treatment plant site and industrial waste (acid waste) line locations (SWMU 45-001), treated and untreated effluent lines and outfalls (SWMUs 45-001 and 1-002, respectively), and the vehicle decontamination facility (SWMU 45-002).

- **Sanitary waste** composed of domestic sewage, and potentially metals and chemical waste was disposed of through sinks and drains. The potential TA-45 source areas for this sanitary waste include the former incoming sewer drain lines to the lift station, the sewage lift station, and the lift station overflow line and outfall (SWMU 45-004).

- **Unknown, uncontrolled, "other" waste** such as high explosives and chemical waste associated with the former vehicle decontamination facility (SWMU 45-002), utility room floor drains and outfall, and the parking lot storm drains and outfall.

TABLE 3.6-3. CHARACTERISTICS OF SWMUS AND ASSOCIATED STRUCTURES IN TA-32

SWMU	DESCRIPTION	CONTAMINANTS OF CONCERN	TRIGGER LEVELS[a]	EXISTING DATA	ADDITIONAL DATA REQUIRED
32-001	Incinerator Site	^{14}C	TBD[b]	None	^{14}C Concentration
		$^{238,239}Pu$	TBD[b]	None	$^{238,239}Pu$ Concentration
		^{241}Am	TBD[b]	None	^{241}Am Concentration
		^{3}H	TBD[b]	None	^{3}H Concentration
		Organic Compounds	Dependent on contaminant TBD[b]	None	Organic Compounds analyses
		TAL Metals	Dependent on contaminant TBD[b]	None	TAL Metals analyses

[a] Trigger levels for nonradionuclides are the proposed RCRA Subpart S action levels (EPA 1990, 0432). Trigger levels for radionuclides and nonradioactive hazardous constituents not listed in Subpart S will be provided in LANL 1992 Installation Work Plan.

[b] TBD: To Be Determined

TABLE 3.6-3. CHARACTERISTICS OF SWMUS AND ASSOCIATED STRUCTURES IN TA-32 (CONT'D)

SWMU	DESCRIPTION	CONTAMINANTS OF CONCERN	TRIGGER LEVELS[a]	EXISTING DATA	ADDITIONAL DATA REQUIRED
32-002(a)	Septic Tanks	^{14}C	TBD[b]	None	^{14}C Concentration
		$^{238,239}Pu$	TBD[b]	None	$^{238,239}Pu$ Concentration
		^{241}Am	TBD[b]	None	^{241}Am Concentration
		^{3}H	TBD[b]	None	^{3}H Concentration
		Organic Compounds	Dependent on contaminant TBD[b]	None	Organic Compounds analyses
		TAL Metals	Dependent on contaminant TBD[b]	None	TAL Metals analyses

[a] Trigger levels for nonradionuclides are the proposed RCRA Subpart S action levels (EPA 1990, 0432). Trigger levels for radionuclides and nonradioactive hazardous constituents not listed in Subpart S will be provided in LANL 1992 Installation Work Plan.

[b] TBD: To Be Determined

TABLE 3.6-3. CHARACTERISTICS OF SWMUS AND ASSOCIATED STRUCTURES IN TA-32 (CONT'D)

SWMU	DESCRIPTION	CONTAMINANTS OF CONCERN	TRIGGER LEVELS[a]	EXISTING DATA	ADDITIONAL DATA REQUIRED
32-002(b)	Septic Tanks	^{14}C	TBD[b]	None	^{14}C Concentration
		$^{238,239}Pu$	TBD[b]	None	$^{238,239}Pu$ Concentration
		^{241}Am	TBD[b]	None	^{241}Am Concentration
		^{3}H	TBD[b]	None	^{3}H Concentration
		Organic Compounds	Dependent on contaminant TBD[b]	PPB levels in sludge	Organic Compounds analyses
		TAL Metals	Dependent on contaminant TBD[b]	Pb and Cr > EP toxicity in sludge	TAL Metals analyses
C-32-001	Sites of removed laboratories and warehouses	Unknown	N/A	None	None unless SWMUs above show evidence of contamination

[a] Trigger levels for nonradionuclides are the proposed RCRA Subpart S action levels (EPA 1990, 0432). Trigger levels for radionuclides and nonradioactive hazardous constituents not listed in Subpart S will be provided in LANL 1992 Installation Work Plan.

[b] TBD: To Be Determined

TABLE 3.6-4. CHARACTERISTICS OF SWMUS AND ASSOCIATED STRUCTURES IN TA-45

SWMU	DESCRIPTION	CONTAMINANTS OF CONCERN	TRIGGER LEVELS [a]	RANGE OF EXISTING DATA [c]	ADDITIONAL DATA REQUIRED
45-001	Waste Treatment Facility Site	^{238}Pu	TBD[b]	0.0-24.4 pCi/g	^{238}Pu concentration (to confirm existing data)
		^{239}Pu	TBD[b]	0.0-0.27 pCi/g	^{239}Pu concentration (to confirm existing data)
		^{3}H	TBD[b]	None	^{3}H concentration in soil moisture
		^{90}Sr	TBD[b]	0.0-9.62 pCi/g	^{90}Sr concentration (to confirm existing data)
		^{241}Am	TBD[b]	None	^{241}Am concentration
		Organic Compounds	Dependent on contaminant TBD[b]	None	Organic Compounds analyses
		TAL Metals	Dependent on contaminant TBD[b]	None	TAL Metals analyses
		Natural and Depleted Uranium	TBD[b]	0.7-36 µg/g	U concentration (to confirm existing data)
		^{137}Cs	TBD[b]	0.0-3.2 pCi/g	^{137}Cs concentration (to confirm existing data)

[a] Trigger levels for nonradionuclides are the proposed RCRA Subpart S action levels (EPA 1990, 0432). Trigger levels for radionuclides and nonradioactive hazardous constituents not listed in Subpart S will be provided in the LANL 1992 Installation Work Plan.

[b] TBD: To Be Determined

[c] LANL 1981, 0141 and Gunderson et al. 1983, 0671

TABLE 3.6-4. CHARACTERISTICS OF SWMUS AND ASSOCIATED STRUCTURES IN TA-45 (CONT'D)

SWMU	DESCRIPTION	CONTAMINANTS OF CONCERN	TRIGGER LEVELS [a]	RANGE OF EXISTING DATA [c]	ADDITIONAL DATA REQUIRED
45-002	Vehicle Decontamination Facility Site	^{238}Pu	TBD[b]	None	^{238}Pu concentration
		^{239}Pu	TBD[b]	None	^{239}Pu concentration
		^{3}H	TBD[b]	None	^{3}H concentration in soil moisture
		^{90}Sr	TBD[b]	None	^{90}Sr concentration
		Organic Compounds	Dependent on contaminant TBD[b]	None	Organic Compounds analyses
		TAL Metals	Dependent on contaminant TBD[b]	None	TAL Metals analyses
		Natural and Depleted Uranium	TBD[b]	0.7-36 µg/g	U concentration (to confirm existing data)
		^{241}Am	TBD[b]	0.4-5.4 pCi/g	^{241}Am concentration (to confirm existing data)
		^{137}Cs	TBD[b]	1.2-8.5 pCi/g	^{137}Cs concentration (to confirm existing data)
		High Explosives	Dependent on composition TBD[b]	None	Explosives concentration

a Trigger levels for nonradionuclides are the proposed RCRA Subpart S action levels (EPA 1990, 0432). Trigger levels for radionuclides and nonradioactive hazardous constituents not listed in Subpart S will be provided in the LANL 1992 Installation Work Plan

b TBD: To Be Determined

c LANL 1981, 0141 and Gunderson et al 1983, 0671

TABLE 3.6-4. CHARACTERISTICS OF SWMUS AND ASSOCIATED STRUCTURES IN TA-45 (CONT'D)

SWMU	DESCRIPTION	CONTAMINANTS OF CONCERN	TRIGGER LEVELS [a]	RANGE OF EXISTING DATA (ABOVE BACKGROUND) [c]	ADDITIONAL DATA REQUIRED
45-003	Industrial Waste (Acid Waste) Lines	^{238}Pu	TBD[b]	0.003-0.33 pCi/g	^{238}Pu concentration (to confirm existing data)
		^{239}Pu	TBD[b]	0.12-35.2 pCi/g	^{239}Pu concentration (to confirm existing data)
		^{3}H	TBD[b]	None	^{3}H concentration in soil moisture
		^{90}Sr	TBD[b]	0.42-0.56 pCi/g	^{90}Sr concentration (to confirm existing data)
		^{241}Am	TBD[b]	0.68-1.16 pCi/g	^{241}Am concentration (to confirm existing data)
		Organic Compounds	Dependent on contaminant TBD[b]	None	Organic Compounds analyses
		TAL Metals	Dependent on contaminant TBD[b]	None	TAL Metals analyses
		Natural and Depleted Uranium	TBD[b]	2.1-3.8 µg/g	U concentration (to confirm existing data)
		^{137}Cs	TBD[b]	0.16-0.25 pCi/g	^{137}Cs concentration (to confirm existing data)

[a] Trigger levels for nonradionuclides are the proposed RCRA Subpart S action levels (EPA 1990, 0432). Trigger levels for radionuclides and nonradioactive hazardous constituents not listed in Subpart S will be provided in the LANL 1992 Installation Work Plan.

[b] TBD: To Be Determined

[c] LANL 1981, 0141 and Gunderson et al 1983, 0671

TABLE 3.6-4. CHARACTERISTICS OF SWMUS AND ASSOCIATED STRUCTURES IN TA-45 (CONT'D)

SWMU	DESCRIPTION	CONTAMINANTS OF CONCERN	TRIGGER LEVELS[a]	RANGE OF EXISTING DATA[c]	ADDITIONAL DATA REQUIRED
45-004	Sanitary Sewer Outfall	Unknown	TBD[b]	None	Full gamma spec analysis. TAL Metals analyses Organic Compounds analyses.
C-45-001	Parking Lot	Unknown	TBD[b]	None	Full gamma spec analysis. TAL Metals analyses. Organic Compounds analyses.

[a] Trigger levels for nonradionuclides are the proposed RCRA Subpart S action levels (EPA 1990, 0432). Trigger levels for radionuclides and nonradioactive hazardous constituents not listed in Subpart S will be provided in the LANL 1992 Installation Work Plan.

[b] TBD: To Be Determined

[c] LANL 1981, 0141 and Gunderson et al. 1983, 0671

TABLE 3.6-4. CHARACTERISTICS OF SWMUS AND ASSOCIATED STRUCTURES IN TA-45 (CONT'D)

SWMU	DESCRIPTION	CONTAMINANTS OF CONCERN	TRIGGER LEVELS [a]	RANGE OF EXISTING DATA [c]	ADDITIONAL DATA REQUIRED
1-002	Untreated Waste Outfall	^{238}Pu	TBD[b]	0.0-1.4 pCi/g	^{238}Pu concentration (to confirm existing data)
		^{239}Pu	TBD[b]	0.09-370 pCi/g	^{239}Pu concentration (to confirm existing data)
		^{3}H	TBD[b]	None	^{3}H concentration in soil moisture
		^{90}Sr	TBD[b]	0.6-1.0 pCi/g	^{90}Sr concentration (to confirm existing data)
		^{241}Am	TBD[b]	0.3-1.0 pCi/g	^{241}Am concentration (to confirm existing data)
		Organic Compounds	Dependent on contaminant TBD[b]	None	Organic Compounds analyses
		TAL Metals	Dependent on contaminant TBD[b]	None	TAL Metals analyses
		Natural and Depleted Uranium	TBD[b]	None	U concentration
		^{137}Cs	TBD[b]	0.1-2.3 pCi/g	^{137}Cs concentration (to confirm existing data)

[a] Trigger levels for nonradionuclides are the proposed RCRA Subpart S action levels (EPA 1990, 0432). Trigger levels for radionuclides and nonradioactive hazardous constituents not listed in Subpart S will be provided in the LANL 1992 Installation Work Plan

[b] TBD. To Be Determined

[c] LANL 1981, 0141 and Gunderson et al. 1983, 0671

3.6.2 Potential Pathways of Contaminant Migration

Available data suggest that low level surface and subsurface contamination with uranium and ^{90}Sr exists at the former TA-10 site. Therefore, several migration pathways are possible for the contaminants from the Firing Sites and Subsurface Disposal SWMU Aggregates. Potential pathways include erosional transport of contaminated surface soils by wind and water. Distribution and transport of contaminants in terrestrial ecosystems is typically dominated by the hydrologic processes and will likely influence the migration of contaminants at the Bayo Canyon Site. Research over several years at Los Alamos, Trinity Site, and the Nevada Test Site demonstrates the effectiveness of runoff and erosion in transporting radionuclides in arid and semiarid environments (Hakonson and Bostick 1976, 0679; Nyhan et al. 1976, 0160; Nyhan et al. 1976, 0685; Hakonson and Nyhan 1980, 0117; Nyhan et al. 1985, 0168; Essington and Romney 1986, 0666). Soil samples collected in Bayo Canyon show that some contamination was present on or near the soil surface such that transport of that material in association with runoff and sediment is highly probable given the steep canyon topography and stream channel network that drains the site.

Even though the relative mobility of contaminants depends on the affinity of the contaminants for the minerals in soil, laboratory studies (e.g., Conca 1991, 0665 and Wierenga et al. 1975, 0687) indicate that the mobility of contaminants under unsaturated conditions is very limited. Conca (1991, 0665) has reported the hydraulic conductivities for tuffaceous materials in the Yucca Mountain area as a function of water content. Hydraulic conductivity decreases dramatically with decreasing water content. Consequently, even assuming no affinity of the contaminants for the soil (as is expected for organics such as benzene and carbon tetrachloride), a very limited amount of transport is expected under unsaturated conditions and it is reasonable to assume that radioactive contamination correlates with nonradioactive contamination.

Several migration pathways are possible from SWMU 31-001, the former septic tank and outfall location at TA-31. Potential pathways include erosional transport of contaminated surface soils by wind and surface water. Distribution and transport of contaminants is dominated by the hydrologic processes, and will likely influence the migration of contaminants from SWMU 31-001.

Several migration pathways are possible from SWMUs 32-001 (former incinerator) and 32-002(a-b) (former septic tanks and outfalls) at TA-32. Potential pathways include erosional transport of contaminated surface soils by wind and surface water. Distribution and transport of contaminants is dominated by the hydrologic processes, and will likely influence the migration of contaminants from SWMUs 32-001 and 32-002(a-b).

Available data suggest that low level surface and subsurface contamination with radionuclides exist at the former TA-45 site. Therefore, several migration pathways are possible from the former TA-45 SWMUs. Potential pathways include erosional transport of exposed contaminated subsurface soils by wind and surface water. Distribution and transport of contaminants is dominated by the hydrologic processes, and will likely influence the migration of contaminants at the TA-45 Site.

3.6.2.1 Air Transport

The estimation of risk due to the air transport pathway for the COCs requires data on the particle size distribution of each contaminant, and the wind speed in the area of contamination. Suspension of soil dust is described by Hidy (1984, 0724). Hidy (1984, 0724) notes that the gravitational sedimentation process strongly depletes particles larger than 10 μm in diameter; hence, it can be inferred that casual exposure to larger particles will be limited. However, tilling or excavating is expected to expose the worker to larger particles.

3.6.2.2 Soil Erosion and Surface Water Transport

Erosional transport of exposed contaminants within subsurface soils is highly probable in Acid Canyon and Bayo Canyon. However, the surficial erosion rate in the vicinity of the former TA-10, TA-31, TA-32, and TA-45 SWMUs is not known. Previous studies in nearby canyons (Hakonson and Bostick 1976, 0679; Nyhan et al. 1976, 0685) show that once contaminants reach the stream channel, the alluvium can be rapidly transported to downstream areas by runoff. Frequent flushing of sediments to downstream areas can keep upstream inventories of contaminants relatively low. Therefore, when transport of soil contaminants to the channel ceases (such as after a cleanup operation), contaminant inventories in the channel decrease commensurate with the size and frequency of runoff events. This means that monitoring results based upon infrequent sampling of channel sediments will have limited relevance in evaluating the magnitude of contaminant movement to downstream areas.

3.6.3 Potential Public Health and Environmental Impacts

Radiological dose and associated risks from residual contamination following cleanup of Bayo Canyon were assessed by Ferenbaugh et al. (1982, 0667) and Mayfield et al. (1979, 06-0041), using the FUSRAP data collected in 1977. Dose calculations indicate that doses for the Firing Sites SWMU Aggregate for recreational users of the canyon, permanent residents, and construction workers, and doses for workers involved in excavation of contaminated soil are less than DOE guidelines. Extensive details of this assessment are found in Ferenbaugh et al. (1982, 0667), and Mayfield et al. (1979, 06-0041).

Radiological dose and associated risks from residual contamination following cleanup of TA-45 and Acid Canyon were assessed by Ferenbaugh et al. (1982, 0668) using the FUSRAP data collected in 1977. Calculations based on actual measurements indicate that the annual dose at the location having the greatest residual activity in Acid Canyon would be about 12% of the DOE guideline.

Extensive details of this assessment are found in Ferenbaugh et al. (1982, 0668) and LANL (1981, 0141).

3.6.3.1 Direct Exposure of Receptors To On-Site Constituents

Radiological Hazard

Receptors living on or visiting the former TAs in OU 1079 could potentially receive radiation exposures directly or through dermal abrasions, if radionuclides are present. Former TAs 10 and 45 may present the most radiological hazard, based on historical site use. Probable locations of residual radioactivity would be in the area of the untreated waste outfall on the Acid Canyon north-facing slope, and in the canyon floors of Bayo, Acid and Pueblo Canyons, where previous monitoring has confirmed residual radionuclides in the channel sediment.

Relatively low levels of near-surface radiation reduces the hazard of significant radiation dosage. Nonetheless, the long history of activities at former TAs-10 and -45 and the variety of potential contaminants require a comprehensive radiological survey review, and a thorough sampling and analysis regime to understand the complexities of contaminant interrelationships (e.g., radiological materials vs. heavy metal concentration).

Chemical Hazard

Receptors living on or visiting the OU 1079 sites might be exposed to residual concentrations of chemicals potentially contaminating the soils, sediments, and/or bedrock. All receptors present on the sites could be subject to dermal, ingestion and/or inhalation exposure to chemicals and their vapors contaminating the soils in the area.

3.6.3.2 Mobilization and Dispersion of Constituents via Air Transport

Radiological Hazard

Radiological constituents adsorbed onto soil or sediment particles or occurring as discrete grains would be mobilized by wind or by human activity such as bulldozing, tilling, or excavation. The particles would be transported downwind to potential receptors. Exposure from this pathway would occur through the inhalation and ingestion exposure modes.

Chemical Hazard

Chemical constituents adsorbed onto soil or sediment particles or occurring as discrete grains would be mobilized by wind or by human activity such as bulldozing, tilling, or excavation. Particles would be transported downwind to potential receptors. Exposure from this pathway would occur through the inhalation and ingestion exposure modes.

3.6.3.3 Mobilization and Dispersion of Constituents as Sediments and Solutes

A third exposure pathway could result from the erosion of contaminated surface soils by wind or running water. Sediments would be intermittently transported down slope to the stream channel. Some portion of the constituents would remain in the channel as sediment, while the remainder would be transported either as particles or as dissolved species in the stream water. The exposure pathway is ingestion of stream-borne sediments, dry sediments, or stream water carrying dissolved constituents.

Radiological Hazard

Radioactive materials could occur among sediments as adsorbed particles or discrete grains would be accessible for ingestion by humans resulting in long-term exposure. Bedrock (tuff) beneath the outfall areas could act as a reservoir for downward-migrating radioactive particulates. More rapid transport of soluble ^{90}Sr in the stream channel and the vadose zone may potentially affect off-site receptors.

Chemical Hazard

The health threat posed by small reservoirs of chemical residue, dissolved chemical species, or dispersed concentrations of heavy metals in sediments and solutes resides mainly in the ingestion of soil and contaminated water. This exposure mode may both surface and subsurface waters due to mobilization downgradient by sufficient pulses of water from precipitation events. However, likelihood of constituents eventually reaching the deep aquifer is thought to be insignificant.

3.6.4 Conceptual Model TA-10

Historical D & D programs for SWMUs in Operable Unit 1079 have focussed on the removal of radioactive contamination. While these D & D activities likely removed hazardous constituents from the environment concurrently with the radionuclides, no data were collected to confirm the presence or absence of residual hazardous constituents. The conceptual models for each of the SWMU aggregates are summarized in the following sections and include discussions of the nature and extent of documented residual contamination at the SWMUs comprising OU 1079, the potential environmental pathways and transport mechanisms for contaminant release, and the potential contaminant receptors.

The TA-10 Firing Sites SWMU Aggregate is located near the ephemeral stream channel in Bayo Canyon and was active between 1944 and 1961. Implosion devices were detonated at the firing sites shot pads; consequently 10-001(a-e) are designated as SWMUs. Based on the operational history of the site, constituents related to test firings were widely distributed over the canyon floor, up the canyon hillslopes, and on the adjacent mesa tops.

The TA-10 Subsurface Disposal SWMU Aggregate is located near the ephemeral stream channel in Bayo Canyon and was active between 1944 and 1961. The purposes of the laboratories, personnel buildings, waste and leach pits were to support the manufacture, assembly, and detonation of implosive devices; to perform radiochemical analyses on the detonation products; and on-site disposal of both mixed hazardous and sanitary wastes. Constituents related to laboratory processing of device components and products were disposed of in either solid or liquid disposal systems, and either on the surface or in the shallow subsurface.

A flow chart illustrating the conceptual site model for TA-10 is presented in Figure 3.6-1. The chart follows the constituent pathways from source to receptor. The sequence includes test components and waste products which provide the primary source for residual contaminants, the release mechanisms for those primary sources, the secondary sources and release mechanisms, environmental pathways, and modes of exposure to receptors. The conceptual model proposes exposure units comprised of the canyon floor (including the channel of the stream bed), the canyon hillslopes, and the adjacent mesa tops. The last column provides a relative ranking of the significance of each SWMU based on release mechanism, pathway, and availability of, and pathway to, a receptor. This qualitative ranking is intended to further guide the development of a sampling and analysis plan.

There are three dominant potential exposure modes for receptors at the sites. These are direct exposure to on-site constituents (primarily radiological), inhalation of constituents via air transport, and exposure through ingestion of soil, sediments, and water.

3.6.5 Conceptual Model TA-31

Figure 3.6-2 is a flow chart illustrating the conceptual site model for TA-31, which shows the contaminant pathways from source to receptor. The chart takes into account the most probable sources or contaminant reservoirs, including the underlying bedrock. Since the septic tank has been removed, the primary source of contamination is no longer available. The secondary sources of potential contamination are the soil, sediments, and bedrock, which may contain potential residual contaminants. The secondary release mechanisms include excavation, dust emissions, and water/runoff. Pueblo Canyon contains perennial stream flow and is located adjacent to the hillslope beneath SWMU 31-001.

There are three exposure scenarios for receptors of these constituents both on site and off, should transport beyond SWMU 31-001 occur. These are direct exposure, dispersion of constituents via air transport, and mobilization and dispersion of contaminants as sediments and solutes.

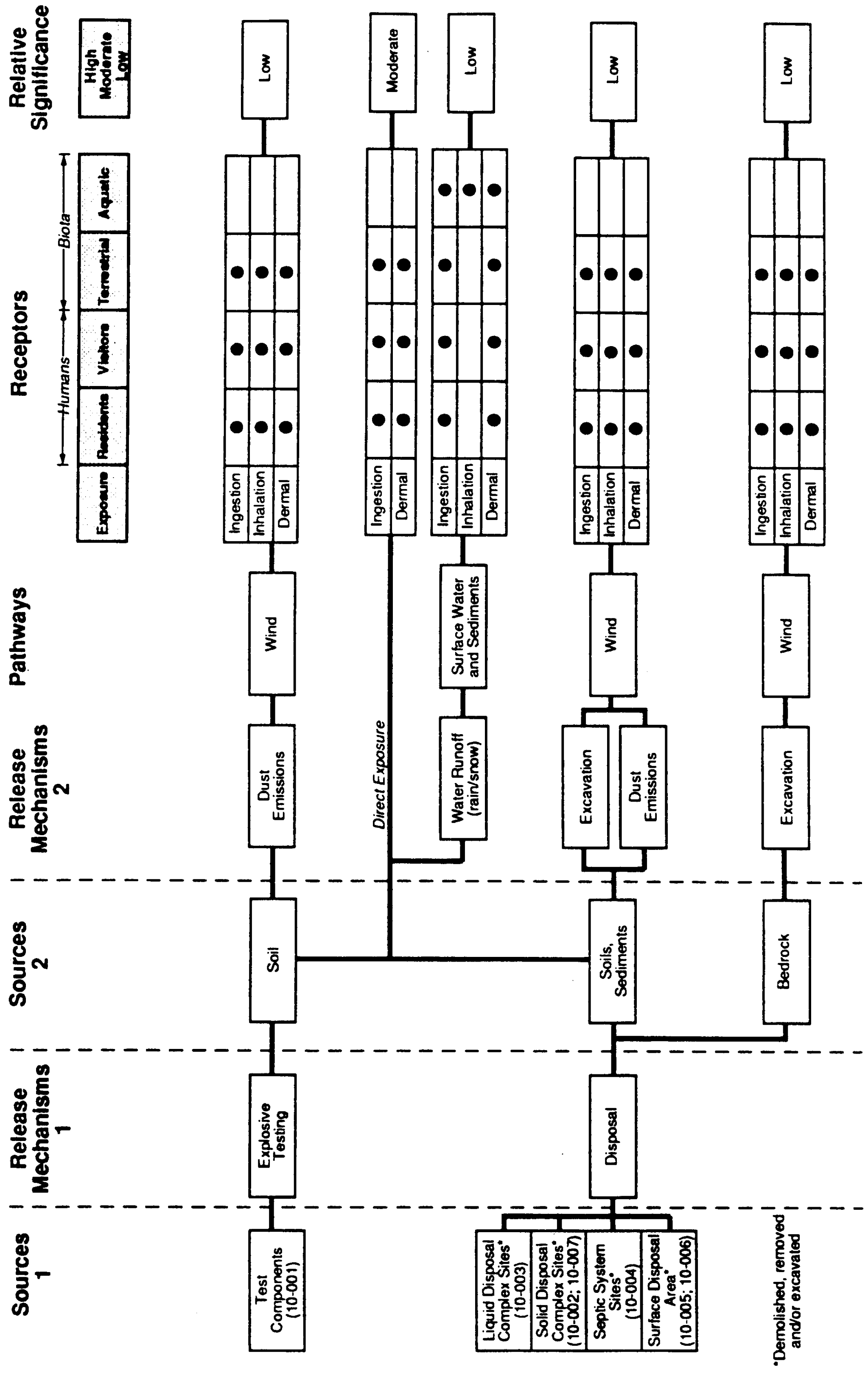

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FIGURE 3.6-1. TA-10 conceptual model flow diagram.

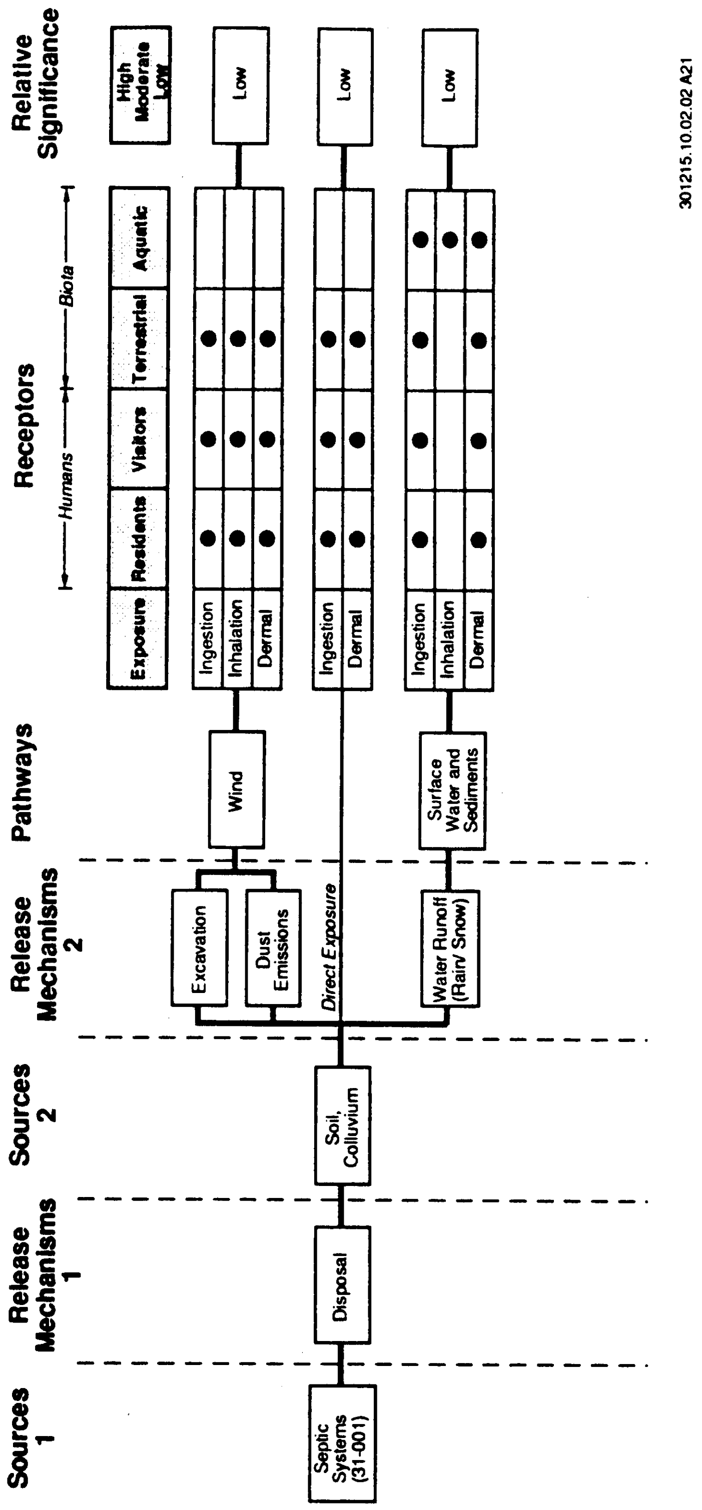

FIGURE 3.6-2. TA-31 conceptual model flow diagram.

3.6.6 Conceptual Model TA-32

Figure 3.6-3 is a flow chart illustrating the conceptual site model for TA-32, which shows the contaminant pathways from source to receptor. The chart takes into account the most probable sources or contaminant reservoirs, including the underlying bedrock. Since the incinerator (SWMU 32-001) and the septic tanks [SWMUs 32-002(a-b)] have been removed, the primary sources of contamination are no longer available. The secondary sources of potential contamination are the soil, sediments, and bedrock, which may contain residual contaminants. The secondary release mechanisms include excavation, dust emissions, and water/runoff. Los Alamos Canyon contains a perennial stream flow located adjacent to the hillslope beneath SWMUs 32-002(a-b).

There are three exposure scenarios for receptors of these constituents both on site and off, should contaminant transport beyond SWMUs 32-001 and 32-002(a-b) occur. These are direct exposure, dispersion of constituents via air transport, and mobilization and dispersion of contaminants as sediments and solutes.

3.6.7 Conceptual Model TA-45

A flow chart illustrating the conceptual site model for the former TA-45 site is presented in Figure 3.6-4. The chart follows the constituent pathways from source to receptor. The sequence includes SWMUs associated with waste treatment, which provides the primary sources for residual contaminants, the release mechanisms for those primary sources, the secondary sources and release mechanisms, environmental pathways, and modes of exposure to receptors. The conceptual model proposes exposure units comprised of the canyon floor (including the channel of the stream bed), the canyon hillslopes, and the adjacent mesa top. The last column provides a relative ranking of hazard based on release mechanism, pathway, and availability of, and pathway to, a receptor. This qualitative ranking is intended to further guide the development of a sampling and analysis plan.

There are three potential exposure modes for receptors at the sites. These are direct exposure to on-site constituents (primarily radiological), inhalation of constituents via air transport, and exposure through ingestion of soil, sediments, and water. No chemical constituents posing a health risk to the public have been detected in water and sediment samples collected from the Acid Weir station during the annual surveillance monitoring program (see Appendix C).

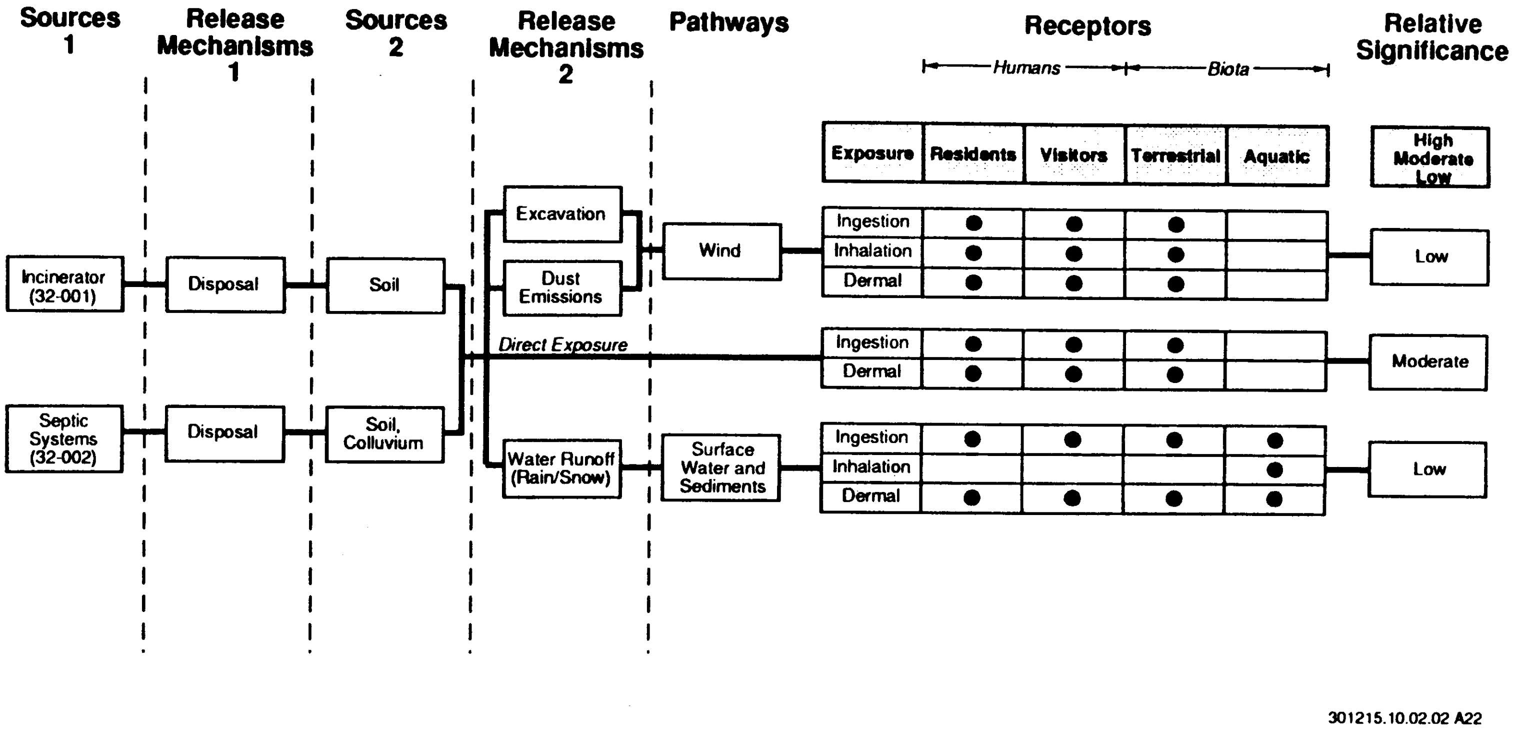

FIGURE 3.6-3. TA-32 conceptual model flow diagram.

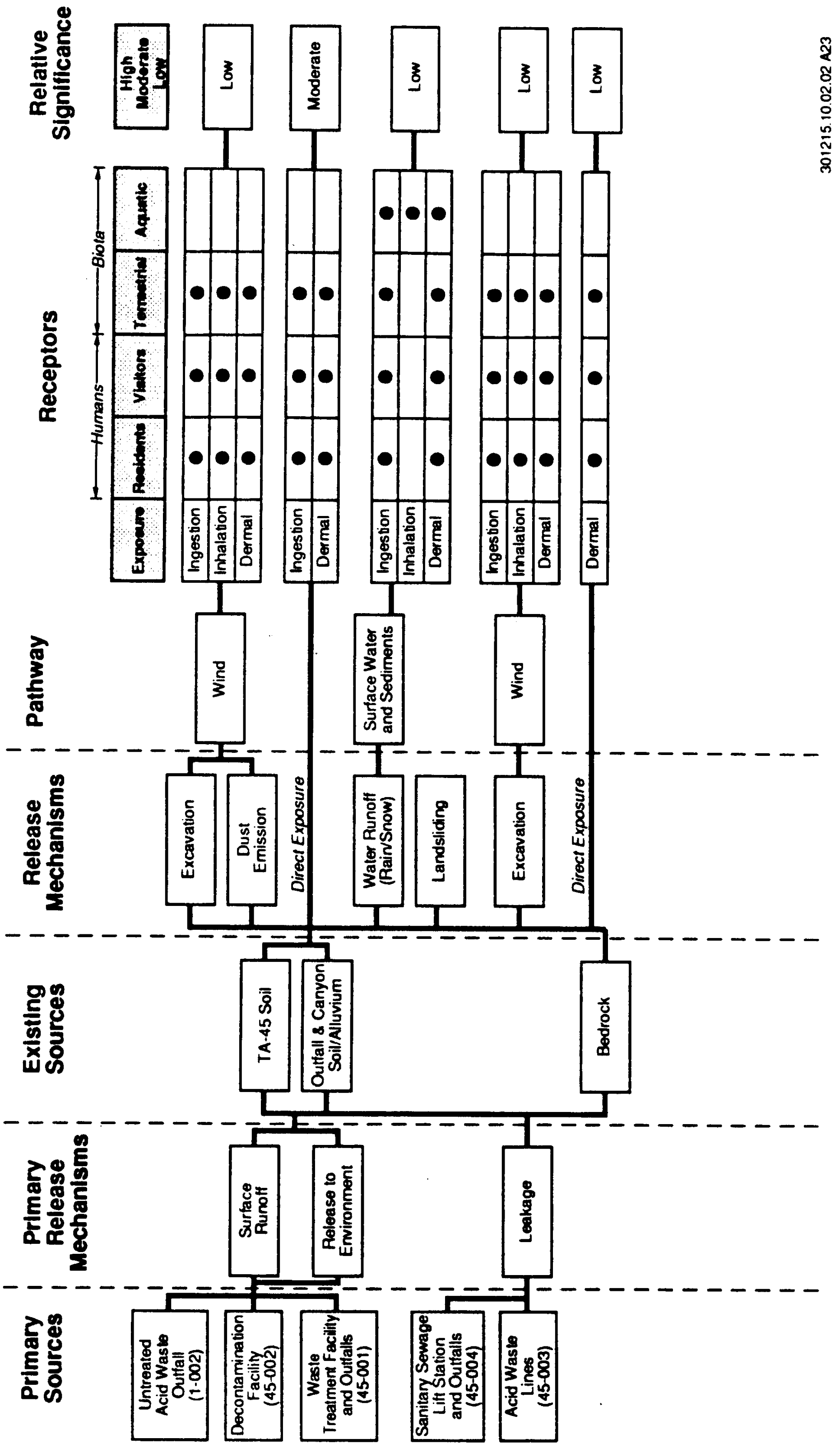

FIGURE 3.6-4. TA-45 conceptual model flow diagram.

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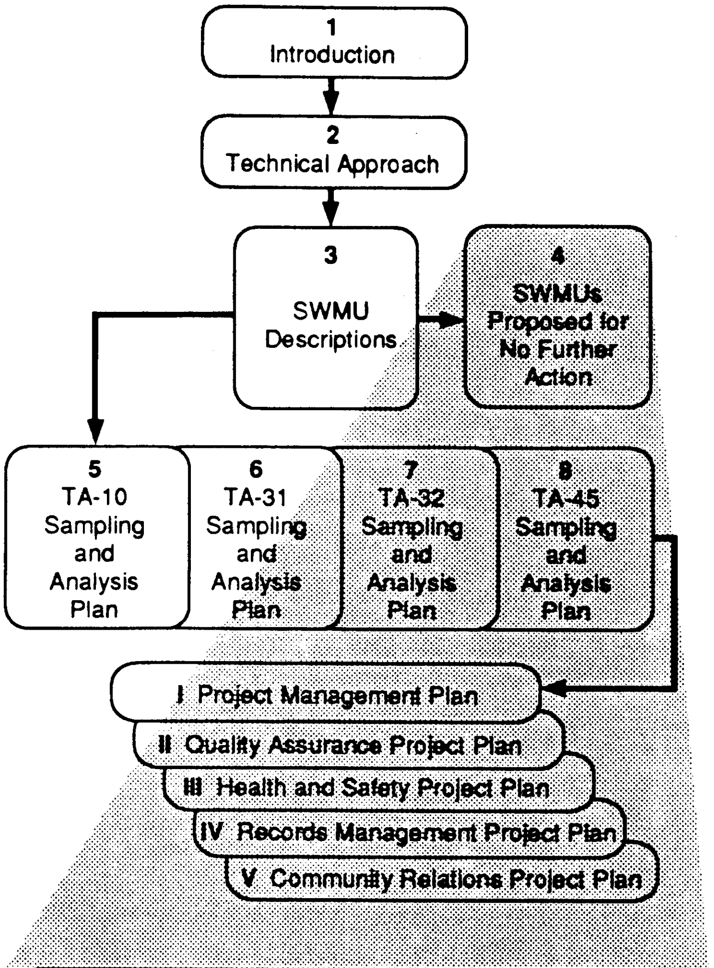
CHAPTER 4



SWMUs Proposed for No Further Action

- SWMU Description and Historical Operation
- Recommendation Rationale

4.0 SWMUS PROPOSED FOR NO FURTHER ACTION

4.1 Technical Area 10 (TA-10) - Bayo Canyon

There are two Solid Waste Management Units (SWMUs) in TA-10 proposed for no further action: SWMU 10-001(e), a sand pile detonation test area; and SWMU 10-006, unspecified locations where various open burning operations took place.

4.1.1 SWMU 10-001(e)

4.1.1.1 SWMU Description and Historical Operation

An area adjacent to the firing sites [SWMUs 10-001(a-d)] was used for sand pile detonation tests, reportedly to develop procedures for containing shot debris. This site, which has been designated as SWMU 10-001(e), was thought to be located in the vicinity of the firing sites shot pads (Figure 4.1-1; Figure A-10-1, Appendix A). However, the SWMU is not documented in any of the original site maps and contained no aboveground structures (LANL 1990, 0145).

4.1.1.2 Rationale for Recommendation

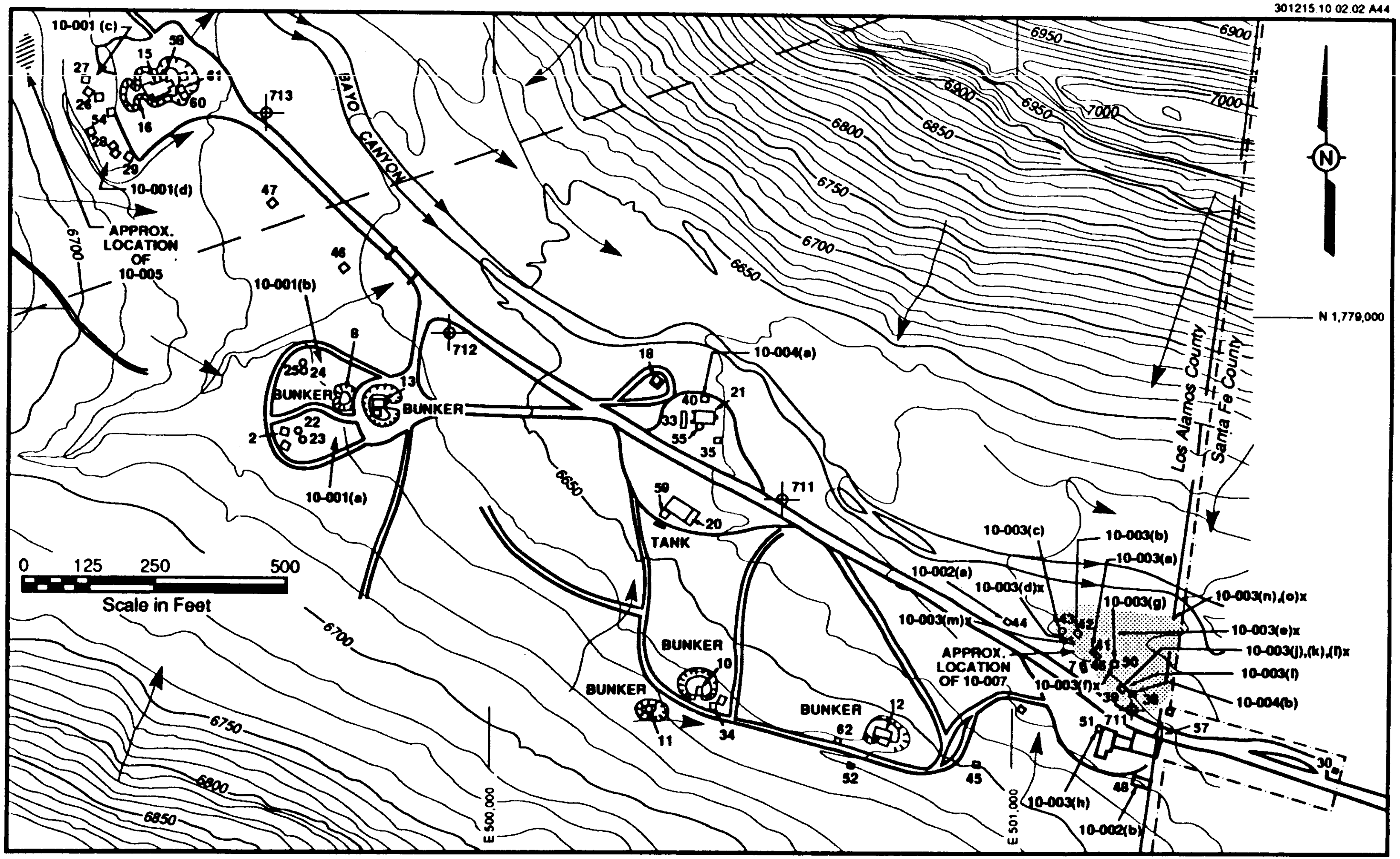
SWMU 10-001(e) is proposed for no further action as an individual unit because any potential residual surface contamination from SWMU 10-001(e) will be encountered during the sampling activities associated with the Firing Sites SWMU Aggregate (see Chapter 5). Due to this SWMU's proximity to the firing sites, it is probable that the extensive surface soil removal in the vicinity of the firing sites during the 1963 decontamination and decommissioning of TA-10 included the area that comprises SWMU 10-001(e) (Figure A-10-4, Appendix A).

4.1.2 SWMU 10-006

4.1.2.1 SWMU Description and Historical Operation

Various burning operations were conducted at TA-10, primarily during the 1950s and early 1960s. In 1955, ^{238}U solutions were deposited on plywood and burned for unknown reasons (H-Division 1955, 0673). The fate of the ash, which emanated 20 mR/h of gamma radiation on contact, is also unknown. In 1956, a Laboratory work order (LASL 1956, 06-0024) was issued to initiate construction of a burning pit for combustibles. The ash was to be disposed of in MDA-C at TA-50. While the creation of this pit coincided with the excavation and burning of waste from the surface disposal site (SWMU 10-005) in 1957, it is not definitely known what the burn pit was used for, or where it was located (Figure 4.1-1) (LANL 1990, 0145).

As decommissioning of TA-10 began, many of the structures were burned either in place, or in other locations at the site such as the stream channel and open



NOTE: Exact Locations of 10-001(e) and 10-005, Unknown
x - Approximate Locations

LEGEND

10 – TA Structure Number

10-001(a) – SWMU Number

▨ – Probable Extent of 10-007

– – – – Fence

Figure 4.1-1. TA-10 site map and no further action SWMUs (modified from LANL 1990, 0145; AEC 1963, 06-0045; AEC 1963, 06-0044; AEC 1963, 06-0046; AEC 1963, 06-0047; AEC 1963, 06-0048; AEC 1963, 06-0049; AEC 1963, 06-0050; LASL 1961, 06-0056; LASL 1961, 06-0057; LASL 1962, 06-0058).

areas around the site. Overall, the records concerning open burning activities are incomplete, and details concerning location, type of combustible material, and disposition of the ash are largely unknown. Based upon reported radiation doses of a few mR/h in the ash, it is likely that contaminated ash was transported to either MDA-C at TA-50 or MDA-G at TA-54 (LANL 1990, 0145).

Contaminants associated with open burning activities would have included uranium (natural and depleted), ^{90}Sr, and high explosives. The quantities of contaminants associated with the open burning operations is unknown (LANL 1990, 0145).

4.1.2.2 Rationale for Recommendation

SWMU 10-006 is proposed for no further action as an individual unit because any residual surface contamination from SWMU 10-006 will be encountered during the sampling activities associated with the Firing Sites SWMU Aggregate (see Chapter 5).

4.2 Technical Area 31 (TA-31) - East Receiving Yard

There is one area in TA-31 proposed for no further action: Area of Concern (AOC) C-31-001, potential soil contamination beneath former structures and the parking lot.

4.2.1 Area of Concern C-31-001

4.2.1.1 AOC Description and Historical Operation

AOC C-31-001 consists of the soil beneath former structure locations and the paved parking area, and is considered an AOC based on the potential for surface spills during past operation of TA-31 (Figure 4.2-1). The structures at TA-31 included six warehouses, a roofed receiving dock, a small virgin oil drum storage area (less than 100 ft^2), a transformer station, and a septic tank system (SWMU 31-001). No chemicals were routinely stored at TA-31 during its operation. Hazardous chemicals, when received by the Laboratory, were transported to the chemical storage area at TA-21. The only liquid storage documented at TA-31 was the virgin oil products (likely fuel oil).

4.2.1.2 Rationale for Recommendation

The storage yard AOC was paved with asphalt soon after TA-31 was opened, which protected the underlying soils from liquid spills. Possible contamination on the asphalt and soil immediately under it would have been removed or disturbed beyond the point at which the site could be characterized when the site was decommissioned (exact date unknown). The storage site has been occupied by the Eastern Area residential development since 1955 (Figure A-31-2, Appendix A).

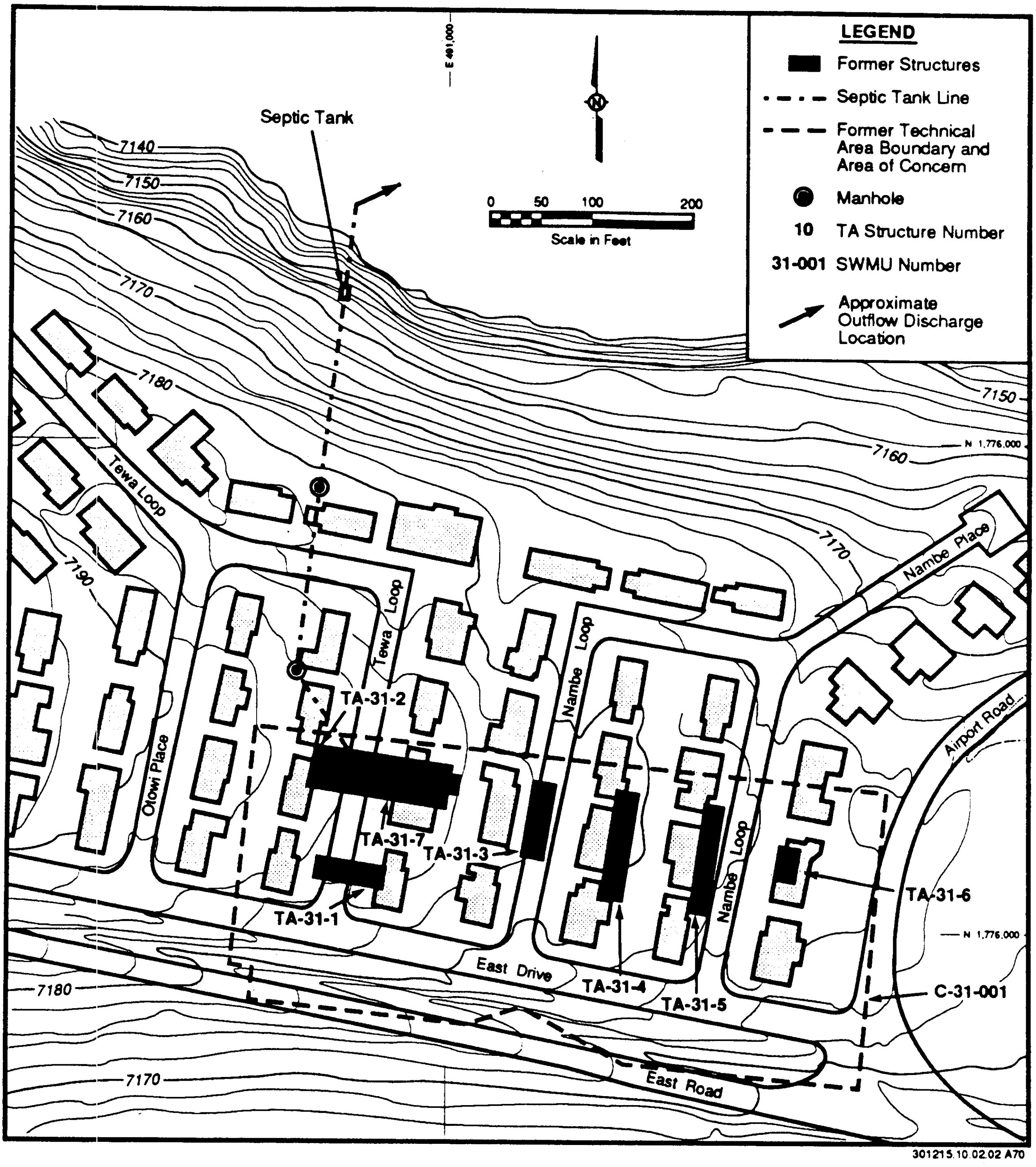


Figure 4.2-1. TA-31 site map and Area of Concern location (modified from LANL 1990, 0145; AEC 1963, 06-0016; AEC 1963, 06-0030; Los Alamos County 1986, 06-0061; LASL 1950, 06-0054).

No further action is proposed for the AOC because there are no records of any hazardous materials being stored at the site or any documented spills of hazardous material.

4.3 Technical Area 32 (TA-32) - Medical Research Facility

There is one area in TA-32 proposed for no further action: AOC C-32-001, potential soil contamination beneath former structure locations.

4.3.1 Area of Concern C-32-001

4.3.1.1 AOC Description and Historical Operation

AOC C-32-001 consists of the soil beneath the former structure locations at TA-32, and is considered an AOC based on the potential for surface spills during past operation of TA-32 (Figure 4.3-1). The structures at TA-32 included three laboratories, four warehouses, an office building, a valve house, an incinerator (SWMU 32-001), and two septic tanks [SWMUs 32-002(a-b)].

4.3.1.2 Rationale for Recommendation

Possible contamination in the soil beneath the former structures would have been removed or disturbed beyond the point at which characterization could take place when the site was decommissioned. No further action is proposed for the AOC because there are no records of any spills of hazardous material occurring at the site.

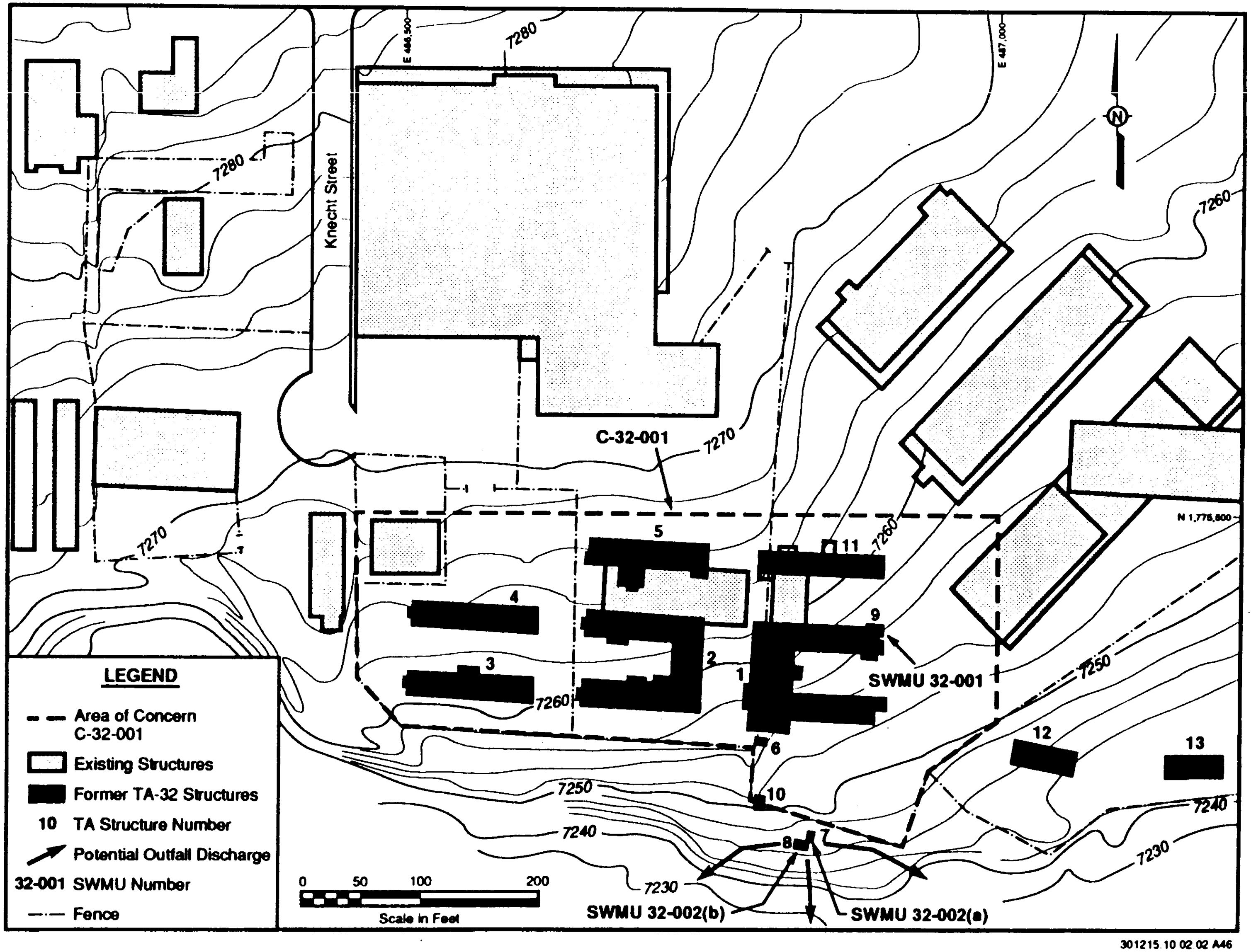


Figure 4.3-1. TA-32 site map and Area of Concern location (modified from LANL 1990, 0145; AEC 1963, 06-0032; AEC 1963, 06-0031; Los Alamos County 1986, 06-0062; Los Alamos County 1986, 06-0063; LASL 1953, 06-0055).

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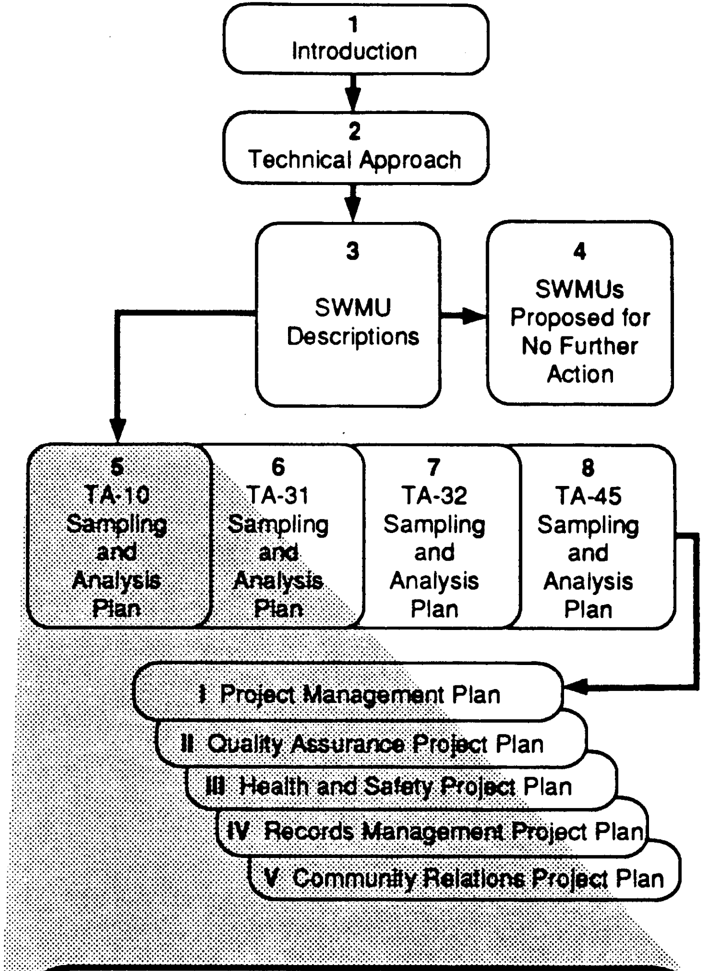
CHAPTER 5



TA-10 Sampling and Analysis Plan

- Firing Sites SWMU Aggregate
- Subsurface Disposal SWMU Aggregate

5.0 TECHNICAL AREA 10 (TA-10) SAMPLING AND ANALYSIS PLANS

Section 2.2 describes the Data Quality Objectives (DQO) process as applied in this work plan. In the following sections, the DQO process is used to develop the sampling rationale and sampling plans for collecting environmental data at the TA-10 SWMU Aggregates. These data will be used to determine whether a SWMU or SWMU Aggregate should be recommended for no further action or should be investigated further. DQOs are developed for the Firing Sites SWMU Aggregate for surface and sediment sampling and for the Subsurface Disposal SWMU Aggregate for subsurface sampling.

5.1 DQO Process for Firing Sites SWMU Aggregate 10-001(a-d)

As discussed in Chapter 3, possible residual contamination from previous firing site activities is limited to the surface soils. However, any contaminants being transported along the surface, either in solution or adsorbed onto sediment particles will move down gradient toward the channel and be incorporated into the sediments moving along the bed of the channel. Therefore, DQOs have been developed for both the surface soils and the channel sediments.

5.1.1 Surface Soils

5.1.1.1 Problem Statement

Surface soils consist of the upper 5 to 10 cm of soil. Previous studies show that the only residual radiological contaminants from former firing site activities are strontium-90 (^{90}Sr) and total uranium (U). These studies also show that health-risks from these contaminants are well below acceptable levels for residential use scenarios. Chapter 3 identifies three possible contaminants of concern that have not been investigated in previous studies: beryllium (Be), barium (Ba), and lead (Pb). The possibility of residual surface soil contamination from these metals is considered to be the primary problem for the Firing Sites SWMU Aggregate. Therefore, the sampling objective is to answer the question,

> "Are risks from surface soil concentrations of Be, Ba, and Pb below acceptable levels at TA-10?"

Answering this question requires providing adequate data for a baseline risk assessment.

Concerns about surface soil contamination from Be, Ba, and Pb drive the sampling plan design (spacing of grid, etc.). However, to verify results from earlier studies of ^{90}Sr and total U, all samples will also be analyzed for these constituents. These data will be used to confirm the results that ^{90}Sr and total U present no unacceptable health risk under residential scenarios. In addition, the previous data will be reevaluated using current risk assessment protocols for residential scenarios.

5.1.1.2 Decision Process

The following "if, then" statements describe the decision process associated with the surface soil investigation.

If the average concentrations of contaminants in all exposure units are below trigger levels for the unrestricted use scenario, then there will be no need for surface soil remediation . Previous studies, as described in Chapter 3, indicate that this is the most probable outcome. Trigger levels for nonradiological contaminants, methods of analyses, and detection limits are given in Table 5.1-1.

If the exposure unit contaminant levels are greater than the trigger levels and background concentrations then a Voluntary Corrective Action (VCA) may be conducted or a baseline risk assessment may be performed. If the baseline risk assessment if performed and indicates unacceptable health-risks, then a VCA may be conducted or corrective measures study will be implemented. However, if the baseline risk assessment indicates that contaminant concentrations do not present unacceptable health-risks, then there will be no need for surface soil remediation.

In the unlikely case that remediation of surface soils is required, it may be necessary to take additional samples in the contaminated areas (Phase II sampling) to more narrowly define the extent of contamination and thus reduce the amount of material that will be cleaned-up. A flow diagram of the decision process is summarized in Figure 5.1-1.

5.1.1.3 Data Needs

5.1.1.3.1 Source Characterization

A land survey must be conducted to locate positions of all former buildings and other facilities, locate the boundaries of the previous Bayo Canyon survey, and determine the grid for surface sampling.

The source data required to support the decision process described above are the concentrations of Be, Ba, Pb, ^{90}Sr, and total U in surface soils. The plan for collecting these data is described in Sections 5.1.1.6.

5.1.1.3.2 Environmental Setting

Risk scenarios for baseline risk assessments include residential, worker, and recreational use. These scenarios can be evaluated with existing environmental data.

TABLE 5.1-1 LABORATORY ANALYSES FOR THE TA-10 SWMU INVESTIGATIONS

SWMU	DESCRIPTION	CONTAMINANTS OF CONCERN	TRIGGER LEVELS[a]	METHOD OF ANALYSIS	DETECTION LIMIT	QUALITY LEVEL
10-001 (a-d)	Firing Sites and Sand Pile Detonation Area	^{90}Sr	TBD[b]	Gas Flow Proportional Counting	2.0 pCi/g	III
		Natural and Depleted Uranium	TBD[b]	Radiochemical Separation and Alpha Spectroscopy	0.01 pCi/g	III
		Lead	TBD[b]	EPA SW-846 Method 6010 Inductively Coupled Plasma-Atomic Emission Spectroscopy	42 µg/L 4.2 mg/kg[c]	III
		Beryllium	0.2 mg/kg	EPA SW-846 Method 6010 Inductively Coupled Plasma-Atomic Emission Spectroscopy	0.3 µg/L 0.03 mg/kg[c]	III
		High Explosives	TBD[b]	USATHAMA by High Performance Liquid Chromatography	Contaminant Dependent (see Table V.10, LANL 1991,0412)	III
		Barium	4,000 mg/kg	EPA SW-846 Method 6010 Inductively Coupled Plasma-Atomic Emission Spectroscopy	2 µg/L 0.2 mg/kg[c]	III

[a] Trigger levels for nonradionuclides are the proposed RCRA Subpart S action levels (EPA 1990,0432). Trigger levels for radionuclides and nonradioactive hazardous constituents not listed in Subpart S will be provided in the LANL 1992 Installation Work Plan.

[b] TBD: To Be Determined

[c] Assuming all the contaminant in 1g of soil can be extracted into 100 ml of solution.

TABLE 5.1-1 LABORATORY ANALYSES FOR THE TA-10 SWMU INVESTIGATIONS (CONT'D)

SWMU	DESCRIPTION	CONTAMINANTS OF CONCERN	TRIGGER LEVELS[a]	METHOD OF ANALYSIS	DETECTION LIMIT	QUALITY LEVEL
10-002 (a-b)	Solid Disposal Pits	^{90}Sr	TBD[b]	Gas Flow Proportional Counting	2.0 pCi/g	III
		Natural and Depleted Uranium	TBD[b]	Radiochemical Separation and Alpha Spectroscopy	0.01 pCi/g	III
		Barium	4,000 mg/kg	EPA SW-846 Method 6010 Inductively Coupled Plasma-Atomic Emission Spectroscopy	2 µg/L 0.2 mg/kg[c]	III
		Cadmium	40 mg/kg	EPA SW-846 Method 6010 Inductively Coupled Plasma-Atomic Emission Spectroscopy	4 µg/L 0.4 mg/kg[c]	III
		TAL Metals	Dependent on Contaminant TBD[b]	EPA SW-846 Method 6010, 7060, 7470, and 7740 (Inductively Coupled Plasma Emission Spectroscopy, Graphite Furnace Atomic Absorption Spectroscopy, and Cold Vapor Atomic Absorption Spectroscopy)	Contaminant Dependent (see TableV.7, LANL 1991,0412)	III
		Semivolatile Organic Compounds	Dependent on Contaminant TBD[b]	EPA SW-846 Method 8270 Gas Chromatography/ Mass Spectrometry Capillary Column Technique	Contaminant Dependent (see Table V.4, LANL 1991,0412)	III
		Volatile Organic Compounds	Dependent on Contaminant TBD[b]	EPA SW-846 Method 8240 Gas Chromatography/ Mass Spectrometry	Contaminant Dependent (see Table V.3, LANL 1991,0412)	III

a Trigger levels for nonradionuclides are the proposed RCRA Subpart S action levels (EPA 1990,0432). Trigger levels for radionuclides and nonradioactive hazardous constituents not listed in Subpart S will be provided in the LANL 1992 Installation Work Plan.

b TBD: To Be Determined

c Assuming all the contaminant in 1g of soil can be extracted into 100 ml of solution.

TABLE 5.1-1 LABORATORY ANALYSES FOR THE TA-10 SWMU INVESTIGATIONS (CON'T)

SWMU	DESCRIPTION	CONTAMINANTS OF CONCERN	TRIGGER LEVELS[a]	METHOD OF ANALYSIS	DETECTION LIMIT	QUALITY LEVEL
10-003 (a-o)	Liquid Disposal System	^{90}Sr	TBD[b]	Gas Flow Proportional Counting	2.0 pCi/g	III
		Natural and Depleted Uranium	TBD[b]	Radiochemical Separation and Alpha Spectroscopy	0.01 pCi/g	III
		Barium	4,000 mg/kg	EPA SW-846 Method 6010 Inductively Coupled Plasma-Atomic Emission Spectroscopy	2 μg/L 0.2 mg/kg[c]	III
		Cadmium	40 mg/kg	EPA SW-846 Method 6010 Inductively Coupled Plasma-Atomic Emission Spectroscopy	4 μg/L 0.4 mg/kg[c]	III
		Lead	TBD[b]	EPA SW-846 Method 6010 Inductively Coupled Plasma-Atomic Emission Spectroscopy	42 μg/L 4.2 mg/kg[c]	III
		Beryllium	0.2 mg/kg	EPA SW-846 Method 6010 Inductively Coupled Plasma-Atomic Emission Spectroscopy	0.3 μg/L 0.03 mg/kg[c]	III
		Semivolatile Organic Compounds	Dependent on Contaminant TBD[b]	EPA SW-846 Method 8270 Gas Chromatography/Mass Spectrometry Capillary Column Technique	Contaminant Dependent (see Table V.4, LANL 1991, 0412)	III
		Volatile Organic Compounds	Dependent on Contaminant TBD[b]	EPA SW-846 Method 8240 Gas Chromatography/Mass Spectrometry	Contaminant Dependent (see Table V.3, LANL 1991, 0412)	III

[a] Trigger levels for nonradionuclides are the proposed RCRA Subpart S action levels (EPA 1990,0432). Trigger levels for radionuclides and nonradioactive hazardous constituents not listed in Subpart S will be provided in the LANL 1992 Installation Work Plan.

[b] TBD: To Be Determined

[c] Assuming all the contaminant in 1g of soil can be extracted into 100 ml of solution.

TABLE 5.1-1 LABORATORY ANALYSES FOR SWMU INVESTIGATIONS IN TA-10 (CONT'D)

SWMU	DESCRIPTION	CONTAMINANTS OF CONCERN	TRIGGER LEVELS[a]	METHOD OF ANALYSIS	DETECTION LIMIT	QUALITY LEVEL
10-004 (a-b)	Septic Tanks	^{90}Sr	TBD[b]	Gas Flow Proportional Counting	2.0 pCi/g	III
		Natural and Depleted Uranium	TBD[b]	Radiochemical Separation and Alpha Spectroscopy	0.01 pCi/g	III
		Barium	4,000 mg/kg	EPA SW-846 Method 6010 Inductively Coupled Plasma-Atomic Emission Spectroscopy	2 µg/L 0.2 mg/kg[c]	III
		Cadmium	40 mg/kg	EPA SW-846 Method 6010 Inductively Coupled Plasma-Atomic Emission Spectroscopy	4 µg/L 0.4 mg/kg[c]	III
		Lead	TBD[b]	EPA SW-846 Method 6010 Inductively Coupled Plasma-Atomic Emission Spectroscopy	42 µg/L 4.2 mg/kg[c]	III
		Beryllium	0.2 mg/kg	EPA SW-846 Method 6010 Inductively Coupled Plasma-Atomic Emission Spectroscopy	0.3 µg/L 0.03 mg/kg[c]	III
		Semivolatile Organic Compounds	Dependent on Contaminant TBD[b]	EPA SW-846 Method 8270 Gas Chromatography/Mass Spectrometry Capillary Column Technique	Contaminant Dependent (see Table V.4, LANL 1991, 0412)	III
		Volatile Organic Compounds	Dependent on Contaminant TBD[b]	EPA SW-846 Method 8240 Gas Chromatography/Mass Spectrometry	Contaminant Dependent (see Table V.3, LANL 1991, 0412)	III

[a] Trigger levels for nonradionuclides are the proposed RCRA Subpart S action levels (EPA 1990,0432). Trigger levels for radionuclides and nonradioactive hazardous constituents not listed in Subpart S will be provided in the LANL 1992 Installation Work Plan.

[b] TBD: To Be Determined

[c] Assuming all the contaminant in 1g of soil can be extracted into 100 ml of solution

TABLE 5.1-1 LABORATORY ANALYSES FOR THE TA-10 SWMU INVESTIGATIONS (CONT'D)

SWMU	DESCRIPTION	CONTAMINANTS OF CONCERN	TRIGGER LEVELS[a]	METHOD OF ANALYSIS	DETECTION LIMIT	QUALITY LEVEL
10-005	Surface Disposal	^{90}Sr	TBD[b]	Gas Flow Proportional Counting	2.0 pCi/g	III
		Natural and Depleted Uranium	TBD[b]	Radiochemical Separation and Alpha Spectroscopy	0.01 pCi/g	III
		Lead	TBD[b]	EPA SW-846 Method 6010 Inductively Coupled Plasma-Atomic Emission Spectroscopy	42 µg/L 4.2 mg/kg[c]	III
		Beryllium	0.2 mg/kg	EPA SW-846 Method 6010 Inductively Coupled Plasma-Atomic Emission Spectroscopy	0.3 µg/L 0.03 mg/kg[c]	III
		Barium	4,000 mg/kg	EPA SW-846 Method 6010 Inductively Coupled Plasma Atomic Emission Spectroscopy	2 µg/L 0.2 mg/kg[c]	III
		High Explosives	TBD[b]	USATHAMA by High Performance Liquid Chromatography	Contaminant Dependent (see Table V.10, LANL 1991,0412)	III

a Trigger levels for nonradionuclides are the proposed RCRA Subpart S action levels (EPA 1990,0432). Trigger levels for radionuclides and nonradioactive hazardous constituents not listed in Subpart S will be provided in the LANL 1992 Installation Work Plan.

b TBD: To Be Determined

c Assuming all the contaminant in 1g of soil can be extracted into 100 ml of solution.

TABLE 5.1-1 LABORATORY ANALYSES FOR THE TA-10 SWMU INVESTIGATIONS (CONT'D)

SWMU	DESCRIPTION	CONTAMINANTS OF CONCERN	TRIGGER LEVELS[a]	METHOD OF ANALYSIS	DETECTION LIMIT	QUALITY LEVEL
10-007	Landfill	^{90}Sr	TBD[b]	Gas Flow Proportional Counting	2.0 pCi/g	III
		Natural and Depleted Uranium	TBD[b]	Radiochemical Separation and Alpha Spectroscopy	0.01 pCi/g	III
		Barium	4,000 mg/kg	EPA SW-846 Method 6010 Inductively Coupled Plasma-Atomic Emission Spectroscopy	2 µg/L 0.2 mg/kg[c]	III
		Cadmium	40 mg/kg	EPA SW-846 Method 6010 Inductively Coupled Plasma-Atomic Emission Spectroscopy	4 µg/L 0.4 mg/kg[c]	III
		Lead	TBD[b]	EPA SW-846 Method 6010 Inductively Coupled Plasma-Atomic Emission Spectroscopy	42 µg/L 4.2 mg/kg[c]	III
		Beryllium	0.2 mg/kg	EPA SW-846 Method 6010 Inductively Coupled Plasma-Atomic Emission Spectroscopy	0.3 µg/L 0.03 mg/kg[c]	III
		Semivolatile Organic Compounds	Dependent on Cantaminant TBD[b]	EPA SW-846 Method 8270 Gas Chromatography/Mass Spectrometry Capillary Column Technique	Contaminant Dependent (see Table V.4, LANL 1991, 0412)	III
		Volatile Organic Compounds	Dependent on Contaminant TBD[b]	EPA SW-846 Method 8240 Gas Chromatography/Mass Spectrometry	Contaminant Dependent (see Table V.3, LANL 1991, 0412)	III

[a] Trigger levels for nonradionuclides are the proposed RCRA Subpart S action levels (EPA 1990,0432). Trigger levels for radionuclides and nonradioactive hazardous constituents not listed in Subpart S will be provided in the LANL 1992 Installation Work Plan.

[b] TBD: To Be Determined

[c] Assuming all the contaminant in 1g of soil can be extracted into 100 ml of solution.

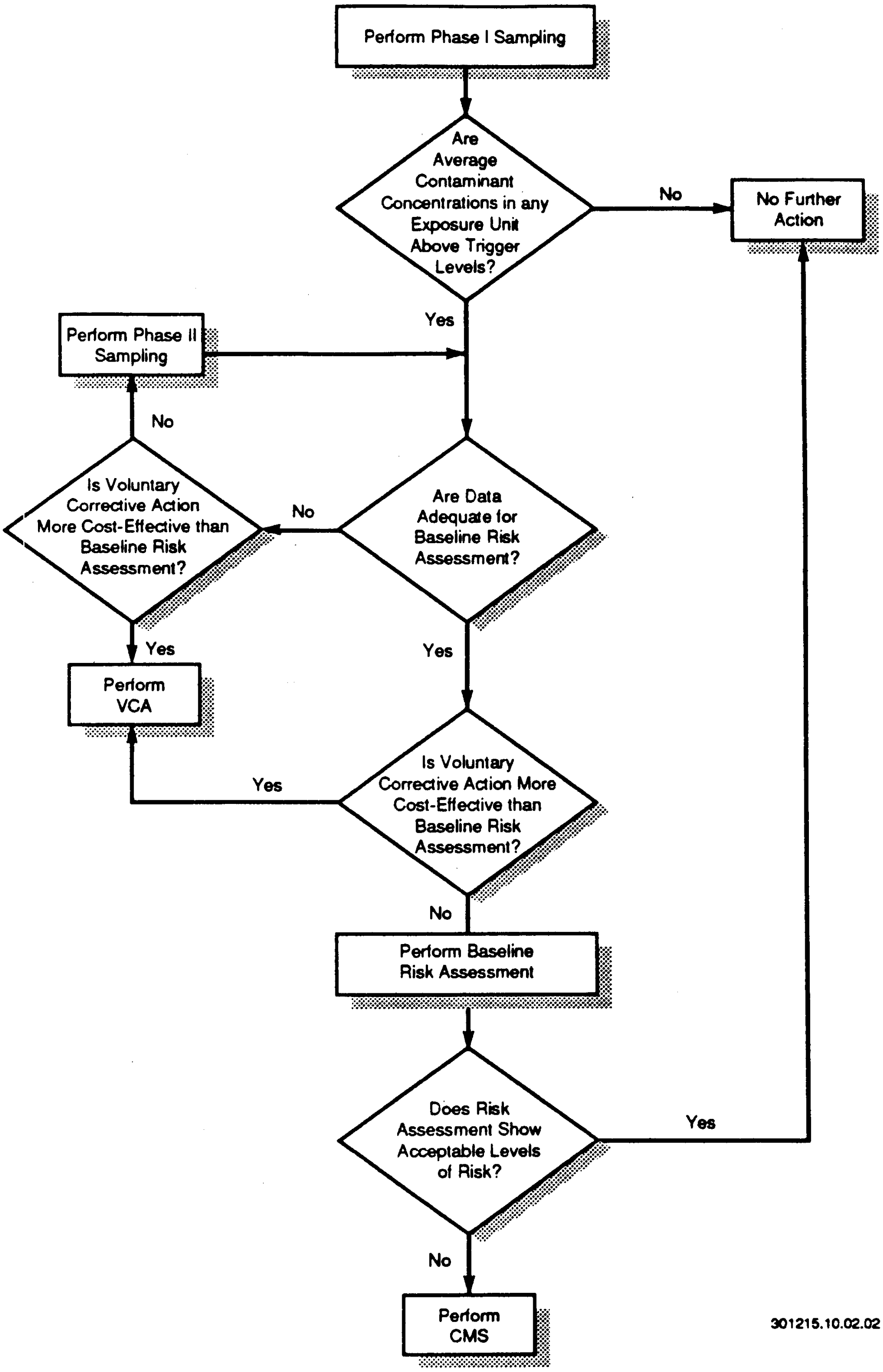


Figure 5.1-1. TA-10 Firing Sites SWMU Aggregate DQO decision logic flow diagram for surface sampling plan.

5.1.1.3.3 Potential Receptors

Trigger levels are used in the Phase I investigation to determine if there is a potential for adverse human health effects associated with the surface soil. These trigger levels will be conservatively based on a hypothetical on-site receptor (constant exposure). As such, no specific information regarding the activities, behavior, or location of actual receptors is required for the Phase I investigation.

The baseline risk assessment will be based on the residential use scenarios. No additional information is needed on potential receptors.

5.1.1.4 Decision Logic

5.1.1.4.1 Domain of the Decision

Since the most conservative remediation alternative (in the sense of acceptable risk levels) is to allow residential development at TA-10, this scenario is used to develop exposure units and acceptable risk levels. The exposure unit is defined as the smallest area over which a residential adult or child would reasonably limit activities on the site, and is assumed to be the average size of a residential yard (4,900 ft^2) (Neptune and Blacker 1990, 0684). The contaminant levels will be evaluated over exposure units comprising the canyon floor, slopes, and mesa tops that may have been affected by the firing sites. Excluding canyon slopes that are too steep to sample (and unlikely for residential development), the total sampling area is approximately 17,000,000 ft^2.

The time domain focuses on current risks because they present an upper bound for long-term risks from surface contamination.

5.1.1.4.2 Logic Statement

To support the decision process, the average concentrations of the possible contaminants, Be, Ba, Pb, ^{90}Sr, and total U, will be estimated over 4,900 ft^2 exposure units by kriging the data with the highest contaminant concentrations (from visual inspection of the data). These kriged estimates will be compared to test criterion described in Appendix B, Section 1.4.

5.1.1.5 Design Criteria

The DQO process attempts to limit the probability of incorrect decisions to an acceptable level (Neptune et al. 1990, 0511). Incorrect decisions translate into two types of errors. The first type of error occurs when it is decided that an exposure unit poses an unacceptable risk when, in fact, the risk posed by the exposure unit is less than the acceptable risk level. This is a false positive error [F(+)] or Type I error. This error is quantified by the probability of rejecting the null hypothesis when it is true, and results in investing time, money, and valuable resources to clean up a site that poses no risk. It also results in loss of credibility and needless public concern, since the site has already been released for unrestricted use.

The second type of error occurs when it is decided that an exposure unit does not pose an unacceptable risk when, in fact, the risk posed by the exposure unit exceeds the acceptable risk level. This is a false negative [F(-)]or Type II error. This error is quantified by determining the probability of accepting the null hypothesis that the true mean of the contaminant concentration over the exposure unit is below the trigger level, when it is actually greater than the trigger level. This incorrect decision could lead to an unacceptable health-risk for the exposed population.

The approach taken for designing the surface sampling follows the DQO process by considering both Type I [F(+)] and Type II [F(-)] errors. Constraints on the Type I and Type II errors, along with information about the spatial variability of the contaminants, were used to determine the number of samples needed. The constraints on the errors depend on the underlying true level of the contaminant. These constraints were developed for Be by the OU 1079 technical team based on an analysis of the consequences of incorrect decisions. A discomfort curve was not developed for Pb because of the difficulty of relating a trigger level and other possible levels to risk in a way that was meaningful. A discomfort curve was not developed for Ba because Be has much more conservative trigger levels for acceptable risk. Since the spatial distributions of the three contaminants are expected to be similar, it is probable that a design for Be will provide adequate data for Ba and Pb. If this assumption proves to be wrong, additional data will be collected. To develop the discomfort curve for Be, simple qualitative consequences of the errors were first developed, as shown in Table 5.1-2. These qualitative evaluations were then translated into quantitative estimates shown in Table 5.1-3. The process of going from qualitative to quantitative values included ranking the consequences, giving numerical values to errors as functions of true risks, and adjusting the results to make sure that there was consistency between the rank ordering and the numerical values. The quantitative error tolerances are also summarized in a discomfort curve (Figure 5.1-2). The vertical axis of the discomfort curve provides the acceptable error rates (probability of making an incorrect decision) given various possible true risk levels, shown on the horizontal axis. The areas of false negatives (Type II errors) are denoted as F(-) and the areas of false positives as F(+) (Type I errors). Note the hatched region where neither decision is considered to be in error.

Based on kriging theory (Appendix B), a methodology was developed to determine the required sample grid size as a function of the acceptable prediction error for the kriged estimate of the contaminant mean over an exposure unit. A description of the general problem is given in Appendix B, Section 1.1. This technique requires knowledge of the spatial correlation structure for the contaminant concentration. Section 1.2 of Appendix B presents the spatial correlation information for ^{90}Sr and total U and explains why ^{90}Sr data were used to estimate the spatial correlation for Be. Section 1.3 shows how prediction error is used to determine the required grid size. The prediction error is dictated by the restrictions on Type I and Type II errors specified in the discomfort curve. Section 1.4 derives

TABLE 5.1-2 QUALITATIVE CONSEQUENCES OF DECISION ERRORS

F(+) Take action when unnecessary	**F(-) Take no action when there is an unacceptable health risk**
Alarm public unnecessarily	Expose public to an unacceptable risk
Loss of credibility - Laboratory, DOE (since land was released to public)	Liable for not taking action when should have
Large expenditure of money and resources (unnecessarily)	Loss of credibility (Program, Laboratory, DOE)
Divert resources from real problems	Professional, personal loss by making wrong decision (possible liability?)
Possible lengthy and costly law suits (unnecessarily)	
Negative impact on environment (unnecessarily)	
Stress waste disposal system (unnecessarily)	

TABLE 5.1-3 UNCERTAINTY CONSTRAINTS FOR BERYLLIUM

Postulated "True" Risk Levels	**Concentration Range (ppm)**	**Acceptable Probability For False Negatives (%) (TYPE I ERROR)**
$> 1 \times 10^{-4}$	> 20	5
$1 \times 10^{-5} - 1 \times 10^{-4}$	2 - 20	15
$1.25 \times 10^{-6} - 1 \times 10^{-5}$	0.25 - 2	25
Postulated "True" Risk Levels	**Concentration Range (ppm)**	**Acceptable Probability For False Positives (%) (TYPE II ERROR)**
$< 1 \times 10^{-8}$	< 0.002	5
$1 \times 10^{-8} - 5 \times 10^{-8}$	0.002 - 0.01	15
$5 \times 10^{-8} - 1 \times 10^{-7}$	0.01 - 0.02	25
$1 \times 10^{-7} - 5 \times 10^{-7}$	0.02 - 0.1	30

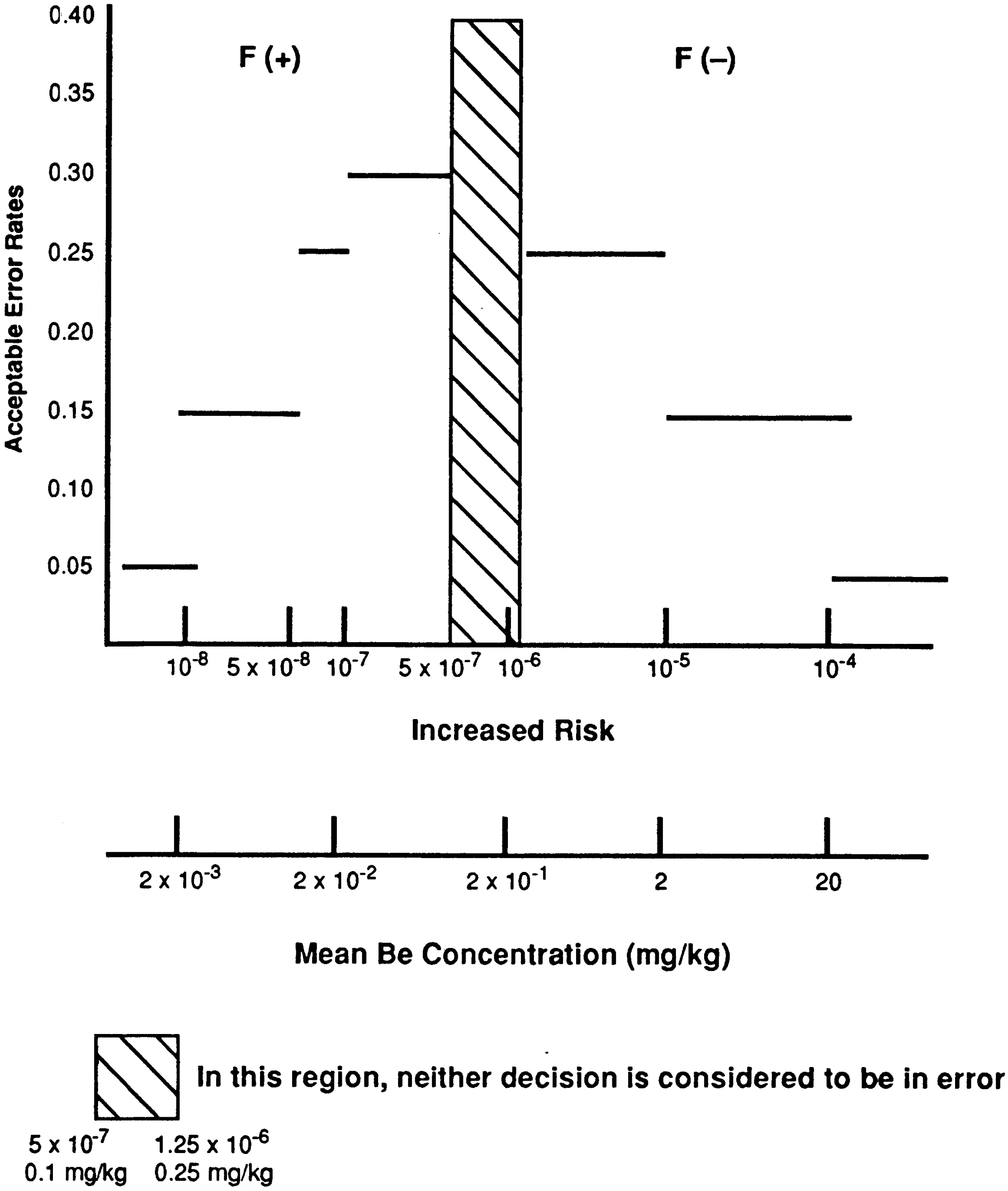


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Figure 5.1-2. Acceptable limits for decision error for Be.

the general criterion for the prediction error as a function of points on a discomfort curve. Finally, Section 1.5 applies the methodology to the sample design for Be. Section 1.5 describes how the acceptable level for the prediction error of Be was determined from the discomfort curve (Figures 5.1-2), and shows how this allowable prediction error was used to determine the grid size.

5.1.1.6 Surface Sampling Plan for Surface Soils

5.1.1.6.1 Land Survey

A land survey will first be conducted in order to relocate the positions of all former buildings and other facilities, including buried structures. The land survey will also locate the boundaries of the previous Bayo Canyon survey. Locations of former buried structures were recorded on existing site maps, but locations need to be recovered at the sites. The survey will also establish a 17,000,000 ft^2 sampling grid (500-ft grid interval) to locate the surface sampling points (shown in Figure 5.1-3). The locations of any additional or relocated sample points will also be surveyed. All points will be recorded in the New Mexico State Planar Coordinate System and flagged. The survey requires an accuracy of plus or minus 1 ft horizontally and plus or minus 0.1 ft vertically. The conventional survey procedures to be used are documented by Facilities Engineering personnel.

5.1.1.6.2 Sample Collection

The decision flow diagram for this sampling plan is shown in Figure 5.1-4. Sixty-eight surface samples will be collected from the 500-ft interval grid sampling points (see Figure 5.1-3). Samples will be collected to a depth of 5 to 10 cm. If a designated sample location falls on an outcrop of bedrock, that sample point will be moved to the nearest soil outcrop, and its new location will be surveyed in. An additional five samples will be taken 100 ft from randomly selected grid nodes. The procedure for selecting grid nodes is as follows: four grid nodes will be randomly selected from those grid nodes falling in the canyon bottom, and three from the grid nodes on each of Otowi and Kwage Mesas. At each of the 10 selected grid nodes, a cardinal direction will be randomly specified (eliminating those directions that are not feasible because of topography). A single sample will then be taken at a distance of 100 ft from the node in the selected direction.

5.1.2 Channel Sediments

5.1.2.1 Problem Statement

It is expected that surface contaminants from anywhere in the TA-10 site will be concentrated in the Bayo Canyon channel. Although sediments have been analyzed previously and showed no contamination, sediment flux is probably very high and intermittent in the canyon. The problem, therefore, is to determine if there are levels of contaminants in the channel sediments that present a health

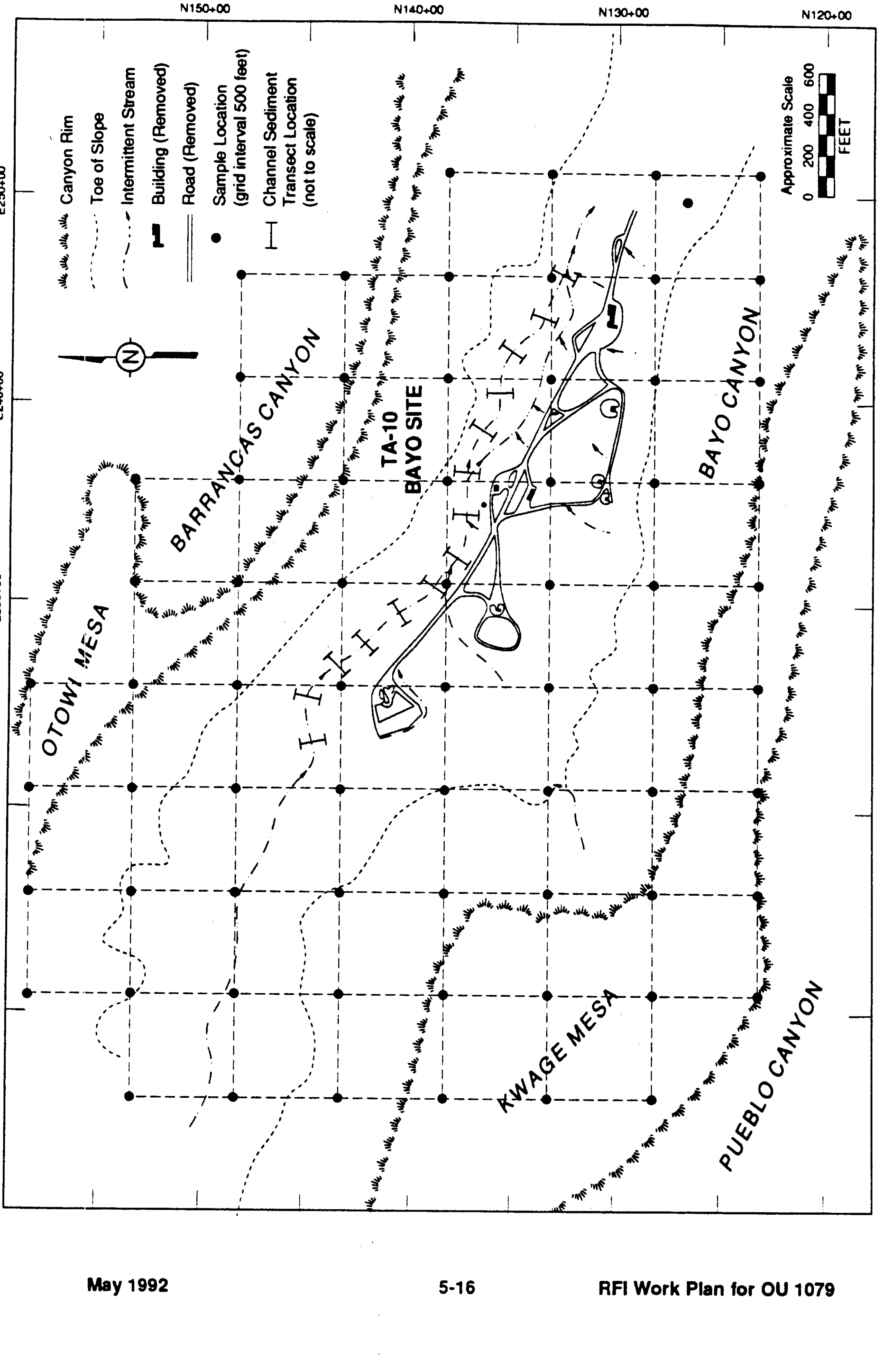
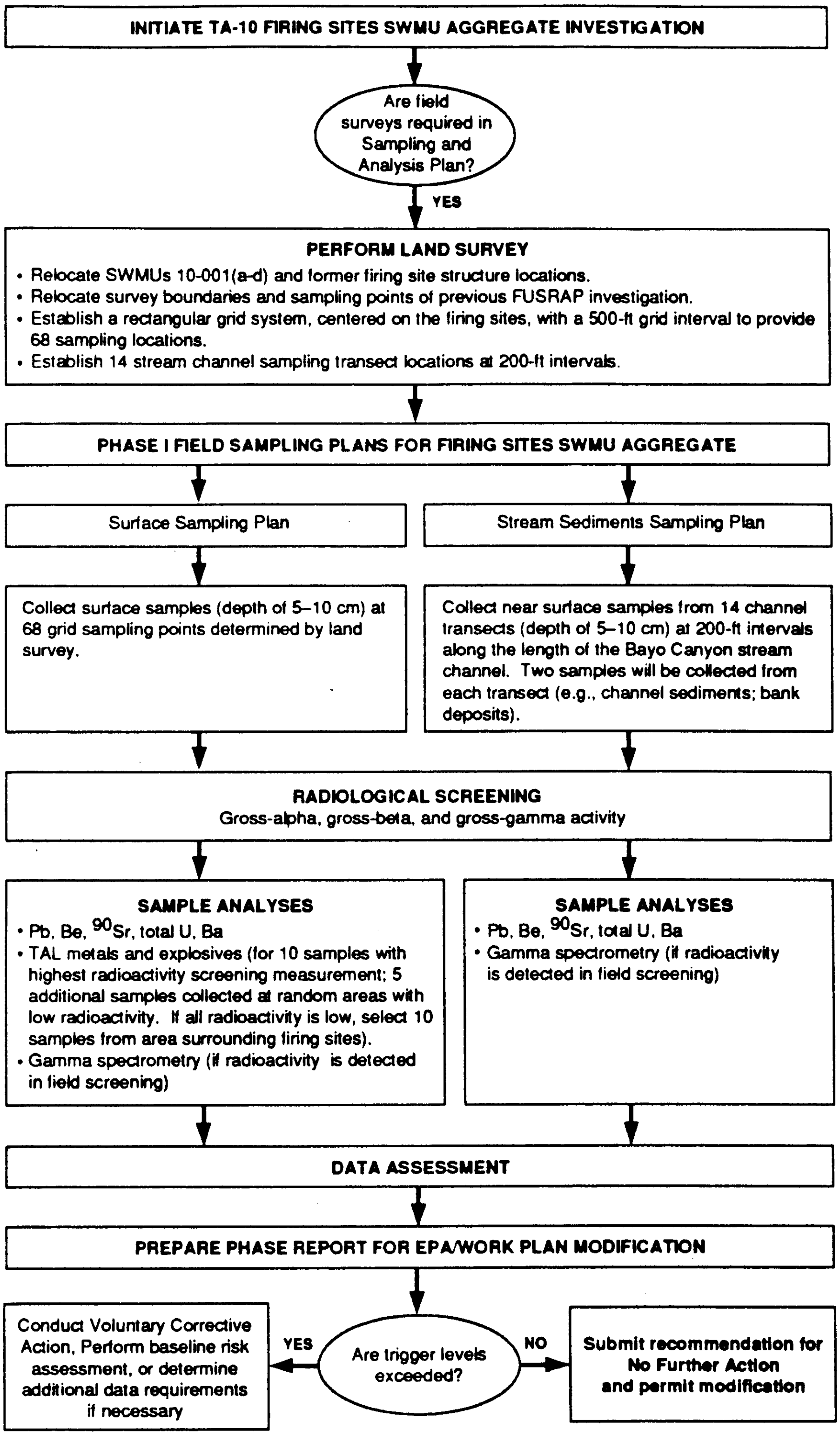


Figure 5.1-3. TA-10 surface sampling locations (modified from Mayfield et al. 1979, 06-0041).



PERFORM LAND SURVEY

- Relocate SWMUs 10-001(a-d) and former firing site structure locations.
- Relocate survey boundaries and sampling points of previous FUSRAP investigation.
- Establish a rectangular grid system, centered on the firing sites, with a 500-ft grid interval to provide 68 sampling locations.
- Establish 14 stream channel sampling transect locations at 200-ft intervals.

Collect surface samples (depth of 5–10 cm) at 68 grid sampling points determined by land survey.

Collect near surface samples from 14 channel transects (depth of 5–10 cm) at 200-ft intervals along the length of the Bayo Canyon stream channel. Two samples will be collected from each transect (e.g., channel sediments; bank deposits).

RADIOLOGICAL SCREENING

Gross-alpha, gross-beta, and gross-gamma activity

SAMPLE ANALYSES

- Pb, Be, ^{90}Sr, total U, Ba
- TAL metals and explosives (for 10 samples with highest radioactivity screening measurement; 5 additional samples collected at random areas with low radioactivity. If all radioactivity is low, select 10 samples from area surrounding firing sites).
- Gamma spectrometry (if radioactivity is detected in field screening)

SAMPLE ANALYSES

- Pb, Be, ^{90}Sr, total U, Ba
- Gamma spectrometry (if radioactivity is detected in field screening)

Conduct Voluntary Corrective Action, Perform baseline risk assessment, or determine additional data requirements if necessary

Submit recommendation for No Further Action and permit modification

Figure 5.1-4. TA-10 Firing Sites SWMU Aggregate Phase I sampling plan flow diagram.

risk that might have been missed in previous surveys. The contaminants of concern for this investigation include Be, Pb, Ba, ^{90}Sr, and total U. In general, sampling of stream sediments in canyon bottoms will be included in the Canyons Work Plan (OU 1079). However, because of the proximity of the ephemeral stream in Bayo Canyon to the known contamination in the canyon bottom, and because stream sediment samples will serve as an additional control on potential migration of contaminants out of the former TA-10 site, a few stream sediment samples will be taken. These samples will then be integrated into a more complete study of stream sediments during development of the Canyons Work Plan.

5.1.2.2 Decision Process

The following "if, then" statements describe the decision process associated with the sediment investigation.

> "If the maximum concentration of contaminants from all samples is below trigger levels for the unrestricted use scenario, then there will be no need for further investigation."

If any sample is above trigger levels and background concentrations, then a Voluntary Correction Action (VCA) may be performed, a baseline risk assessment conducted, or additional sampling (Phase II) may be performed. If conducted, the Phase II investigation will determine the geomorphology and young (Quaternary) sediments of the TA-10 area in order to locate the surface source of the contamination. The Phase I and Phase II data may then be used in a baseline risk assessment. If the risk assessment shows that there are no unacceptable health risks, then there will be no further action. Otherwise, a corrective measures study will be implemented. The DQO decision logic flow diagram is shown in Figure 5.1-5.

5.1.2.3 Data Needs

5.1.2.3.1 Source Characterization

The source data required to support the decision process described above are the concentrations of Pb, Be, Ba, ^{90}Sr, and total U in the channel sediments. The plan for collecting this data is described in Section 5.1.2.6.

5.1.2.3.2 Environmental Setting

If sediment contamination is identified and a baseline risk assessment is performed, then a Phase II geomorphic mapping of the surface may be required to determine the source of the sediment contamination.

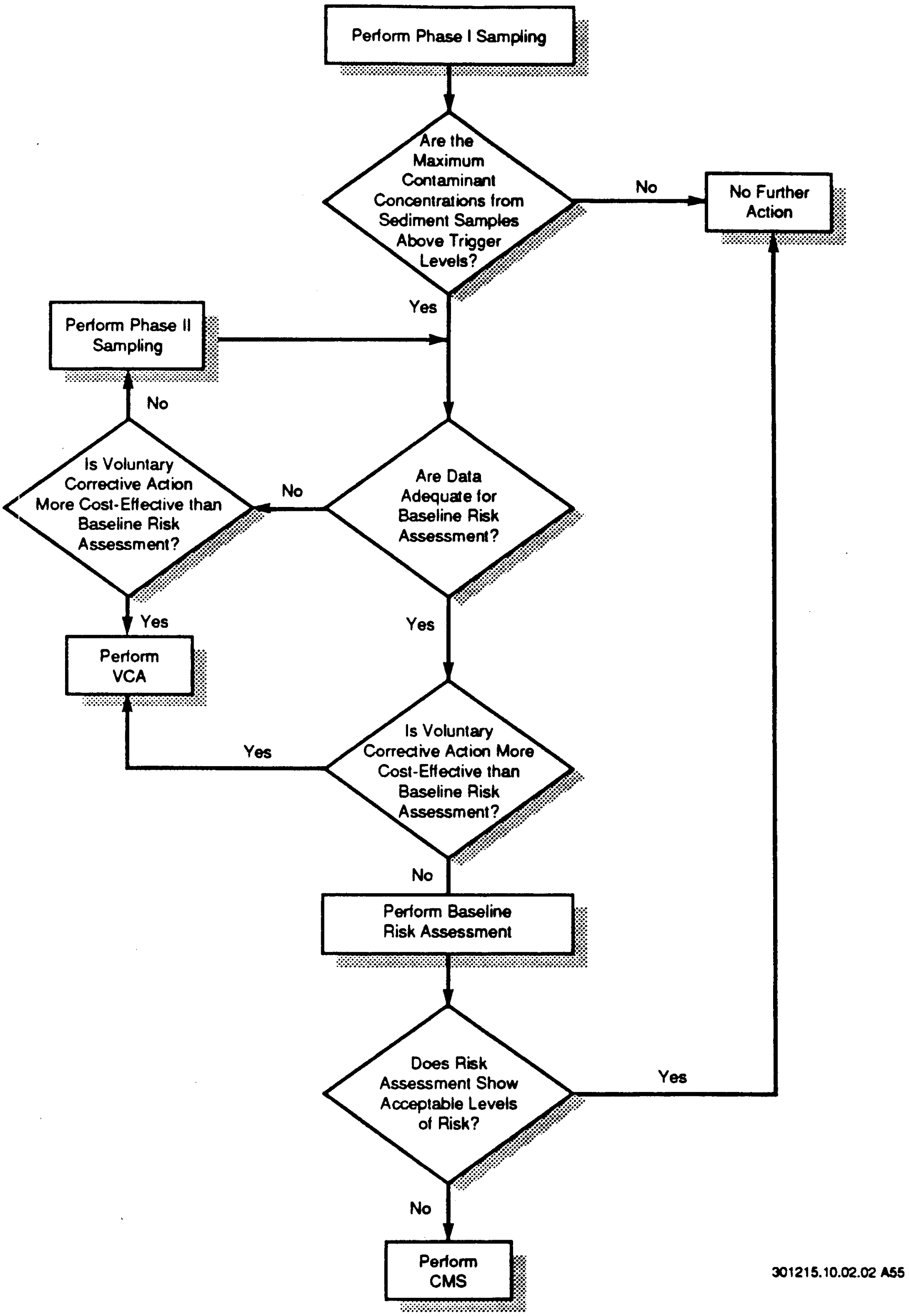


Figure 5.1-5. TA-10 Firing Sites SWMU Aggregate DQO decision logic flow diagram for sediment sampling plans.

5.1.2.3.3 Potential Receptors

Trigger levels are used in the Phase I investigation to determine if there is a potential for adverse human health effects associated with the channel sediments. These trigger levels will be conservatively based on a hypothetical on-site receptor (constant exposure). As such, no specific information regarding the activities, behavior, or location of actual receptors is required for the Phase I investigation.

The baseline risk assessment will be based on the residential use scenarios. No additional information is needed on potential receptors.

5.1.2.4 Decision Logic

5.1.2.4.1 Domain of the Decision

The spatial domain includes the channel from the Santa Fe County Line to a point 200 ft upstream of the firing sites. Samples will be collected from the fine-grained sediments to a depth of 5 to 10 cm. These sediments should contain maximal residual contamination if it exists, and should therefore bound the levels of contaminant concentrations in the channel.

The time domain focuses on current risks for setting trigger levels; however, long-term risks due to flooding will be considered if a baseline risk assessment is required.

5.1.2.4.2 Logic Statement

The maximum level of contaminant concentrations from all samples will be compared to trigger levels.

5.1.2.5 Design Criteria

The objective of the design criterion is to collect data that will bound the levels of possible contaminant concentrations based on expert judgement about possible contaminant distribution in the channel sediments. To bound possible contaminant concentrations, data will be collected from the fine-grained sediments from both the channel bottom and the banks. To capture the possible variability from intermittent sediment transport, samples will be collected along transects every 200 ft.

A transect interval of 200 ft provides a compromise between excessively large numbers of samples, and reasonable confidence that no contamination is present. A large number of samples is not justified at this stage; no contamination has been found in stream sediment samples previously, and none is expected in the present sampling phase.

Conversely, a 200 ft transect interval permits sampling of different parts of the stream where sediments may be stored, and provides a large enough number of samples for reasonable statistical confidence. Areas of the stream channel to be sampled include point bars and bank deposits, where fine-grained sediments are stored. Based on past experience, contaminants, if present, are expected to be lodged in reservoirs of fine-grained sediments. Although sampling of the stream channel will occur over a short time period, by sampling different parts of the stream channel it will be possible to sample deposits of difference ages, thereby capturing the time element in the evolution of the stream.

Finally, a transect interval of 200 ft provides a very high level of confidence that if contamination above actions levels exists, it will be found. Specifically, there is 95% probability that if the stream channel has contamination above actions levels over 10% or more of its area, then at least one sample will be above actions levels.

5.1.2.6 Sampling Plan for Channel Sediments

5.1.2.6.1 Land Survey

A land survey will first establish 14 stream channel sampling transect locations at 200-ft intervals (Figure 5.1-3). The locations of any additional or relocated sample points will also be surveyed. All points will be recorded in the New Mexico State Planar Coordinate System and flagged. The survey requires an accuracy of plus or minus 1 ft horizontally and plus or minus 0.1 ft vertically. The conventional survey procedures to be used are documented by Facilities Engineering personnel.

5.1.2.6.2 Sample Collection

Stream sediments will be collected from 14 channel transects at 200 ft intervals along the length of the Bayo Canyon channel from approximately the Santa Fe County Line to a point several hundred feet upstream of the firing sites (a total distance of approximately 2,800 ft). Two samples will be taken from each transect (one sample from the channel bottom and one sample from the channel bank), resulting in 28 samples for analysis. Sampling will be based on a judgmental determination of maximum residual contamination, where applicable. Samples should, if possible, be taken from fine-grained size fractions. It may be necessary to shift the exact sample point by up to several feet in order to sample the finest grain size at a given sampling location. Channel sediment samples will be collected to a depth of 5 to 10 cm using a spade-and-scoop method (see Appendix D).

5.1.3 Field Screening of Samples

All samples will be screened in the field for radioactivity (gross-alpha, gross-beta, and gross-gamma activity) to identify gross concentrations of contaminants and provide information on sample selection for further laboratory analysis. Field screening methods are detailed in Appendix D.

5.1.4 Sample Analyses

After the radiological screening, all 68 grid samples and the five random samples will be analyzed for Pb, Be, Ba, ^{90}Sr, and total U. Of the 68 samples from the 500 ft interval grid sampling, the 10 samples that indicate the highest radioactivity during field screening and the five random samples will be chosen for analysis of TAL metals, radionuclides, and explosives. If all field screening measurements are low, 10 samples will be selected from around the firing sites. The purpose of the analyses is to survey for unanticipated metal contaminants or high explosives. Sample analyses are summarized in Table 5.1-4.

For this investigation, it is assumed that concentrations of Pb, Be, Ba, ^{90}Sr, and total U will correlate positively with the levels of radioactivity determined from the radiological survey; i.e., that the highest radioactivity will correlate with the highest concentrations of metals. If it is determined that metals and radionuclides are not correlated, or that individual metals are not correlated with each other, then it may be necessary to design a Phase II sampling plan to collect and/or analyze additional samples.

All 28 stream samples will be analyzed for Pb, Be, Ba, ^{90}Sr, and total U (Table 5.1-4). If radioactivity (gross-alpha, gross-beta, or gross-gamma activity) is detected in any sample during field screening, those samples will also be analyzed using gamma spectrometry. Three of the 28 samples will be randomly selected for explosives analyses. Table 5.1-4 presents the screening and analysis for the channel sediments samples.

5.1.5 Sample Quality Assurance/Quality Control

Field quality assurance (QA) samples will be collected during the course of the field investigation and are outlined in Table 5.1-4. These samples include field duplicates and equipment rinsate blanks. The definition of each kind of sample and its purpose are given in Annex II, Quality Assurance Project Plan (QAPjP) of this work plan.

5.1.6 Field Operations

The organizational structure for the field investigation team is identified in Figure 5.1-6. The team will have individual responsibilities for health and safety, sample identification, sample handling and chain of custody, and related activities. Facilities such as a field screening laboratory or an equipment decontamination facility may be shared by OU 1079 field teams. Premobilization activities, health and safety, site control, site monitoring, and support service aspects of the field operations are described in Appendix D.

TABLE 5.1-4 SCREENING AND ANALYSIS FOR TA-10 INVESTIGATION OF FIRING SITES SWMU AGGREGATE

				Field Screening						Laboratory Analysis											
Sample Type/Location	Sample Number	Sample Depth	Sample Identification	Gross Alpha	Gross Beta	Gross Gamma	Combustible Gas/oxygen	Organic Vapor	Lithological Logging	Gamma Spectrometry	Total Uranium	Strontium-90	Beryllium	Lead	TAL Metals	Explosives	Semivolatiles (SW 8270)	Barium	PCB (SW 8080)	VOA (SW 8240)
SWMU Aggregate 10-001 (a–d)																				
Firing Sites																				
Surface Soils (grid)	1–68	5–10 cm		X	X	X					X	X	X	X				X		
Surface Soils (random grid with	69–73	5–10 cm		X	X	X					X	X	X	X	X	X		X		
low radioactivity)																				
Surface Soils (grid with highest																				
radioactivity or near firing sites)	10 of 68	5–10 cm	(see Fig. 5.1-3)	X	X	X				X	X	X	X	X	X	X		X		
Field Duplicates	74-79	5–10 cm		X	X	X					X	X	X	X				X		
Rinsate Blank	80-83			X	X	X					X	X	X	X				X		
Channel Sediment Sampling																				
Channel Bottom	84-97	5–10 cm		X	X	X				●	X	X	X	X				X		
Channel Bank	98-111	5–10 cm		X	X	X				●	X	X	X	X				X		
Random Samples	3 of 28															X				
Field Duplicates	112-113	5–10 cm		X	X	X					X	X	X	X				X		
Rinsate Blank	114-115			X	X	X					X	X	X	X				X		

X Mandatory Analysis

● Analyze if Positive Field Screening Measurement

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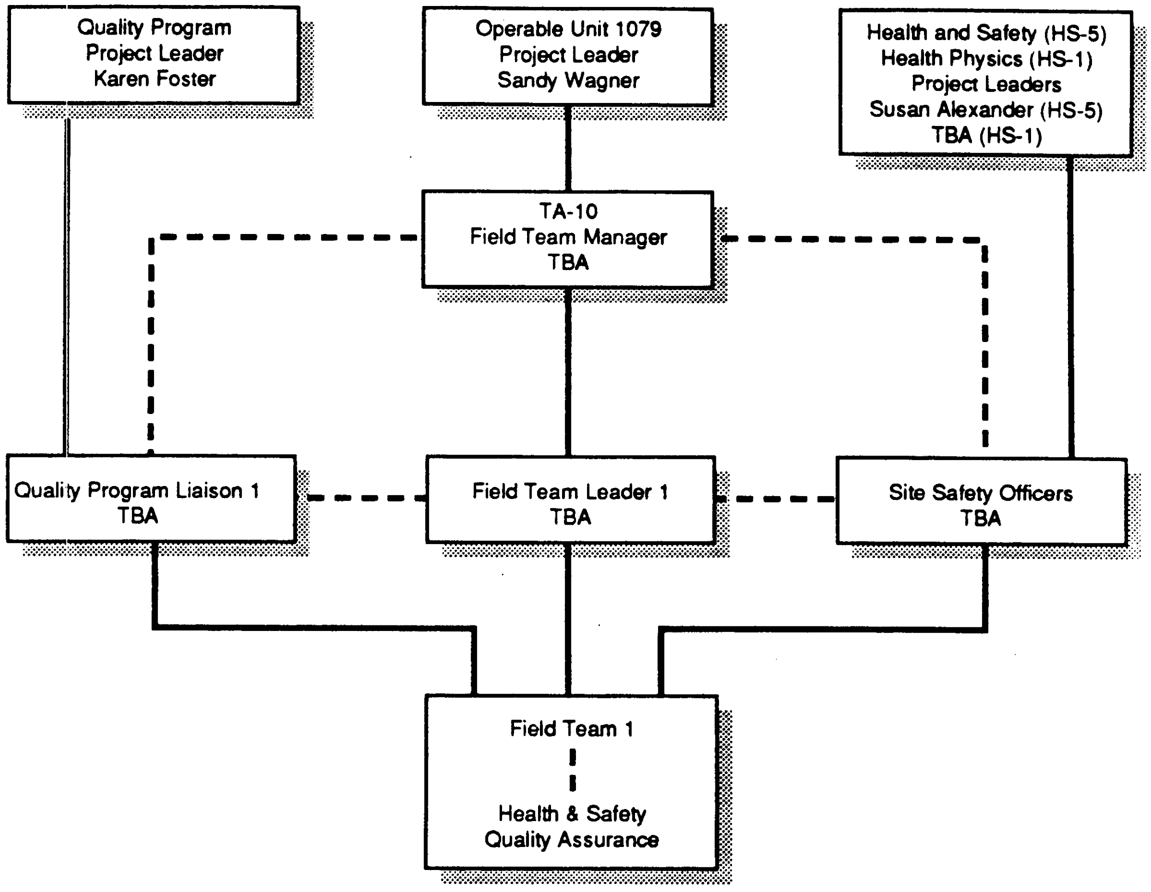

▬▬	Authority
▬ ▬ ▬	Communication
TBA =	To Be Announced

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Figure 5.1-6. TA-10 field investigation team.

5.2 DQO Process for the Subsurface Disposal SWMU Aggregate - SWMUs 10-002(a-b), 10-003 (a-o), 10-004(a-b), 10-005, and 10-007

5.2.1 DQO Process for SWMUs with Known Residual Contamination

As discussed in Chapter 3, TA-10 contains SWMUs with documented residual contamination. These SWMUs include 10-002(a) [TA-10-44]; 10-002(b) [TA-10-48]; 10-003(a-o) [TA-10-Central area]; 10-004(b) [TA-10-38]; and 10-007, the landfill placed in the 10-003(a-o) excavation following remediation. While some of these SWMUs are physically separated and have had different uses, they have the same investigation objectives. Therefore, the DQO sections are combined for these areas and only the details of the sampling plans differ.

As described in Section 2.1, the observational approach recommends that the RFI establish the most probable site conditions with sufficient precision so that the remaining uncertainties can be handled by contingency plans. It is in this spirit that the notion of a maximum removal remediation volume, VMAX, is defined. VMAX is the volume of subsurface soil that would be more cost-effective to remove than to characterize completely. The value of VMAX could be determined simply by calculating the cost of drilling and analyzing samples from three to six holes and determining the volume of soil that could be cleaned-up for that cost. The calculation could also include factors such as timeliness of response and risks to workers. Developing criteria to determine when to stop the iterative process of investigation and when to begin corrective measures studies is the crux of the observational approach. The parameter VMAX is an attempt to develop such a criterion and does not impose removal as the remediation alternative, nor does it mean that the entire VMAX volume must be removed if removal is the alternative chosen. The VMAX volume is simply used to guide the placement of characterization boreholes and to provide a criterion for choosing between characterization efforts and corrective measures evaluation.

5.2.1.1 Problem Statement

Previous investigations indicate that five areas in TA-10 have residual subsurface contamination from ^{90}Sr, and to a lesser degree total U (Section 3.1.4). Although these previous investigations have shown that there are no unacceptable health-risks from this radiological contamination (assuming no intruder excavation scenario), the extent of the contamination has not been determined, and there has been no evaluation of the effects of possible non-radiological constituents. In addition, the previous risk assessment was based on assumptions and acceptable risk levels that may no longer be appropriate. It is prudent to gather additional data for a new risk assessment for these areas. In addition, the previous data will be reevaluated using current risk assessment protocols for residential scenarios. Although there are no known current pathways for exposure from subsurface contamination, the possibility of future pathways must be carefully evaluated.

The problem to be addressed by this investigation is to determine if there is subsurface contamination, either radiological and/or non-radiological, that presents unacceptable near- or long-term health-risks. However, it is recognized that the subsurface characterization required to evaluate these risks explicitly could be very costly and take a long time, and that it may be more cost-effective to bound the risks (bound the level and extent of contamination). An acceptable level of uncertainty for completing the RFI and entering the CMS is to determine if VMAX bounds the extent of contamination. The objective of the Phase I sampling plan is to collect data to answer the questions (1) Do the locations of the plumes identified by the previous data correspond to existing plumes?; and (2) If they do, does VMAX bound the extent of contamination. The Phase I sampling plan also includes contingency plans in case the locations of plumes from previous data do not correspond to current conditions and/or VMAX does not bound the extent of contamination.

5.2.1.2 The Decision Process

The following "if, then" statements describe the decision process associated with the subsurface investigation of SWMUs with known residual contamination.

Phase I borehole locations will be placed at a distance determined by VMAX with the initial borehole at the estimated center of the existing plumes identified in Sections 3.1.4. Core samples will be collected at 5 ft intervals and screened for radioactivity (gross-alpha, gross-beta, and gross-gamma activity) and for volatile organic vapors. Boreholes will be drilled to a minimum of 50 ft and to at least 10 ft below the last detectable field screening (a maximum of 100 ft is set for Phase I boreholes). If the radiological screening or volatile organic vapor screening shows levels above trigger levels on the initial borehole, then it is assumed that a plume has been identified (located correctly) and the remaining three boreholes will be drilled to determine if the volume of contamination is less than VMAX. If samples show levels above trigger levels, then it is also assumed that a plume has been detected (even if screening measurements were below trigger levels), and additional samples will be collected to bound the plume. If the total volume of contamination is less than VMAX, then a VCA may be conducted or a risk assessment may be performed. If the extent of contamination is not bounded by VMAX, then three additional boreholes will be drilled at a distance two times the radius of VMAX to determine the lateral and vertical extent of contamination. The borehole depths will be based on results from the first four boreholes, and may include additional laboratory analyses of the samples collected from those boreholes.

If a plume is not found, that is, if the field screening levels for radionuclides and volatile organics for all samples are below trigger levels, and the laboratory measurements for selected samples are below trigger levels, then there will be no further action. Figure 5.2-1 shows the decision process flow diagram for SWMUs with documented residual contamination.

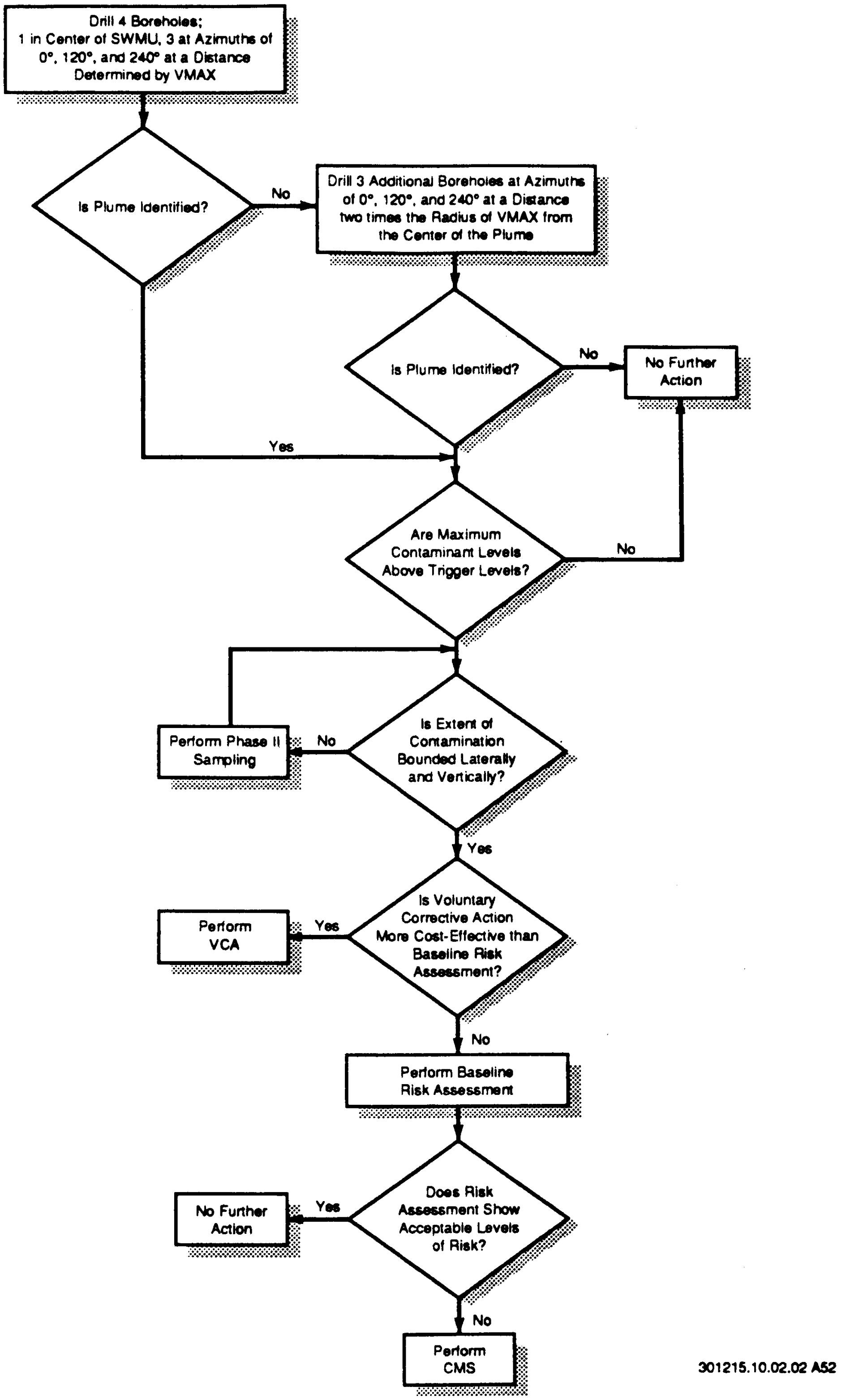

Figure 5.2-1. TA-10 Subsurface Disposal SWMU Aggregate DQO decision logic flow diagram for SWMUS with documented residual contamination.

5.2.1.3 Data Needs

5.2.1.3.1 Source Characterization

A land survey must be conducted to locate positions of all former buildings and other facilities. This survey must identify all subsurface structures and locate the boundaries of the previous Bayo Canyon survey.

To evaluate the extent of subsurface radiological contamination, Phase I radiological and volatile organic vapors screening data must be obtained. In addition, some Phase I data must be analyzed for TAL metals, semivolatile organic compounds, and explosives to determine if nonradiological contamination exists.

5.2.1.3.2 Environmental Setting

Risk scenarios for baseline risk assessments include residential (non-intruder), worker (non-intruder), and recreational use. These scenarios can be evaluated with existing environmental data.

5.2.1.3.3 Potential Receptors

Trigger levels are used in the Phase I investigation to determine if there is a potential for adverse human health effects associated with any contamination in the surface soil. These trigger levels will be conservatively based on a hypothetical on-site receptor (constant exposure). As such, no specific information regarding the activities, behavior, or location of actual receptors is required for the Phase I investigation.

The baseline risk assessments will include the residential use and recreational use scenarios. No additional information is needed on potential receptors.

5.2.1.4 Decision Logic

5.2.1.4.1 Domain of Decision

Samples from boreholes augured in locations where previous data indicated elevated levels of radiological contamination will be used to determine the existence and extent of radiological and non-radiological contamination. The domain of the decision as to the existence and extent of contamination encompasses the known plumes at TA-10 (Section 3.1.4). The assumption is that the plumes determined from the existing data (Sections 3.1.4) identify the subsurface contamination areas. Although radiological and non-radiological contaminants may not have the same extent of contamination, they have the same source. Using the radiological data to guide the sampling investigation to determine the nature of non-radiological contaminants is a reasonable approach. A sampling plan based on expert judgment would identify these same areas, since the plumes are found in the areas where contamination would be most likely; (e.g., liquid disposal pits). It should be noted that elevated gross-beta activity used to identify these plumes are not observed in the top ten ft owing to previous remediation efforts. These previous remediation efforts included extensive clean-up in these areas and around the industrial waste (acid waste) drainlines and radiochemistry laboratory. The existing data indicate that all other areas have been adequately remediated (Section 3.1.4).

5.2.1.4.2 Logic Statements

If the maximum screening levels for radioactivity (gross-alpha, gross-beta, and gross-gamma activity), or organic vapor levels determined from the samples are above the respective trigger level, or laboratory analyses for radiological and nonradiological compounds are above trigger levels, then it will be assumed that a plume has been located. If the plume is bounded by VMAX, no additional sampling will be required.

If the maximum screening levels for radioactivity (gross-alpha, gross-beta, gross-gamma activity), and the organic vapor levels measured from the samples surrounding the plume are below the trigger levels, and the laboratory analyses for radiological and nonradiological compounds are below trigger levels, then these boreholes will be considered to bound the plume. If the plume is not bounded by VMAX, three additional boreholes will be drilled.

If lateral and vertical extent of the plumes is bounded, a VCA may be conducted or a baseline risk assessment will be performed. If a baseline risk assessment is performed and shows that there is no unacceptable risk from the subsurface contamination, no further action will be recommended. Otherwise, a corrective measures study will be implemented.

If no plumes are identified, no further action will be recommended.

5.2.1.5 Design Criteria

The numbers and locations of boreholes and samples required in Phase I are based on existing data and VMAX. If a baseline risk assessment is required, acceptable uncertainties will be determined. It is anticipated that the data collected to determine the extent of contamination will be adequate to meet uncertainty requirements for a VCA or a baseline risk assessment. There will be approximately 28 boreholes with at least four laboratory samples from each hole and screening data for each sample from each hole. If uncertainty constraints are not met, then archived samples from existing holes will be sent to the laboratory and, if necessary, additional boreholes will be drilled.

5.2.1.6 Sampling Plan

5.2.1.6.1 Land Survey

A land survey will be conducted to relocate the positions of all former buildings and other facilities, including buried structures, and to locate the boundaries of the previous Bayo Canyon survey. The locations of former buried structures are recorded on existing site maps, but locations need to be recovered at the sites. The locations of any additional or relocated sample points will also be surveyed. All points will be recorded in the New Mexico State Planar Coordinate System and flagged. The survey requires an accuracy of plus or minus 1 ft horizontally and plus or minus 0.1 ft vertically. The conventional survey procedures to be used are documented by Facilities Engineering personnel.

5.2.1.6.2 Sample Collection

5.2.1.6.2.1 SWMU 10-003(a-o) TA-10 - Central Area

Section 3.1.4 of this work plan describes five plumes of known radionuclide concentrations that were identified in the TA-10-Central Area. The plumes trend in a northwest to southeast direction with highest concentration levels of ^{90}Sr (gross-beta counts) occurring in the center of each plume.

The decision logic diagram for this sampling plan is shown in Figure 5.2-2. During the Phase I field investigation, a total of 20 boreholes will be drilled to characterize the five plumes at SWMU 10-003(a-o). The initial five boreholes will be drilled in the estimated centers of each of these plumes, as shown in Figure 5.2-3. The general procedure for soil and rock boring, including hollow-stem auguring, is outlined in Appendix D. Samples will be taken from a continuous core, and drilled with a hollow stem auger with a core barrel, as outlined in Appendix D.

The first borehole to be installed (borehole 1) will be centered over the first plume to be investigated. Prior to installing the next four auger boreholes, the estimated coordinates of the four remaining plumes will be verified and corrected, if necessary, against the location of this initial plume. Core samples will be collected at 5 ft intervals and screened for radioactivity (gross-alpha, gross-beta, and gross-gamma activity) and for volatile organic vapors. Boreholes will be drilled to a minimum of 50 ft, a maximum of 100 ft, and/or to at least 10 ft below the last detectable field screening measurement.

Soil samples will be collected for analysis at the midpoints of each 5 ft core length, or at the locations where the maximum radioactivity and organic vapor measurements are encountered during field screening in each core. If any of the samples exceed field screening trigger levels, those samples will also be collected for analysis.

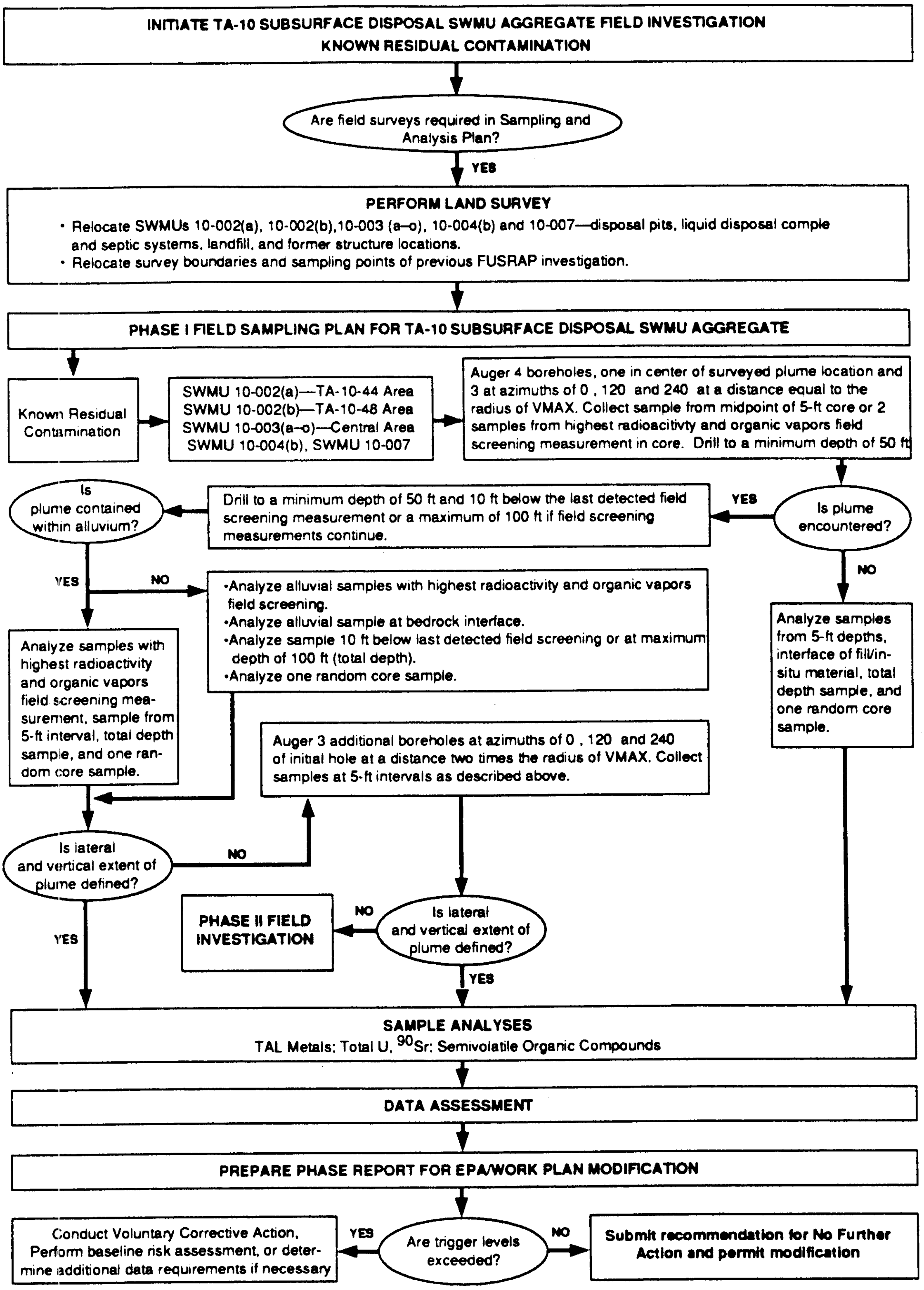

Figure 5.2-2. TA-10 Subsurface Disposal SWMU Aggregate Phase I sampling plan flow diagram for known residual contamination sites.

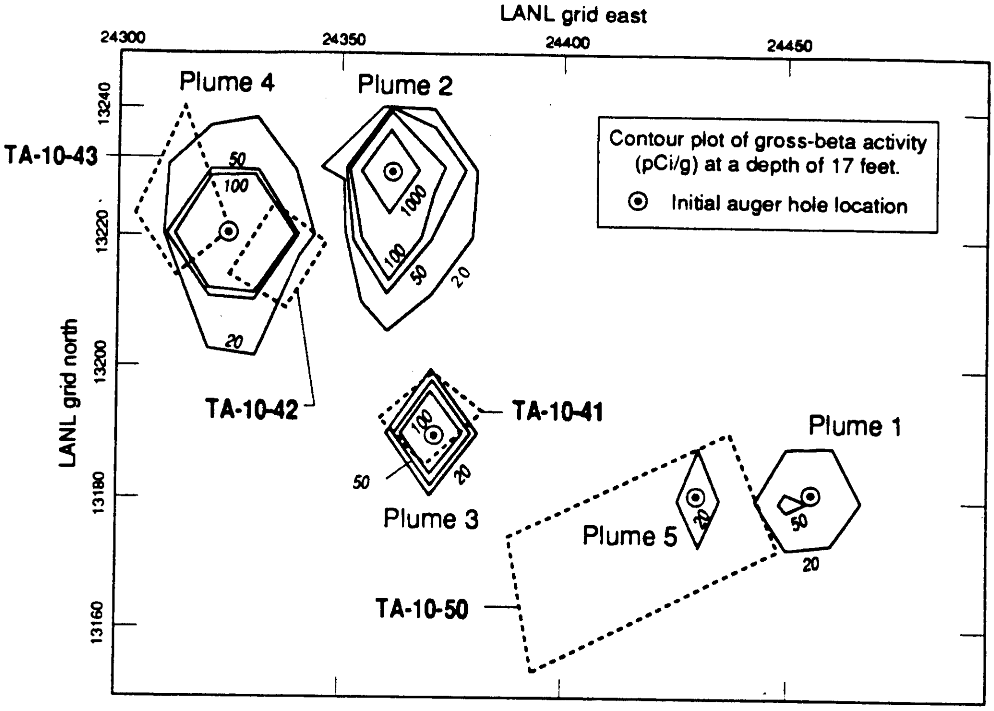

Figure 5.2-3. Locations of initial auger holes in five plumes in TA-10 Central Area.

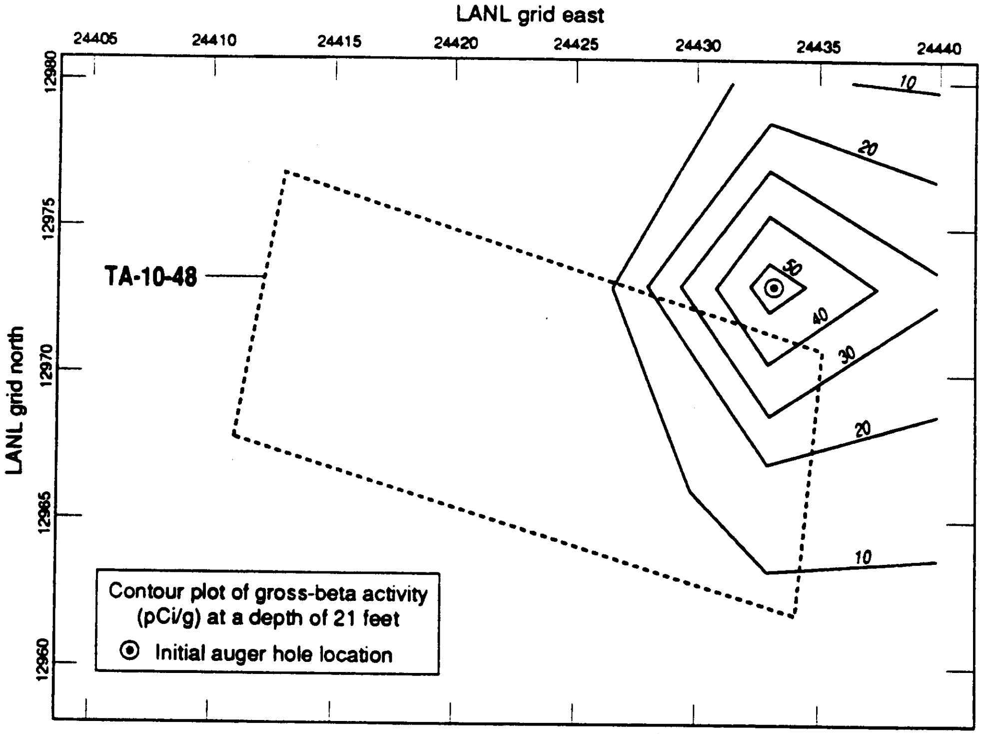

Figure 5.2-4. Location of initial auger hole in SWMU 10-002(b) [TA-10-48 Area].

At least four samples from each borehole will be sent for laboratory analyses; the 5 ft interval sample, the total depth sample, the sample(s) with the highest screening levels (these may be different for radionuclides and organics), and a sample selected at random from samples taken below 10 ft. If contamination extends into the bedrock interface, the alluvial sample collected at the bedrock interface will also be sent for laboratory analyses. The laboratory analyses will include TAL metals, semivolatile organic compounds, total U, and ^{90}Sr. If field screening measurements indicate elevated radioactivity or organic vapors, the samples will be analyzed for radionuclides and volatiles, respectively. If laboratory analyses show TAL metals or semivolatile organic compounds above trigger levels, then all core samples will be sent for laboratory analysis.

For those plumes in which the lateral and vertical extent has not been defined, up to three additional auger boreholes may be installed in order to determine the extent of the plume. These boreholes will be located at azimuths of 0°, 120°, and 240° centered on the initial borehole, and at a distance of two times the radius of VMAX from the original borehole grouping. Borehole depths and sampling intervals will be determined from previous borehole data. Samples will be collected in the new boreholes as described above. If neither the vertical or lateral extent of the plume has been defined, then further sampling and analysis will be conducted in a Phase II field investigation. The approach for Phase II sampling will be similar to that of Phase I discussed above.

If contamination (i.e., a plume) is not encountered in the four boreholes (no field screening measurements detected), the boreholes will be installed to a minimum depth of 50 ft. Samples will be collected and analyzed as described above. In this case, four samples will be selected for analysis: a sample from the 5 ft depth interval, a sample from the interface of the fill/*in-situ* material, a total depth sample, and a random core sample. Missing a plume altogether is a possibility for the Phase I sampling, but because of the data available after Phase I coring and analysis, it should not be a significant likelihood for Phase II.

5.2.1.6.2.2 SWMU 10-002(a) - Structure (TA-10-44)

TA-10-44 was a waste disposal pit for spent chemicals, equipment, and trash which was excavated in 1963. In 1977, residual gross-alpha activity was detected in the subsurface near the former pit location. Four boreholes will be drilled at the SWMU; one initial borehole will be located in the estimated center of this former structure with three additional plumes located at azimuths of 0°, 120°, and 240°. Additional auger boreholes will be installed according to the flow diagram for this sampling plan shown in Figure 5.2-4.

5.2.1.6.2.3 SWMU 10-002(b) - Structure (TA-10-48)

One plume of elevated gross-alpha and gross-beta activity was identified at this SWMU and described in Section 3.1.4 of this work plan. Four boreholes will be drilled at the SWMU: one initial borehole will be located in the estimated center of the plume with three additional boreholes located at azimuths of 0°, 120°, and 240°. Additional auger boreholes will be installed according to the flow diagram for this sampling plan shown in Figure 5.2-4.

5.2.1.6.2.4 SWMU 10-004(b) - Structure TA-10-38

SWMU 10-004(b), a sanitary septic tank system, was removed during the 1963 D&D activities. In 1977, residual gross-alpha activity and gross-beta activity were detected at the site. Four boreholes will be drilled at the SWMU; one initial borehole will be located in the estimated center of this plume with three additional boreholes located at azimuths of 0°, 120°, and 240°. Additional auger boreholes will be installed according to the flow diagram for this sampling plan shown in Figure 5.2-4.

5.2.1.6.2.4 SWMU 10-007 - Landfill

SWMU 10-007 is a landfill containing nonradioactive debris and soil berms from the D&D activities at the firing sites. The landfill location was created during the excavation of the SWMU 10-003(a-o), waste liquid disposal systems and contaminated soil removal. Since the SWMU overlies the location of SWMU 10-003(a-o), all borehole sampling described from SWMU 10-003(a-o) characterization will simultaneously characterize SWMU 10-007. One random sample from each of the boreholes will also be analyzed for explosives to determine if firing site waste is contained in SWMU 10-007.

5.2.2 DQO Process for SWMUs with Unknown Residual Contamination

As discussed in Chapter 3, TA-10 also contains two SWMUs with unknown residual contamination. These SWMUs are 10-004(a) [TA-10-40] and 10-005. Since the investigative objectives for each of these SWMUs is to determine the presence or absence of contaminants, the DQO sections for these two SWMUs have been combined.

5.2.2.1 Problem Statement

SWMU 10-004(a) [TA-10-40] was a sanitary septic tank and overflow pit. No contamination is expected in this area and no previous data have been collected. The sanitary septic tank location will be sampled first. If no contamination is detected, then the overflow location pit will not be sampled.

SWMU 10-005 was a debris disposal pit near the firing site (Section 3.1.4) that was excavated during the FUSRAP survey. Currently, there are no data to support a clean closure of this SWMU with respect to hazardous constituents.

The question to be answered for each of these two SWMUs is "is there any contamination (radiological or nonradiological) of concern in these areas?" The objective of the Phase I investigation is to determine the presence or absence of contaminants (reconnaissance sampling).

5.2.2.2 The Decision Process

Four boreholes will be drilled at the SWMU; one initial borehole in the estimated center of the structure and three additional boreholes located at azimuths at 0°, 120°, and 240° at a distance determined by VMAX. The holes will extend to a maximum depth of 50 ft if no contamination is encountered, and/or to bedrock. Samples will be field-screened for radionuclides and organic vapors. All samples with levels of radionuclides or volatile organic vapors greater than trigger levels will be sent for laboratory analyses. If laboratory analyses indicate that there are no unacceptable levels of contamination, no further action will be recommended. If laboratory analyses indicate that there are levels of contaminants above trigger levels and the plume is bounded, then a VCA may be conducted or a baseline risk assessment may be performed. If the extent of contamination is not bounded, Phase II sampling will be required. Figure 5.2-5 shows the decision process flow diagram.

5.2.2.3 Data Needs

See Section 5.2.1.3.

5.2.2.4 Decision Logic

5.2.2.4.1 Domain of Decision

Samples from boreholes augured in SWMUs 10-004(a) and 10-005] will be used to determine the existence of radiological and nonradiological contamination. The domain of the decision as to the existence of contamination is the boundary of each SWMU. The temporal domain of the decision will include current and future conditions.

5.2.2.4.2 Logic Statements

If any of the maximum screening levels for gross-alpha, gross-beta, and gross-gamma activity, or volatile organic vapors determined from the samples are above the respective trigger levels , then it will be assumed that a plume has been located. If the plume is bounded by VMAX, no additional sampling will be required. If the maximum screening levels for gross-alpha, gross-beta, and gross-gamma activity, and the volatile organic vapors from the samples from the SWMU are below the trigger levels, and if the laboratory analyses are below trigger levels, then no additional sampling will be performed. If any of the laboratory samples for

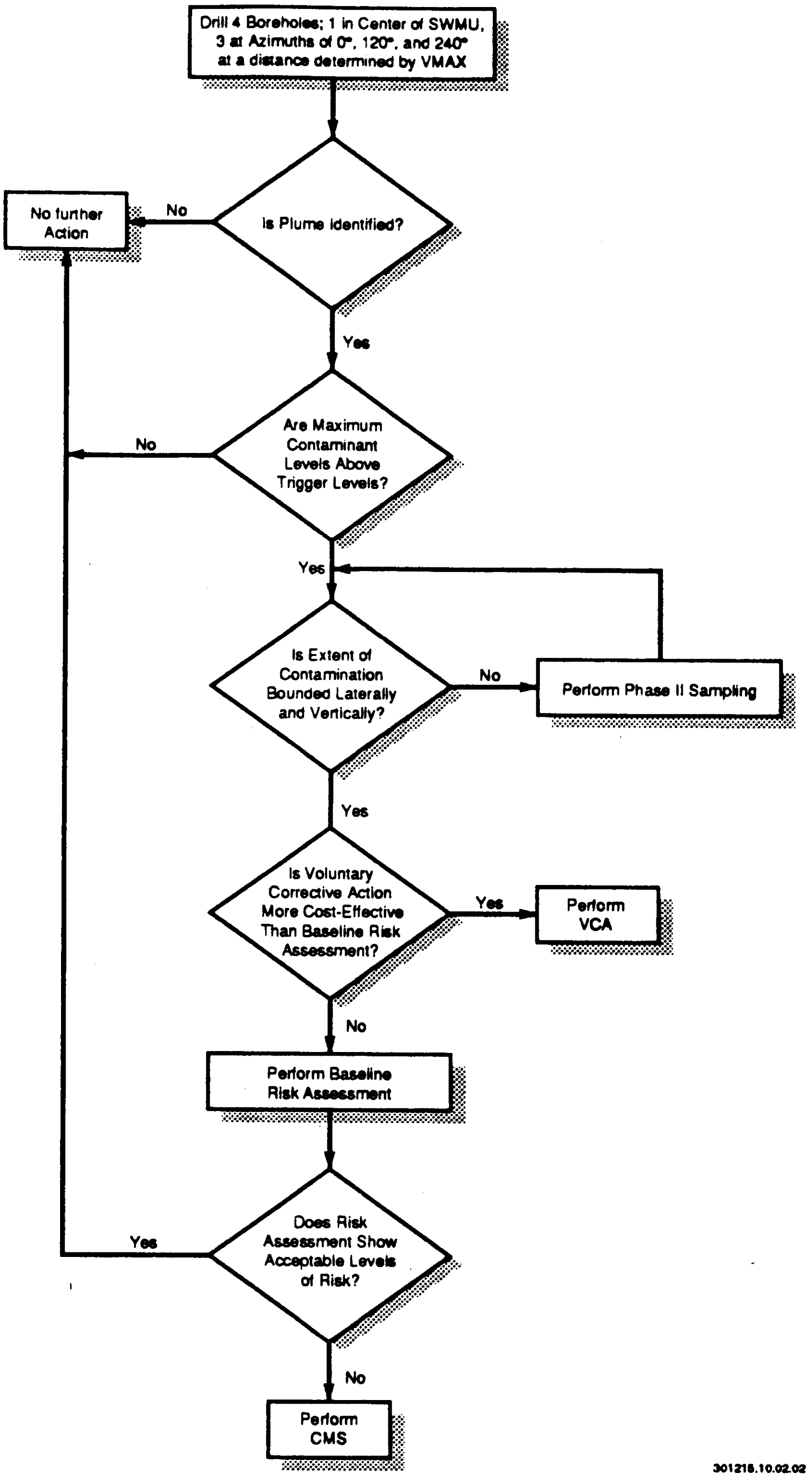

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Figure 5.2-5. TA-10 Subsurface Disposal SWMU Aggregate DQO decision logic flow diagram for SWMUS with unknown residual contamination.

TAL metals or semivolatiles are above trigger levels, all samples will be sent for laboratory analyses. If any of the laboratory analyses show that contaminant levels are above trigger levels and the plumes are bounded, then it will be assumed that a plume has been located and a VCA will be conducted or a baseline risk assessment will be performed. If the extent of contamination is not bounded, then a Phase II sampling will be required to determine the nature and extent of contamination.

5.2.2.5 Design Criteria

Four boreholes will be drilled in each area at a distance determined by VMAX. Previous data indicate that it is unlikely that contamination will be found in these SWMUs. However, if contamination is found, and if the extent of contamination is bounded by VMAX, then a VCA will be conducted or a baseline risk assessment may be performed. If additional data are required to bound the extent, a Phase II sampling plan will be implemented based on the data from the Phase I samples.

5.2.2.6 Sampling Plan

5.2.2.6.1 Sample Collection

During the Phase I field investigation, four boreholes will be installed in the centers of the surveyed structure locations at each SWMU. The sampling plan flow logic diagram for the SWMUs is shown in Figure 5.2-6. The general procedure for soil and rock boring, including hollow-stem auguring, is outlined in Appendix D. Samples will be taken from a continuous core and drilled with a hollow-stem auger with a core barrel, as outlined in Appendix D.

The first borehole installed will be centered in each of the surveyed SWMUs. The remaining three boreholes will be installed at azimuths of 0°, 120°, and 240° at a distance determined by VMAX. All boreholes will be drilled to a maximum depth of 50 ft. During borehole installation, samples will be collected for analysis at the midpoints of each 5 ft core, or at the locations (maximum of two) where the highest radioactivity and organic vapor measurements are encountered during field screening.

If no field screening measurements are detected, samples will be analyzed from the 5 ft depth interval, the interface with fill/*in-situ* material, the total depth, and one random core sample.

If contamination is detected at any of the SWMUs and is not bounded by VMAX, then further sampling and analysis will be conducted in a Phase II field investigation. The approach for Phase II sampling will be similar to that of Phase I discussed above.

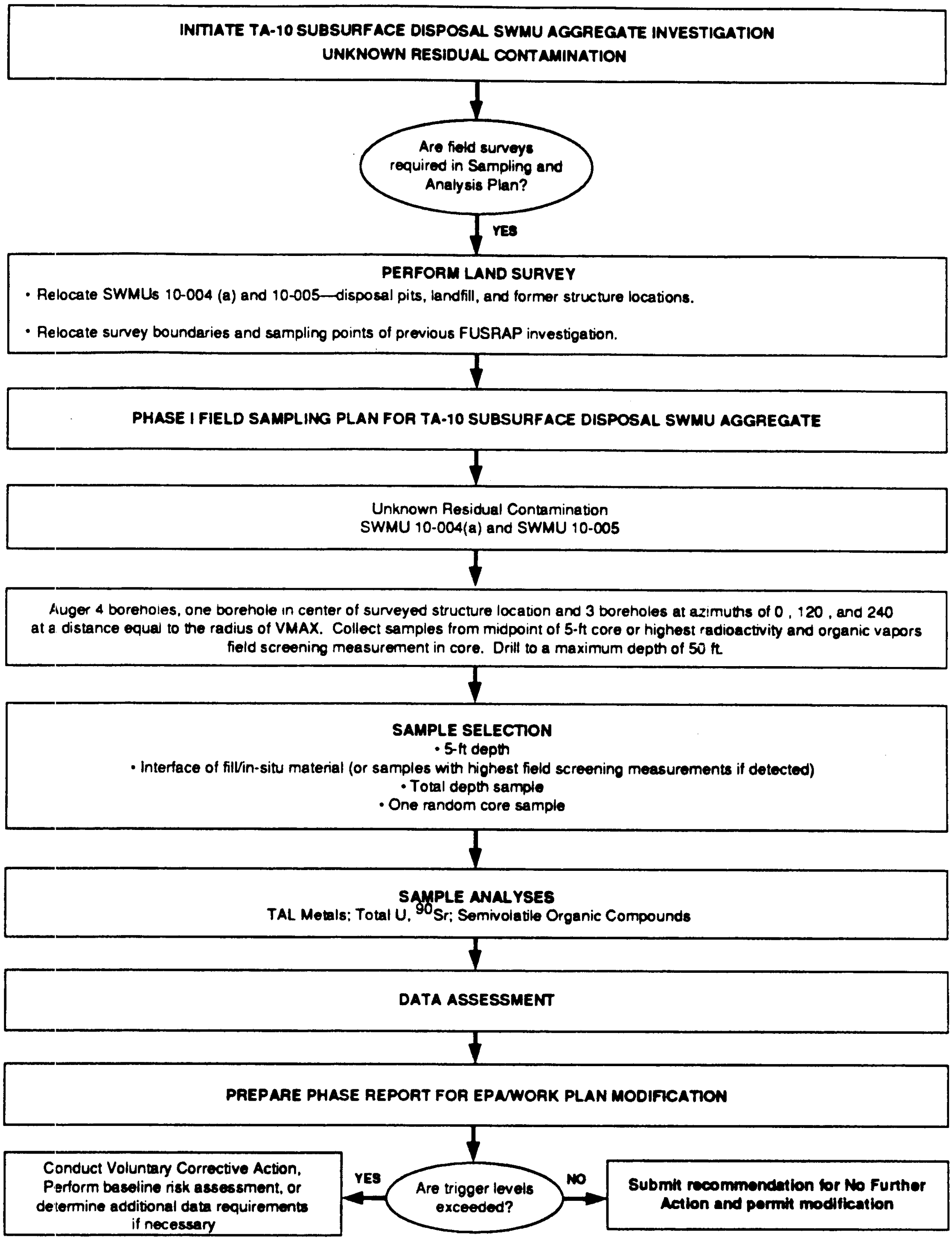

Figure 5.2-6. TA-10 Subsurface Disposal SWMU Aggregate Phase I sampling plan flow diagram for unknown residual contamination.

5.2.3 Field Screening of Samples

All samples will be field screened for radioactivity (i.e., gross-alpha, gross-beta, and gross-gamma activity) to identify gross concentrations of contaminants and to provide information on sample selection for further laboratory analysis. Field screening methods are detailed in Appendix D.

5.2.4 Sample Analyses

All core samples will be analyzed for TAL metals, total U, ^{90}Sr, and semivolatile organic compounds. If radioactivity is detected during field screening, the sediment samples will also be analyzed for gamma spectrometry to identify individual radionuclides. In addition, 20 random samples from the boreholes in the SWMUs 10-003(a-o) characterization will be analyzed for explosives.

5.2.5 Sample Quality Assurance/Quality Control

Field quality assurance (QA) samples will be collected during the course of the field investigation and are outlined in Tables 5.2-1 and 5.2-2. These samples include field duplicates and equipment rinsate blanks. The definition of each kind of sample and its purpose are given in Annex II, Quality Assurance Project Plan (QAPjP) of this work plan.

5.2.6 Field Operations

The organizational structure for the field investigation team is identified in Figure 5.1-6. The team will have individual responsibilities for health and safety, sample identification, sample handling and chain of custody, and related activities. Facilities such as a field screening laboratory or an equipment decontamination facility may be shared by OU 1079 field teams. Premobilization activities, health and safety, site control, site monitoring, and support service aspects of the field operations are described in Appendix D.

TABLE 5.2-1 SCREENING AND ANALYSIS FOR TA-10 INVESTIGATION FOR SUBSURFACE DISPOSAL SWMU AGGREGATE; KNOWN RESIDUAL CONTAMINATION

				Field Screening						Laboratory Analysis										
Sample Type/Location	Sample Number	Sample Depth	Sample Identification	Gross Alpha	Gross Beta	Gross Gamma	Combustible Gas/oxygen	Organic Vapor	Lithological Logging	Gamma Spectrometry	Total Uranium	Strontium-90	Beryllium	Lead	TAL Metals	Explosives	Semivolatiles (SW 8270)	Metals (SW 6010)	PCB (SW 8080)	VOA (SW 8240)
SWMU Aggregate 10-002(a), 10-002 (b), 10-003(a-o), 10-004(b), and 10-007																				
TA-10 Central Area																				
SWMU 10-003(a-o), 10-007																				
Boreholes (20)	1-80	Variable		X	X	X		X	X	●	X	X			X		X			●
Field Duplicate	81-88	Variable		X	X	X		X		●	X	X			X		X			●
Rinsate Blank	89-92										X	X			X		X			
Random Sample Each Borehole	20 of 80															X				
TA-10-44 Area and TA-10-48 Areas																				
SWMU 10-002(a), 10-002(b)																				
Boreholes (8)	93-124	Variable		X	X	X		X	X	●	X	X			X		X			●
Field Duplicate	125-127			X	X	X		X		●	X	X			X		X			●
Rinsate Blank	128-129										X	X			X		X			
TA-10-38 Area																				
SWMU 10-004(b)	130-145																			
Boreholes (4)	146	Variable		X	X	X		X	X	●	X	X			X		X			●
Field Duplicate				X	X	X		X		●	X	X			X		X			●

X Mandatory Analysis

● Analyze if Positive Field Screening Measurement

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TABLE 5.2-2 SCREENING AND ANALYSIS FOR TA-10 INVESTIGATION FOR SUBSURFACE DISPOSAL SWMU AGGREGATE; UNKNOWN RESIDUAL CONTAMINATION

				Field Screening						Laboratory Analysis										
Sample Type/Location	Sample Number	Sample Depth	Sample Identification	Gross Alpha	Gross Beta	Gross Gamma	Combustible Gas/oxygen	Organic Vapor	Lithological Logging	Gamma Spectrometry	Total Uranium	Strontium-90	Beryllium	Lead	TAL Metals	Explosives	Semivolatiles (SW 8270)	Metals (SW 6010)	PCB (SW 8080)	VOA (SW 8240)
SWMU Aggregate 10-004(a) and 10-005																				
SWMU 10-004(a)																				
Boreholes (4)	1-16	Variable		X	X	X		X	X	●	X	X			X		X			●
Field Duplicate	17-18			X	X	X		X		●					X		X			●
Rinsate Blank	19									X					X		X			X
SWMU 10-005 Firing Site																				
Debris Disposal																				
Boreholes (4)	20-35	Variable		X	X	X		X	X	●	X	X			X	X				●
Field Duplicate	36-37			X	X	X		X			X	X			X	X				
Rinsate Blank	38										X	X			X	X				

X Mandatory Analysis

● Analyze if Positive Field Screening Measurement

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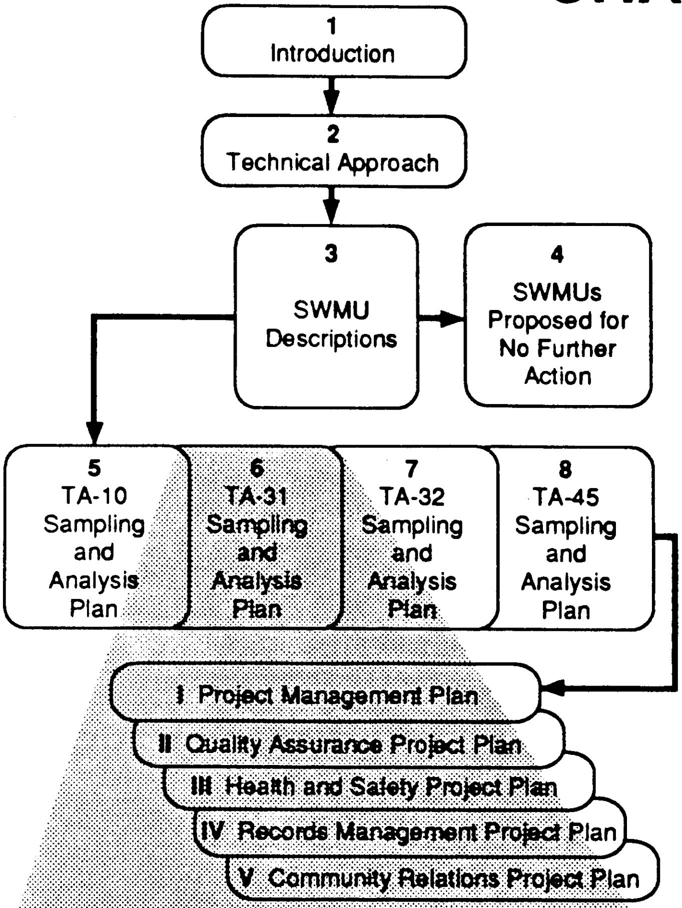
EPA (U.S. Environmental Protection Agency), July 27, 1990. "Corrective Action for Solid Waste Management Units (SWMUs) at Hazardous Waste Management Facilities," proposed rule, Title 40 Parts 264, 265, 270, and 271, Federal Register, Vol. 55. **(EPA 1990, 0432)**

Mayfield, D.L., A.K. Stoker, and A.J. Ahlquist 1979. "Radiological Survey of the Bayo Canyon, Los Alamos, New Mexico," Department of Energy Report DOE/EV-0005/15, Los Alamos, New Mexico. **(Mayfield et al. 1979, 06-0041)**

Neptune, D. and S. Blacker, 1990, "Applying Total Quality Principles to Superfund Planning," Seventeenth Annual National Energy Division Conference American Society for Quality Control, Energy Division. **(Neptune and Blacker 1990, 0684)**

Neptune, D., A.L. Moorehead, and D.I. Michael, 1990 "Streamlining Superfund Soil Studies: Using the Data Quality Objectives Process for Scoping," Office of Research and Development, Environmental Protection Agency, RD-680, Washington, D.C. **(Neptune et al. 1990, 0511)**

CHAPTER 6



TA-31 Sampling and Analysis Plan

- SWMU Aggregate 31-001

6.0 TECHNICAL AREA 31 (TA-31) SAMPLING AND ANALYSIS PLAN

Section 2.2 describes the DQO process as used in this work plan. In the following sections, the DQO process is used to develop the sampling rationale and sampling plan to determine if there is any residual contamination from past activities at TA-31. These Phase I investigations consist of reconnaissance sampling of the areas most likely to be contaminated if a release has occurred. These data will be used to determine if TA-31 should be recommended for no further action (the most probable outcome) or should have further investigation.

6.1 DQO Process For SWMU 31-001

6.1.1 Problem Statement

As previously discussed, TA-31 was a warehouse from 1945 to 1954 for items ranging from stationary and other office supplies to construction materials. As noted in Subsection 3.2.1, no radiological materials were stored at TA-31. It is also unlikely that large quantities of bulk chemicals were stored at TA-31 because other storage areas were used specifically for chemical storage (i.e., TA-21). As there were no documented spills, any residual contamination would be from unreported accidental spills either in the loading and unloading of supplies, or inside the warehouse building. Spills occurring inside the main warehouse could have resulted in contamination of the sanitary septic system. The buildings and parking area were decommissioned in 1954 and homes have been built over these areas. When the septic tank associated with the site was removed in 1988 and sampled, there were no detectable hazardous constituents in any of the samples, however the documentation for this analysis is unavailable. At the time of the tank removal, no septic line was encountered. It may have been removed during the D&D activities or during home construction. The likelihood of any significant residual contamination at this site is very low.

The problems to be addressed are to corroborate the verbal reports of no chemical contamination in the septic tank by sampling the location of the former septic tank and the outfall from the septic tank, and to determine if the former septic line is still in place at the site. If the line is found during the investigation, it will be removed. At this time, sampling the residential area is unwarranted. If residual contamination is found in the septic tank, outfall, or drainline areas, sampling in the residential area will be reconsidered.

6.1.2 Decision Process

The decision logic flow is given in Figure 6.1-1. Phase I samples will be collected and analyzed as described in Section 6.2. If the concentration of a potential contaminant in any sample exceeds a trigger level and background concentrations,

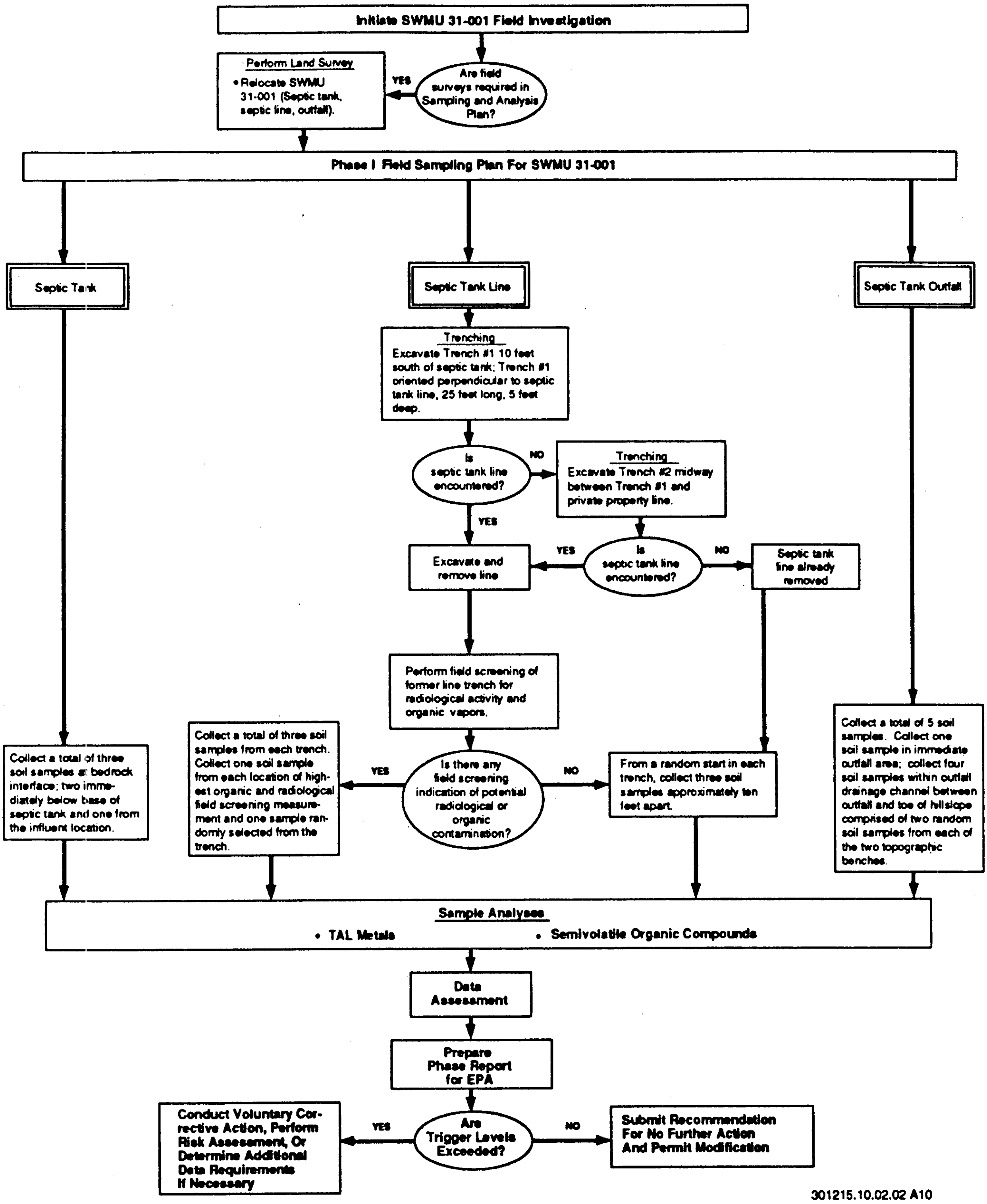


Figure 6.1-1. Decision logic flow diagram for Phase I Investigation of SWMU 31-001 at TA-31.

then a Voluntary Corrective Action (VCA) may be conducted, or additional samples (Phase II) will be collected for a baseline risk assessment (Table 6.1-1).

6.1.3 Data Needs

6.1.3.1 Source Characterization

Prior to sampling, a land survey will be conducted to establish an accurate base map, document all sampling locations, and locate former or buried structure locations. The septic tank location (SWMU 31-001) will be surveyed to establish its former location on which to reference an initial radiological survey, and all sampling localities. All sample localities (auger holes and surface soil samples) will be surveyed and registered to the base map. If, during the course of sampling, any sample points must be relocated, the new positions will be resurveyed and the revised locations will be indicated on the map. Land survey methods are described in Appendix D.

The potential source of contamination is residual chemical contamination in the soil resulting from possible leakage from the former septic system. All trench and auger samples will be field screened for radioactivity and volatile organic vapors. All samples will be sent for laboratory analyses of TAL metals and semivolatile organic compounds. If the field screening measurements detect radionuclides or volatile organic vapors, then those samples will be sent to the laboratory for analysis of specific radionuclides and volatile organic compounds.

6.1.3.2 Environmental Setting

Risk scenarios for baseline risk assessments include residential, worker, and recreational use. These scenarios can be evaluated with existing environmental data.

6.1.3.3 Potential Receptors

The former TA-31 site is in a residential area. Therefore, conservative residential use trigger levels will be used in the Phase I investigation to determine if there is a potential for adverse human health effects associated with the surface or subsurface soil. No additional information is needed on potential receptors.

6.1.4 Decision Logic

6.1.4.1 Domain of the Decision

Judgmental samples to bound the levels of contamination will be collected at the location of the former septic tank and outfall. At the location of the former septic

TABLE 6.1-1 LABORATORY ANALYSES FOR THE TA-31 SWMU INVESTIGATIONS

SWMU	DESCRIPTION	CONTAMINANTS OF CONCERN	TRIGGER LEVELS[a]	METHOD OF ANALYSIS	DETECTION LIMIT	QUALITY LEVEL
31-001	Septic Tank, Septic Tank Line, and Outfall area	Radioactive Materials	Dependent on Contaminant TBD[b]	Field Screening for gross gamma, beta, and alpha, if present, analyze with gamma spectrometry Table V.8, LANL 1991, 0412.	N/A	II
		TAL Metals	Dependent on Contaminant TBD[b]	EPA SW-846 Method 6010, 7060, 7470, and 7740 (Inductively Coupled Plasma Emission Spectroscopy, Graphite Furnace Atomic Absorption Spectroscopy, and Cold Vapor Atomic Absorption Spectroscopy)	Contaminant Dependent (see Table V.7, LANL 1991, 0412)	III
		Volatile Organic Compounds	Dependent on Contaminant TBD[b]	EPA SW-846 Method 8240 (Gas Chromatography/Mass Spectrometry)	Contaminant Dependent (see Table V.3, LANL 1991, 0412)	III
		Semivolatile Organic Compounds	Dependent on Contaminant TBD[b]	EPA SW-846 Method 8270 (Gas Chromatography/Mass Spectrometry Capillary Column Technique)	Contaminant Dependent (see Table V.4, LANL 1991, 0412)	III

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[a] Trigger levels for radionuclides will be provided in 1992 IWP. Trigger levels for nonradionuclides will be the proposed RCRA Subpart S action levels (EPA 1990, 0432).

[b] TBD: To Be Determined

tank, two samples will be collected immediately below the base of the septic tank at the bedrock interface, and a third sample will be collected from the influent line location (Figure 6.1-1). Potential contaminants are likely to be concentrated at this interface since the bedrock presents a relative barrier to the continued downward migration of contaminants. It is unlikely that hazardous constituents would exist at levels deeper than the bedrock interface if they are not present above that level. The immediate outfall area and sediment fan areas on topographic benches in the channel will be sampled. These are the areas with the highest probability of residual contamination accumulation. The time domain focuses on current risks.

6.1.4.2 Logic Statement

The maximum of the contaminant concentrations for all samples will be compared to trigger levels.

6.1.5 Design Criteria

The design criterion for sampling is to detect contamination above trigger levels in small areas where it is expected that, if any contamination exists above trigger levels, a large portion of the area will have at least this level of contamination. Three samples give an 87% probability of detecting contamination if it exists over 50% of the area and a 97% probability of detection if contamination exists over 70% of the area. This rationale has motivated the number of samples taken for the Phase I reconnaissance sampling described in Subsection 6.2.

6.2 Sampling Plan

6.2.1 Septic Tank Location

The former septic tank system (SWMU 31-001) was located aboveground on a shallow bench adjacent to Pueblo Canyon. A total of three soil samples will be collected in the septic tank location at the soil/bedrock interface. Two soil samples will be collected immediately below the former location of the base of the septic tank at the bedrock interface and a third sample will be collected from the influent line location (Figure 6.2-1). The samples will be collected immediately above the bedrock (anticipated at less than 5 ft below the ground surface) using a manual shallow-core sampling technique (see Appendix D).

6.2.2 Septic Tank Line Location

It is unknown whether or not the septic line from warehouse number TA-31-7 to the septic tank was removed during decommissioning in 1954. During the septic tank removal in 1988, no line was found in the immediate tank vicinity. During the site investigation, backhoe trenches will be excavated perpendicular to the former line location (Figure 6.2-1) to determine if the septic tank line was removed.

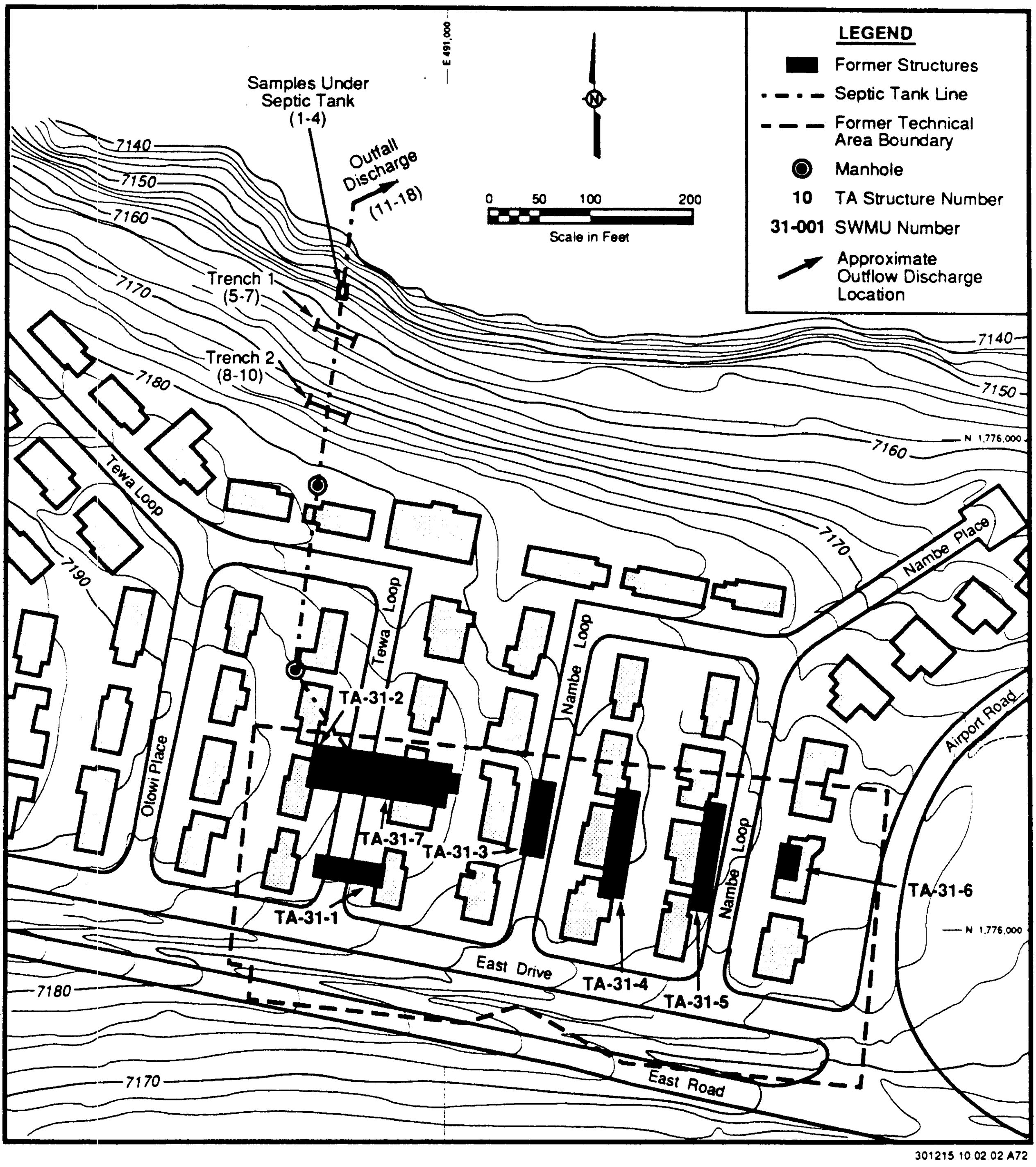

Figure 6.2-1. TA-31 SWMU 31-001 sampling locations (modified from LANL 1990, 0145; AEC 1963, 06-0016; AEC 1963, 06-0030; Los Alamos County 1986, 06-0061; LASL 1950, 06-0054).

Trench #1 will be excavated approximately 10 ft south of the septic tank location. The trench will be approximately 25 ft long, 3 ft wide, and 5 ft deep. If the line is encountered in the trench, it will be excavated and removed to the perimeter of the Eastern Area residential property line.

Field screening measurements for radioactivity and volatile organic vapors will be collected in the line trench. If field screening indicates potential contamination, soil samples will be collected from the location of the highest radioactivity and organic vapors measurements, and one randomly selected location in the trench using a spade-and-scoop method discussed in Appendix D. If field screening indicates no potential contamination, then three soil samples will be collected from the trench at 10 ft intervals from a random start position.

If no line is encountered in Trench #1, a second trench (Trench #2) will be excavated midway between Trench #1 and the Eastern Area property line (Figure 6.2-1). If the septic line is encountered in Trench #2, the line will be excavated and removed, and field screening/soil sampling will be performed as described above. If no line is encountered, and field screening indicates no potential contamination, three soil samples will be collected at 10 ft intervals from a random start position.

6.2.3 Outfall Area

The outfall area is a natural drainage on the southern slope of Pueblo Canyon. The objective of the outfall sampling strategy is to determine the presence of potential contaminants along the trace of the outfall, from outfall vicinity to the toe of the hillslope (Figure 6.2-1). One near surface soil sample will be collected from the immediate outfall area. Four near surface soil samples will be collected from sediments in the channel between the outfall and the toe of the hillslope. Samples will be collected using the spade-and-scoop method (see Appendix D). Sample locations will be selected based on a higher probability of residual contamination accumulation (i.e., sediment fans on topographic benches in the channel). The samples will be collected to a maximum depth of approximately 15 cm below the surface.

6.3 Field Screening of Samples

All samples will be field screened for radioactivity (gross-alpha, gross-beta, and gross-gamma activity) and volatile organic vapors to identify gross concentrations of contaminants and provide information on sample selection for further laboratory analysis. Field screening methods are detailed in Appendix D.

6.4 Sample Analyses

The soil samples will be analyzed for TAL metals and semivolatile organic compounds (see Table 6.1-1, and Table 6.4-1, and Appendix D). If radioactivity

TABLE 6.4-1 SCREENING AND ANALYSIS FOR TA-31 INVESTIGATION OF SWMU 31-001

Sample Type / Location	Sample Number	Sample Depth	Sampling Identification	Field Screening						Laboratory Analysis										
				Gross Gamma	Gross Alpha	Gross Beta	Organic Vapor	Combustible Gas/Oxygen	Lithological Logging	Gamma Spectrometry	Tritium	Total Uranium	Isotopic Plutonium	Isotopic Uranium	Strontium 90	VOA (SW 8240)	Semivolatiles (SW 8270)	Metals (SW 6010)	PCB (SW 8080)	TAL Metals
SWMU 31-001																				
Septic Tank																				
Shallow Boreholes at	1	5 ft.		X	X	X	X			●						●	X			X
Soil / Bedrock Interface	2	5 ft.		X	X	X	X			●						●	X			X
	3	5 ft.		X	X	X	X			●						●	X			X
Field Duplicate	4	5 ft.		X	X	X	X			●						●	X			X
Septic Tank Lines																				
Shallow Trench #1	5	5 ft.		X	X	X	X			●						●	X			X
	6	5 ft.		X	X	X	X			●						●	X			X
	7	5 ft.		X	X	X	X			●						●	X			X
Shallow Trench #2	8	5 ft.		X	X	X	X			●						●	X			X
	9	5 ft.		X	X	X	X			●						●	X			X
	10	5 ft.		X	X	X	X			●						●	X			X
Septic Tank Outfall																				
Near Surface Soil	11	15 cm		X	X	X	X			●						●	X			X
	12	15 cm			X	X	X			●						●	X			X
	13	15 cm		X	X	X	X			●						●	X			X
	14	15 cm		X	X	X	X			●						●	X			X
	15	15 cm		X	X	X	X			●						●	X			X
Rinsate Blank	16																X			X
Field Duplicate	17	15 cm		X	X	X	X			●						●	X			X
Field Duplicate	18	15 cm		X	X	X	X			●						●	X			X

X Mandatory Analysis
● Analyze if Positive Field Screening Measurement

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(gross-alpha, gross-beta, or gross-gamma activity) is detected during the field screening, those samples will also be analyzed using gamma spectrometry to identify individual radionuclides that may be present. If organic vapors are detected during field screening, those samples will also be analyzed for volatile organic compounds.

6.5 Sample Quality Assurance/Quality Control

Field quality assurance (QA) samples will be collected during the course of the field investigation and are outlined in Table 6.4-1. These samples include field duplicates and rinsate blanks. The definition of each kind of sample and its purpose are given in Annex II, Quality Assurance Project Plan (QAPjP) of this work plan.

6.6 Field Operations

The organizational structure for the field investigation team is identified in Figure 6.6-1. The team will have individual responsibilities for health and safety, sample identification, sample handling and chain of custody, and related activities. Facilities such as a field screening laboratory or an equipment decontamination facility may be shared by OU 1079 field teams. Premobilization activities, health and safety, site control, site monitoring, and support service aspects of the field operations are described in Appendix D.

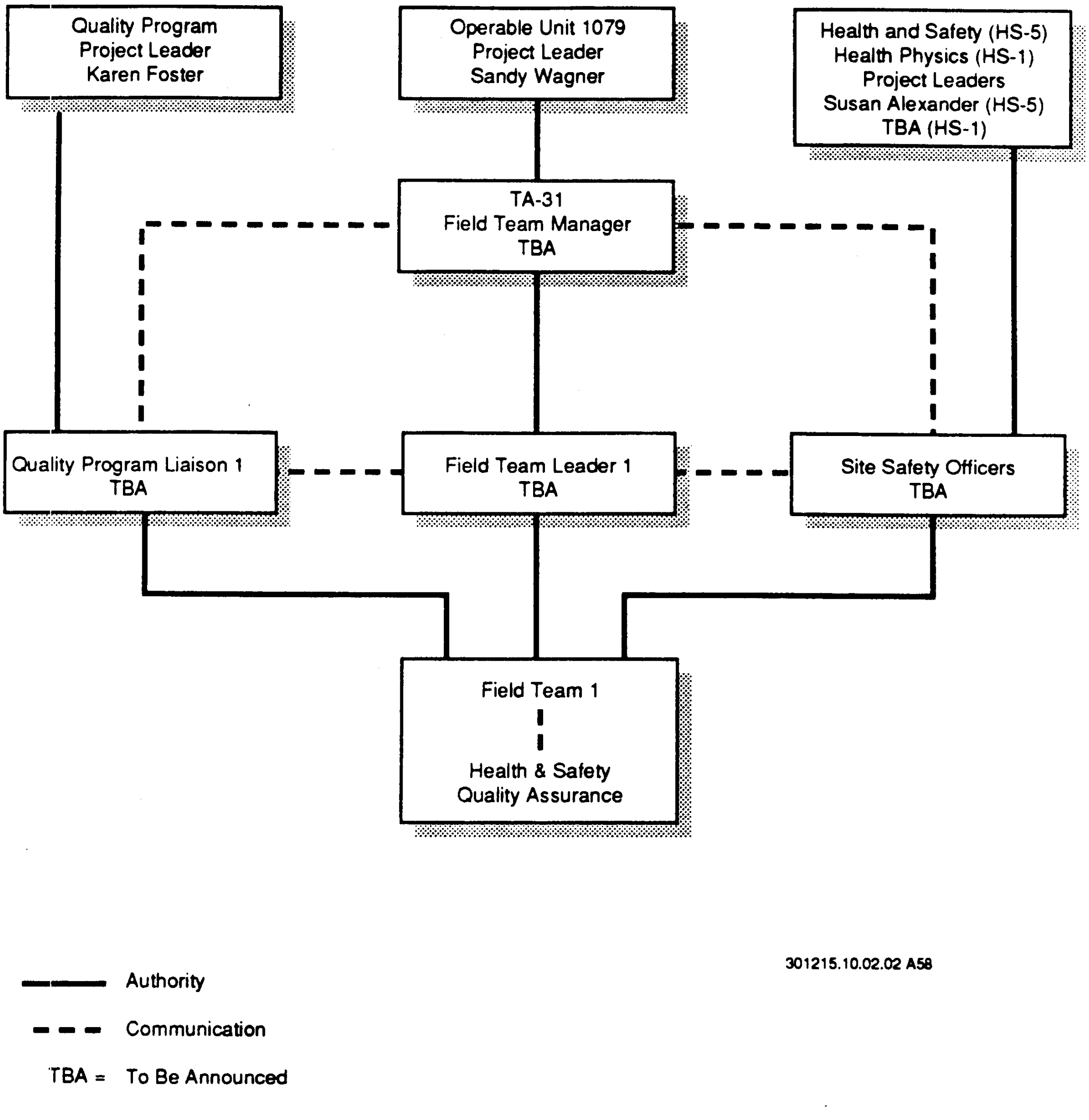

Figure 6.6-1. TA-31 field investigation team.

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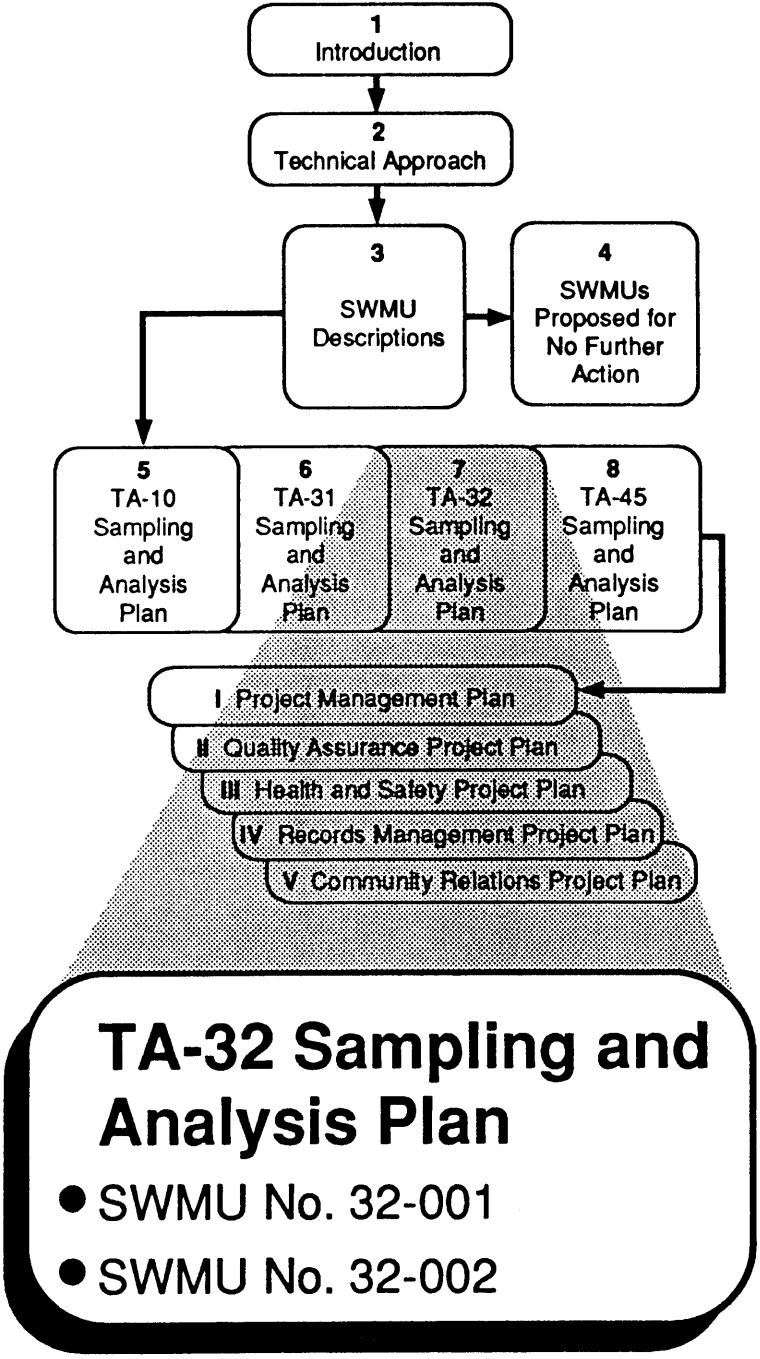
CHAPTER 7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7.0 TECHNICAL AREA 32 (TA-32) SAMPLING AND ANALYSIS PLAN

Section 2.2 describes the DQO process as used in this work plan. In the following sections, the DQO process is used to develop the sampling rationale and sampling plans to determine if there is any residual contamination from past activities at TA-32. These Phase I investigations consist of reconnaissance sampling of the areas most likely to be contaminated if a release has occurred. These data will be used to determine if TA-32 should be recommended for no further action (the most probable outcome) or should have further investigation.

7.1 DQO Process For The TA-32 SWMU Aggregate

7.1.1 Problem Statement

As described in Subsection 3.3, TA-32 was a medical research and medical training facility from 1944 to 1954. The SWMUs at this site consist of two septic tanks [SWMU 32-002(a) and (b)] and an incinerator (SWMU 32-001). The problem to be addressed at this site is to determine if there is a potential health risk from residual soil contamination from hazardous chemicals and radionuclides associated with the incinerator, the septic tanks systems, and outfall areas. Samples collected in 1988 during removal of the TA-32-8 septic [SWMU 32-002(b)] showed parts per billion concentrations of volatile organic and semivolatile organic compounds, and lead and chromium in excess of the EP-Toxicity maximum concentrations. Although no radionuclides were detected in these samples, radionuclides were used in laboratory medical experiments and are potential contaminants.

The incinerator was located at the northeastern edge of building TA-32-1. This locations is currently under a paved area within the Los Alamos County Roads Division storage yard. It is unlikely that any residual contamination remains at the former incinerator location. Any contamination would have either been dispensed as particulates from the stack or been disposed of as ash. While ash disposition from the incinerator in unknown, it is unlikely that it would have been disposed of on site. However, since liquid waste may have been released from the bottom of the incinerator, there is the possibility of residual contamination below the incinerator. If such contamination exists, there is a very high probability that it will be detected by sampling directly below the base of the former incinerator.

The location of the septic tanks can only be determined to within a 40 ft by 30 ft area. Since the bedrock presents a barrier to downward migration, significant leakage from the septic tanks would have spread laterally. Significant leakage is defined as leakage covering at least 50% of the 1200 ft^2 area at the bedrock interface at levels above trigger levels. It is unknown whether the septic lines from the former TA-32 laboratory building to the septic tanks were removed during decommissioning. No line was found during the TA-32-8 septic tank removal. During this investigation, trenches will be excavated to determine if septic lines remain. If lines are found, they will be removed.

7.1.2 Decision Process

The decision logic flow is given in Figure 7.1-1. Phase I samples will be collected and analyzed as described in Sections 7.2, 7.3, and 7.4. If the concentration of a potential contaminant in any sample exceeds its trigger level and background concentration, then a Voluntary Corrective Action (VCA) may be conducted, or additional samples will be collected for a baseline risk assessment Table 7.1-1.

7.1.3 Data Needs

7.1.3.1 Source Characterization

Prior to sampling, a land survey will be conducted to establish an accurate base map, document sampling locations, and locate former or buried structure locations. Locations of former buried structures are recorded on site maps, but locations need to be recovered at the site. SWMU 32-001 (incinerator) and SWMU 32-002 (septic tanks and outfall locations) will be surveyed to establish their former locations on which to reference an initial radiological survey and for all sampling localities. All sample localities (auger holes and surface soil samples) will be surveyed and registered to the basemap. If, during the course of sampling, any sample points must be relocated, the new positions will be resurveyed and the revised locations will be indicated on the map.

The potential source of contamination is residual chemical and radiological contamination in the soil resulting from possible contamination in the former septic system and incinerator. All trench and auger samples will be field screened for radioactivity and organic vapors. All samples will be sent for laboratory analyses of TAL metals and semivolatile organic compounds. If field screening measurements detect radionuclides or volatile organic vapors, then those samples will be sent to the laboratory for analysis of radionuclides and volatile organic compounds.

7.1.3.2 Environmental Setting

Risk scenarios for baseline risk assessments include residential, worker, and recreational use. These scenarios can be evaluated with existing environmental data.

7.1.3.3 Potential Receptors

The former TA-32 site is in an active industrial area. The septic tanks were located on the edge of the mesa, and the outfall areas were on the side of the hillslope adjacent to Los Alamos Canyon. Conservative residential use trigger levels will be used in the Phase I investigation to determine if there is a potential for adverse human health effects associated with the surface or subsurface soil.

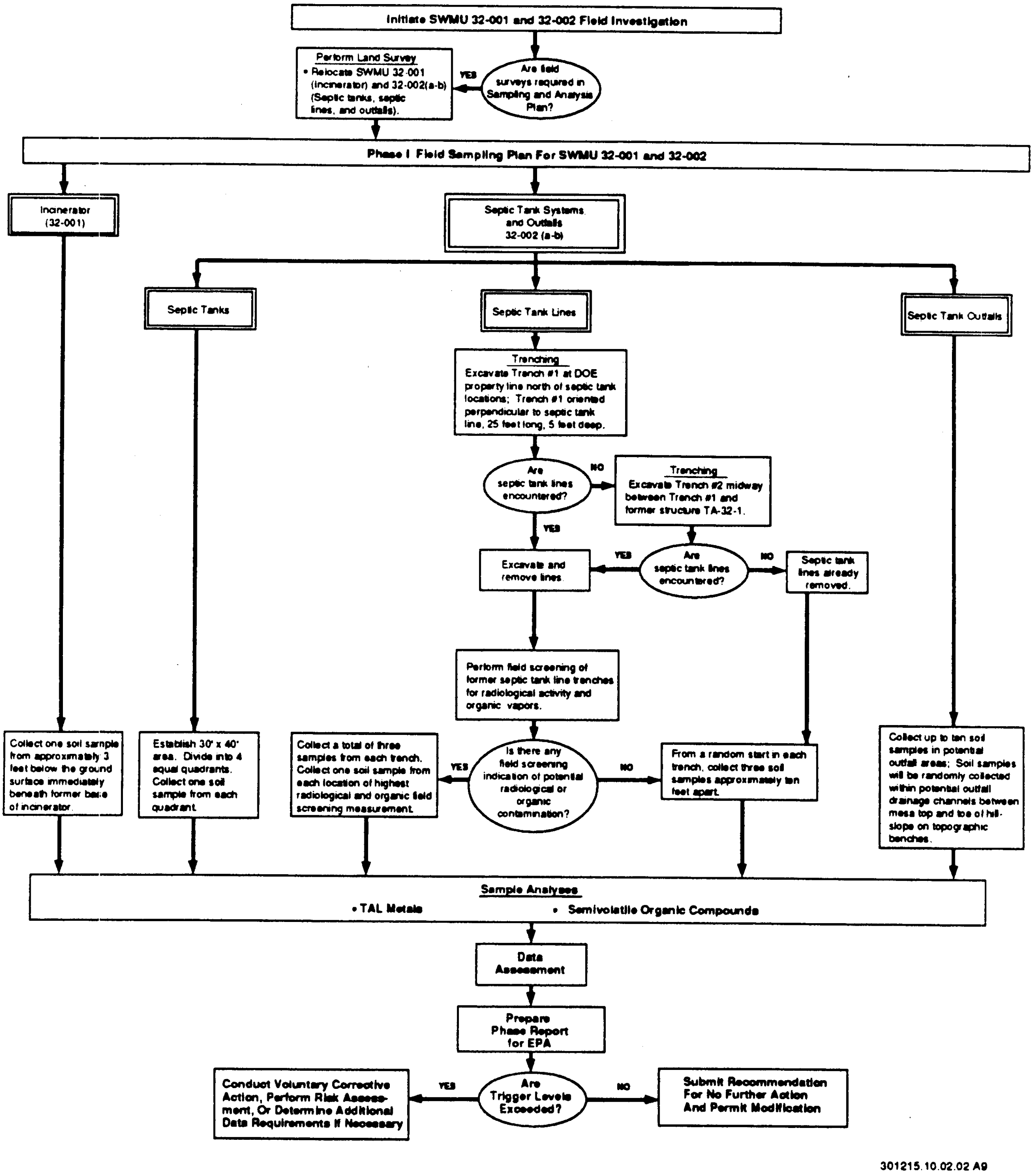

Figure 7.1-1. Decision logic for field investigation of SWMU 32-001 and 32-002 at TA-32.

TABLE 7.1-1 LABORATORY ANALYSES FOR THE TA-32 SWMU INVESTIGATIONS

SWMU	DESCRIPTION	CONTAMINANTS OF CONCERN	TRIGGER LEVELS[a]	METHOD OF ANALYSIS	DETECTION LIMIT	QUALITY LEVEL
32-001	Incinerator Site	^{14}C	TBD[b]	Combustion of Soil Sample followed by Gas Proportional Counting	TBD	III
		$^{238,239}Pu$	TBD[b]	Radiochemical Separation and alpha spectroscopy	0.005 pCi/g	III
		^{241}Am	TBD[b]	Radiochemical Separation and alpha spectroscopy	0.002 pCi/g	III
		^{3}H	TBD[b]	Liquid scintillation counting	400 pCi/L	III
		Volatile Organic Compounds	Dependent on Contaminant TBD[b]	EPA SW-846 Method 8240 (Gas Chromatography/Mass Spectrometry)	Contaminant Dependent (see Table V.3, LANL 1991, 0412)	III
		Semivolatile Organic Compounds	Dependent on Contaminant TBD[b]	EPA SW-846 Method 8270 (Gas Chromatography/Mass Spectrometry Capillary Column Technique)	Contaminant Dependent (see Table V.4, LANL 1991, 0412)	III
		TAL Metals	Dependent on Contaminant TBD[b]	EPA SW-846 Methods 6010, 7060, 7470, and 7740 (Inductively Coupled Plasma Emission Spectroscopy, Graphite Furnace Atomic Absorption Spectroscopy, and Cold Vapor Atomic Absorption Spectroscopy	Contaminant Dependent (see Table V.7, LANL 1991, 0412)	III

[a] Trigger levels for radionuclides will be provided in 1992 IWP. Trigger Levels for nonradionuclides will be the proposed RCRA Subpart S action levels (EPA 1990, 0432)

[b] TBD: To Be Determined

TABLE 7.1-1 LABORATORY ANALYSES FOR THE TA-32 SWMU INVESTIGATIONS (CONT'D)

SWMU	DESCRIPTION	CONTAMINANTS OF CONCERN	TRIGGER LEVELS[a]	METHOD OF ANALYSIS	DETECTION LIMIT	QUALITY LEVEL
32-002 (a-b)	Septic Tanks, Septic Tank Lines, and Outfall Areas	^{14}C	TBD[b]	Combustion of Soil Sample followed by Gas Proportional Counting	TBD	III
		$^{238,239}Pu$	TBD[b]	Radiochemical Separation and alpha spectroscopy	0.005 pCi/g	III
		^{241}Am	TBD[b]	Radiochemical Separation and alpha spectroscopy	0.002 pCi/g	III
		^{3}H	TBD[b]	Liquid scintillation counting	400 pCi/L	III
		Volatile Organic Compounds	Dependent on Contaminant TBD[b]	EPA SW-846 Method 8240 (Gas Chromatography/Mass Spectrometry)	Contaminant Dependent (see Table V.3, LANL 1991, 0412)	III
		Semivolatile Organic Compounds	Dependent on Contaminant TBD[b]	EPA SW-846 Method 8270 (Gas Chromatography/Mass Spectrometry Capillary Column Technique)	Contaminant Dependent (see Table V.4, LANL 1991, 0412)	III
		TAL Metals	Dependent on Contaminant TBD[b]	EPA SW-846 Methods 6010, 7060, 7470, and 7740 (Inductively Coupled Plasma Emission Spectroscopy, Graphite Furnace Atomic Absorption Spectroscopy, and Cold Vapor Atomic Absorption Spectroscopy	Contaminant Dependent (see Table V.7, LANL 1991, 0412)	III

[a] Trigger levels for radionuclides will be provided in 1992 IWP. Trigger levels for nonradionuclides will be the proposed RCRA Subpart S action levels (EPA 1990, 0432).

[b] TBD To Be Determined

If trigger levels are found above action levels and background concentrations, then scenarios for on-site workers and recreational users may be evaluated. No additional information is needed on potential receptors.

7.1.4 Decision Logic

7.1.4.1 Domain of The Decision

The area directly beneath the incinerator is the spatial domain for SWMU 32-001.

Because the exact locations of the septic tanks are unknown, the domain for sampling these tanks is an area 40 ft long by 30 ft wide that is certain to cover the locations of the former tanks. Since the bedrock presents a relative barrier to the continued downward migration of contaminants, samples will be collected at the bedrock interface where contaminants are likely to concentrate.

The domain for outfall sampling consists of sediment fan areas on topographic benches in the channels (the areas with the highest probability of residual contamination accumulation).

The time domain for the site focuses on current risks.

7.1.4.2 Logic Statement

The maximum of the contaminant concentrations for all samples will be compared to residential use trigger levels.

7.1.5 Design Criteria

The design criterion for sampling the outfalls, trenches, and former incinerator location is to detect contamination above trigger levels in small areas where it is expected that, if any contamination exists above trigger levels, a large portion of the site will have at least this level of contamination. Three samples give an 87% probability of detecting contamination if it exists over 50% of the area, and a 97% probability of detection if contamination exists over 70% of the area. Four samples give a 94% probability of detecting contamination if it exists over 50% of the area. The single sample for the incinerator is based on the assumption that the entire area under the base of the former incinerator will show contamination if it exists.

7.2 Sampling Plan

7.2.1 Sampling Plan For SWMU 32-001

One soil sample will be collected immediately beneath the former base of the incinerator (Figure 7.2-1). The sample will be collected using a manual shallow-core sampling technique (see Appendix D) at a depth of approximately 3 ft.

7.2.2 Sampling Plan For SWMU 32-002(a-b)

7.2.2.1 Septic Tank Locations

The 40 ft by 30 ft area will be divided into four equal quadrants. One sample location will be chosen at random from each quadrant. At these locations, one soil sample will be collected at the bedrock interface. The samples will be collected immediately above the bedrock, anticipated at less than 5 ft below the ground surface (Figure 7.2-1), using a manual shallow-cure sampling technique (see Appendix D).

7.2.2.2 Septic Tank Line Locations

During the site investigation, backhoe trenches will be excavated perpendicular to the former line locations to determine if the septic tank lines were removed (Figure 7.2-1). Trench #1 will be excavated north of the septic tank location at the DOE property line. The trench will be approximately 25 ft long, 3 ft wide, and 5 ft deep. If the line is encountered in the trench, it will be excavated and removed.

Field screening measurements for radioactivity and volatile organic vapors will be collected in the line trench. If field screening indicates potential contamination, soil samples will be collected from the location of the highest radioactivity and volatile organic vapor measurements, and from one randomly selected location in the trench using a spade-and-scoop method as discussed in Appendix D. If field screening indicates no potential contamination, then three soil samples will be collected from the trench at 10 ft intervals from a random start position.

If no lines are encountered in Trench #1, a second trench (Trench #2) will be excavated midway between Trench #1 and former structure TA-32-1. If septic tank lines are encountered in Trench #2, the lines will be excavated and removed, and field screening/soil sampling will be performed as described above. If no lines are encountered, and field screening indicates no potential contamination, three soil samples will be collected at 10 ft intervals from a random start position.

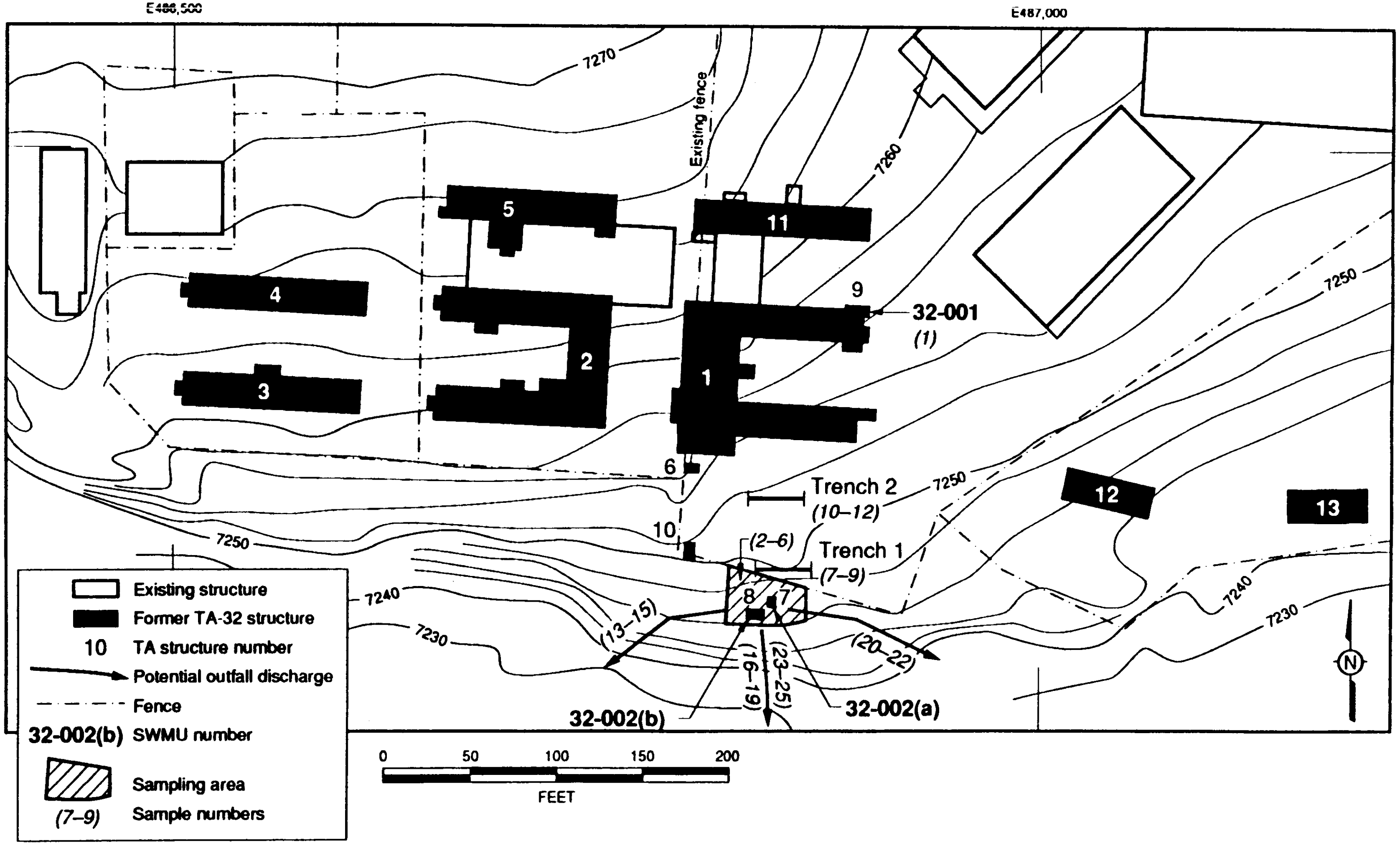

Figure 7.2-1. TA-32 SWMU Aggregate sampling locations (modified from LANL 1990, 0145; AEC 1963, 06-0032; AEC 1963, 06-0031; Los Alamos County 1986, 06-0062; Los Alamos County 1986, 06-0063; LASL 1953, 06-0055).

7.2.2.3 Outfall Areas

The outfall areas for the two septic tanks are not clearly defined. In the vicinity of the septic tanks, there are several natural drainages that converge on the first bench below the canyon rim. The objective of the outfall sampling strategy is to determine the presence of contaminants along the trace of the potential outfalls, from the mesa top to the toe of the hillslope (Figure 7.2-1). Ten near-surface soil samples will be collected from potential outfall areas. These soil samples will be collected from sediments in the channel between the mesa top and the toe of the hillslope. Random samples will be selected from locations with a higher probability of residual contamination accumulation (i.e., sediment fans on topographic benches in the channel). The samples will be collected from a depth of approximately 10 to 15 cm below the surface.

7.3 Field Screening of Samples

All samples will be field screened for radioactivity (gross-alpha, gross-beta, and gross-gamma activity) and volatile organic vapors to identify gross concentrations of contaminants and provide information on sample selection for further laboratory analysis. Field screening methods are detailed in Appendix D.

7.4 Sample Analyses

The soil samples will be analyzed for TAL metals and semivolatile organic compounds (see Tables 7.1-1, Table 7.4-1, and Appendix D). If radioactivity (gross-alpha, gross-beta, or gross-gamma activity) is detected in any sample during the field screening, those samples will also be analyzed using gamma spectrometry to identify individual radionuclides that might be present. If volatile organic vapors are detected during the field screening, those samples will also be analyzed for volatile organic compounds

7.5 Sample Quality Assurance/Quality Control

Field quality assurance (QA) samples will be collected during the course of the field investigation and are outlined in Table 7.4-1. These samples include field duplicates and rinsate blanks. The definition of each kind of sample and its purpose are given in Annex II, Quality Assurance Project Plan (QAPjP) of this work plan.

7.6 Field Operations

The organizational structure for the field investigation team is identified in Figure 7.6-1. The team will have individual responsibilities for health and safety, sample identification, sample handling and chain of custody, and related activities. Facilities such as a field screening laboratory or an equipment decontamination

TABLE 7.4-1 SCREENING AND ANALYSIS FOR TA-32 INVESTIGATION OF SWMUS 32-001 AND 32-002

				Field Screening						Laboratory Analysis										
Sample Type	Sample Number	Sample Depth	Sampling Identification	Gross Gamma	Gross Apha	Gross Beta	Organic Vapor	Combustible Gas/Oxygen	Lithological Logging	Gamma Spectrometry	Tritium	Isotopic Plutonium	Isotopic Uranium	Americium - 241	Carbon 1-4	VOA (SW 8240)	Semivolatiles (SW 8270)	Metals (SW 6010)	PCB (SW 8080)	TAL Metals
SWMU 32-001																				
Incinerator																				
Shallow Borehole	1	3 ft.		X	X	X	X			●	●	●	●	●	●	●	X			X
SWMU 32-002(a-b)																				
Wooden /Concrete Septic Tanks																				
Shallow Boreholes at	2	5 ft.		X	X	X	X			●	●	●	●	●	●	●	X			X
Soil / Bedrock Interface	3	5 ft.		X	X	X	X			●	●	●	●	●	●	●	X			X
in Sampling Quadrants	4	5 ft.		X	X	X	X			●	●	●	●	●	●	●	X			X
	5	5 ft.		X	X	X	X			●	●	●	●	●	●	●	X			X
Field Duplicate	6	5 ft.		X	X	X	X			●	●	●	●	●	●	●	X			X
Septic Tank Lines																				
Shallow Trench #1	7	5 ft.		X	X	X	X			●	●	●	●	●	●	●	X			X
	8	5 ft.		X	X	X	X			●	●	●	●	●	●	●	X			X
	9	5 ft.		X	X	X	X			●	●	●	●	●	●	●	X			X
Shallow Trench #2	10	5 ft.		X	X	X	X			●	●	●	●	●	●	●	X			X
	11	5 ft.		X	X	X	X			●	●	●	●	●	●	●	X			X
	12	5 ft.		X	X	X	X			●	●	●	●	●	●	●	X			X
Septic Tank Outfalls																				
Near Surface Soil	13	15 cm		X	X	X	X			●	●	●	●	●	●	●	X			X
	14	15 cm		X	X	X	X			●	●	●	●	●	●	●	X			X
	15	15 cm		X	X	X	X			●	●	●	●	●	●	●	X			X
	16	15 cm		X	X	X	X			●	●	●	●	●	●	●	X			X
	17	15 cm		X	X	X	X			●	●	●	●	●	●	●	X			X
	18	15 cm		X	X	X	X			●	●	●	●	●	●	●	X			X
	19	15 cm		X	X	X	X			●	●	●	●	●	●	●	X			X
	20	15 cm		X	X	X	X			●	●	●	●	●	●	●	X			X
	21	15 cm		X	X	X	X			●	●	●	●	●	●	●	X			X
	22	15 cm		X	X	X	X			●	●	●	●	●	●	●	X			X
Rinsate Blank	23																X			X
Field Duplicate	24	15 cm		X	X	X	X			●	●	●	●	●	●	●	X			X
Field Duplicate	25	15 cm		X	X	X	X			●	●	●	●	●	●	●	X			X

X Mandatory Analysis

● Analyze if Positive Field Screening Measurement

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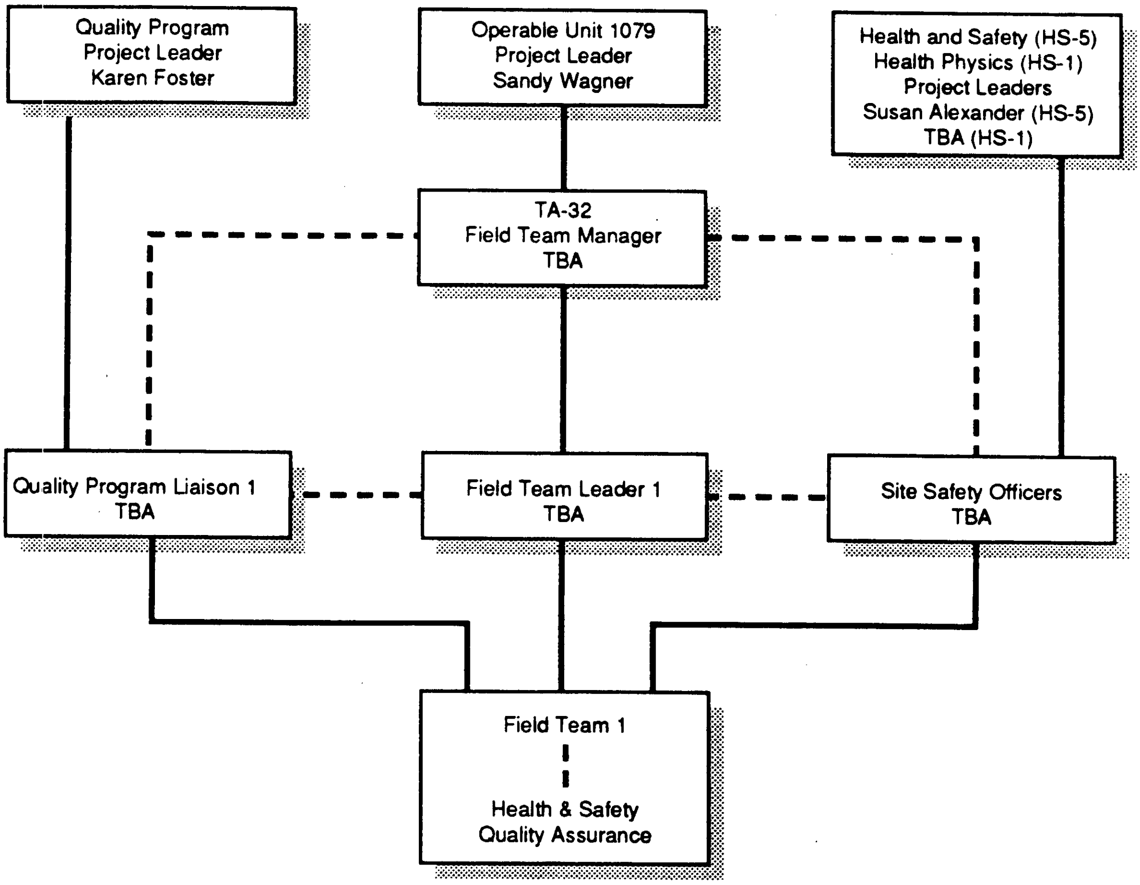

——— Authority

- - - Communication

TBA = To Be Announced

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Figure 7.6-1. TA-32 field investigation team.

facility may be shared by OU 1079 field teams. Premobilization activities, health and safety, site control, site monitoring, and support service aspects of the field operations are described in Appendix D.

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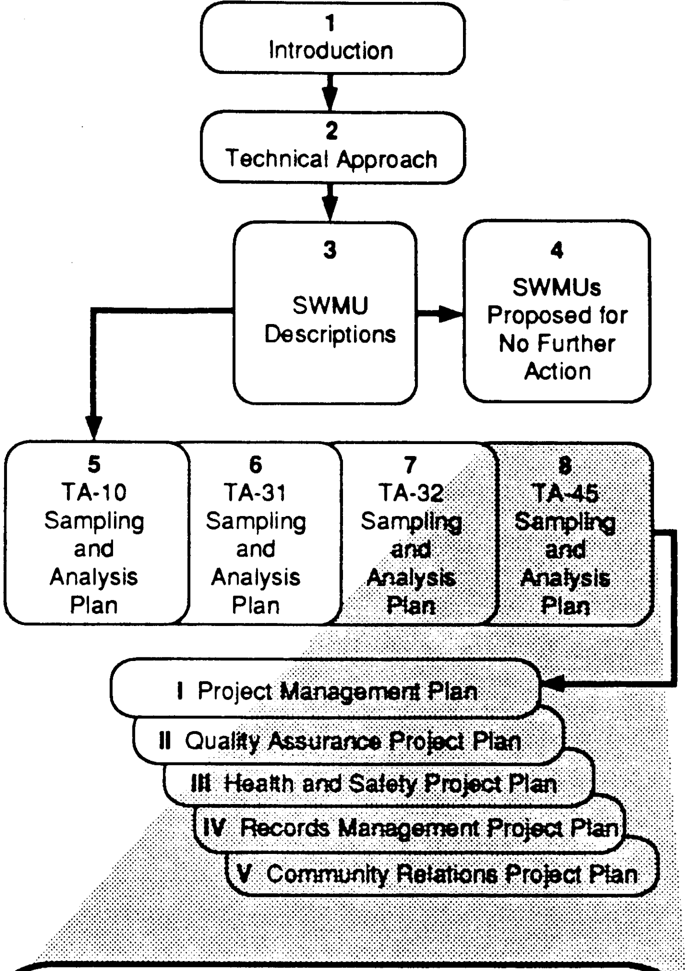
CHAPTER 8



TA-45 Sampling and Analysis Plan

- Treatment Plant SWMU Aggregate
- SWMU No. 45-002
- SWMU No. 45-004

8.0 TECHNICAL AREA 45 (TA-45) SAMPLING AND ANALYSIS PLAN

For the purposes of data analysis, TA-45 has been divided into five geographic subareas (Figure 3.4-10):

(1) the former untreated industrial waste (acid waste) outfall and surrounding areas, including the Acid Canyon drainage (SWMU 1-002),

(2) the former treatment plant (SWMU 45-001) and the surrounding parking lot area AOC C-45-001,

(3) the former vehicle decontamination facility and surrounding areas (SWMU 45-002),

(4) the former untreated industrial waste (acid waste) line (SWMU 45-003), and

(5) the former sanitary sewer outfall (SWMU 45-004).

These five subareas have had different uses, different sampling investigations, and different remediation histories. Therefore, the specifics of the DQO process are developed separately for each of the five subareas.

8.1 DQO Process for Untreated Industrial Waste (Acid Waste) Outfall and Acid Canyon Drainage (SWMU 1-002)

8.1.1 Problem Statement

The area under and around the untreated industrial waste (acid waste) line and outfall area has been remediated twice. Post-remediation data show residual levels of gross alpha and plutonium activity (LANL 1981, 0141); however, risk assessments performed using these data show no unacceptable risk to human health. These results will be verified by recalculating risk using these data combined with new data and current risk assessment protocols. No analyses have been performed in these areas for nonradiological contaminants, and no samples have been taken from the bedrock. Very little additional sampling has been conducted in the immediate vicinity of TA-45 in the Acid Canyon drainage, except at the Acid Weir Station near the confluence with Pueblo Canyon during annual surveillance activities. Therefore, the sampling objectives for this area are as follows:

- to collect radiological and nonradiological data from bedrock samples in the area from the industrial waste (acid waste) line outfall to the drop off into Acid Canyon (these data will be used to confirm or refute previous results and to determine if nonradionuclide contamination is above trigger levels), and

- to collect radiological and nonradiological data to support a baseline risk assessment or Voluntary Corrective Action (VCA), if necessary.

8.1.2 Decision Process

There are two sampling efforts for this area: (1) bedrock samples from the area of the industrial waste (acid waste) line outfall to the drop off into Acid Canyon; and (2) surface soil/sediment samples in the Acid Canyon drainage. All samples will be analyzed for radionuclides, TAL metals, and semivolatile organics compounds.

If all contaminant concentrations are below trigger levels for screening and laboratory samples, then there will be no further action. Trigger levels for nonradiological contaminants, methods of analyses, and detection limits are provided in Table 8.1-1.

If the contaminant levels are above the trigger levels in some areas, and if there are sufficient data, then a baseline risk assessment or VCA will be conducted. If performed, the baseline risk assessment will include all data collected at TA-45. If additional data are required to support the baseline risk assessment or VCA, then additional sampling (Phase II) will be conducted. The decision to collect additional data during Phase II sampling or implement a corrective measures study without a risk assessment will be based on the decision analysis methodology as described in Appendix I of the Installation Work Plan (IWP) (LANL 1991, 0553). If a baseline risk assessment is performed and shows acceptable levels of risk, then there will be no further action. Otherwise, a VCA or corrective measures study will be implemented. The decision process flow diagram is shown in Figure 8.1-1.

8.1.3 Data Needs

8.1.3.1 Source Characterization

Prior to sampling, a land survey will be conducted to establish an accurate base map, to document sampling locations, and to locate former or buried structure locations. Locations of former buried structures are recorded on existing site maps, but locations need to be recovered at the sites. The SWMU will be surveyed to establish the former outfall location on which to reference an initial radiological survey, and for all sampling localities. All planned sample localities will be surveyed and registered on the base map. If, during the course of sampling, any sample points must be relocated, the new positions will be resurveyed and the revised locations will be indicated on the map. Land survey methods are described in Appendix D.

Required source data include gross-alpha gross-beta, and gross-gamma activity, and laboratory analyses for radionuclides, TAL metals, and semivolatile organic compounds. The plan for collecting these data is described in Subsection 8.1.6.

TABLE 8.1-1 LABORATORY ANALYSES FOR THE TA-45 SWMU INVESTIGATIONS

SWMU	DESCRIPTION	CONTAMINANTS OF CONCERN	TRIGGER LEVELS[a]	METHOD OF ANALYSIS	DETECTION LIMIT	QUALITY LEVEL
45-001	Waste Treatment Facility Site	^{238}Pu	TBD[b]	Radiochemical Separation and Alpha Spectroscopy	0.005 pCi/g	III
		^{239}Pu	TBD[b]	Radiochemical Separation and Alpha Spectroscopy	0.005 pCi/g	III
		^{3}H	TBD[b]	Distillation and Liquid Scintillation	400 pCi/L	III
		^{90}Sr	TBD[b]	Gas Flow Proportional Counting	2 pCi/g	III
		^{241}Am	TBD[b]	Radiochemical Separation and Alpha Spectroscopy	0.002 pCi/g	III
		Natural and Depleted Uranium	TBD[b]	Radiochemical Separation and Alpha Spectroscopy	0.01 pCi/g	III
		^{137}Cs	TBD[b]	Gamma Spectroscopy	0.1 pCi/g	III
		Semivolatile Organic Compounds	TBD[b]	EPA SW-846 Method 8270 Gas Chromatography/Mass Spectrometry Capillary Column Technique	Contaminant Dependent (see Table V.4 LANL 1991, 0412)	III
		Volatile Organic Compounds	TBD[b]	EPA SW-846 Method 8240 Gas Chromatography/Mass Spectrometry	Contaminant Dependent (see Table V.3, LANL 1991, 0412)	III
		TAL Metals	TBD[b]	EPA SW-846 Method 6010, 7060, 7470, and 7740 (Inductively Coupled Plasma Emission Spectroscopy, Graphite Furnace Atomic Absorption Spectroscopy, and Cold Vapor Atomic Absorption Spectroscopy)	Contaminant Dependent (see Table V.7, LANL 1991, 0412)	III

[a] Trigger levels for nonradionuclides are the proposed RCRA Subpart S action levels (EPA 1990,0432). Trigger levels for radionuclides and nonradioactive hazardous constituents not listed in Subpart S will be provided in the LANL 1992 Installation Work Plan.

[b] TBD: To Be Determined

TABLE 8.1-1 LABORATORY ANALYSES FOR THE TA-45 SWMU INVESTIGATIONS (CONT'D)

SWMU	DESCRIPTION	CONTAMINANTS OF CONCERN	TRIGGER LEVELS[a]	METHOD OF ANALYSIS	DETECTION LIMIT	QUALITY LEVEL
45-002	Vehicle Decontamination Facility Site	^{238}Pu	TBD[b]	Radiochemical Separation and Alpha Spectroscopy	0.005 pCi/g	III
		^{239}Pu	TBD[b]	Radiochemical Separation and Alpha Spectroscopy	0.005 pCi/g	III
		^{3}H	TBD[b]	Distillation and Liquid Scintillation	400 pCi/L	III
		^{90}Sr	TBD[b]	Gas Flow Proportional Counting	2 pCi/g	III
		^{241}Am	TBD[b]	Radiochemical Separation and Alpha Spectroscopy	0.002 pCi/g	III
		Natural and Depleted Uranium	TBD[b]	Radiochemical Separation and Alpha Spectroscopy	0.01 pCi/g	III
		^{137}Cs	TBD[b]	Gamma Spectroscopy	0.1 pCi/g	III

[a] Trigger levels for nonradionuclides are the proposed RCRA Subpart S action levels (EPA 1990,0432) Trigger levels for radionuclides and nonradioactive hazardous constituents not listed in Subpart S will be provided in the LANL 1992 Installation Work Plan.

[b] TBD: To Be Determined

TABLE 8.1-1 LABORATORY ANALYSES FOR THE TA-45 SWMU INVESTIGATIONS (CONT'D)

SWMU	DESCRIPTION	CONTAMINANTS OF CONCERN	TRIGGER LEVELS[a]	METHOD OF ANALYSIS	DETECTION LIMIT	QUALITY LEVEL
45-002 (Cont'd)		TAL Metals	TBD[b]	EPA SW-846 Method 6010, 7060, 7470 and 7740 (Inductively Coupled Plasma Emission Spectroscopy, and Cold Vapor Atomic Absorption Spectroscopy)	Dependent on contaminant (see Table V.7, LANL 1991, 0412)	III
		Volatile Organic Compuonds	TBD[b]	EPA SW-846, Method 8240 (Gas Chromatography/Mass Spectrometry)	Dependent on contaminant (see Table V.3, LANL 1991, 0412)	III
		Semivolatile Organic Compounds	TBD[b]	EPA SW-846, Method 8270 (Gas Chromatography/Mass Spectrometry Capillary Column Technique)	Dependent on contaminant (see Table V.4, LANL 1991, 0412)	III
		High Explosives	TBD[b]	USATHAMA by High Performance Liquid Chromatography	Depends on composition (see Table V.10, LANL 1991,0412)	III

[a] Trigger levels for nonradionuclides are the proposed RCRA Subpart S action levels (EPA 1990,0432). Trigger levels for radionuclides and nonradioactive hazardous constituents not listed in Subpart S will be provided in the LANL 1992 Installation Work Plan.

[b] TBD: To Be Determined

TABLE 8.1-1 LABORATORY ANALYSES FOR THE TA-45 SWMU INVESTIGATIONS (CONT'D)

SWMU	DESCRIPTION	CONTAMINANTS OF CONCERN	TRIGGER LEVELS[a]	METHOD OF ANALYSIS	DETECTION LIMIT	QUALITY LEVEL
45-003	Industrial Waste (Acid Waste) Lines	^{238}Pu	TBD[b]	Radiochemical Separation and Alpha Spectroscopy	0.005 pCi/g	III
		^{239}Pu	TBD[b]	Radiochemical Separation and Alpha Spectroscopy	0.005 pCi/g	III
		^{3}H	TBD[b]	Distillation and Liquid Scintillation	400 pCi/L	III
		^{90}Sr	TBD[b]	Gas Flow Proportional Counting	2 pCi/g	III
		^{241}Am	TBD[b]	Radiochemical Separation and Alpha Spectroscopy	0.002 pCi/g	III
		Natural and Depleted Uranium	TBD[b]	Radiochemical Separation and Alpha Spectroscopy	0.01 pCi/g	III
		^{137}Cs	TBD[b]	Gamma Spectroscopy	0.1 pCi/g	
		Semivolatile Organic Compounds	TBD[b]	EPA SW-846 Method 8270 Gas Chromatography/Mass Spectrometry Capillary Column Technique	Contaminant Dependent (see Table V.4 LANL 1991, 0412)	III
		Volatile Organic Compounds	TBD[b]	EPA SW-846 Method 8240 Gas Chromatography/Mass Spectrometry	Contaminant Dependent (see Table V.3, LANL 1991, 0412)	III
		TAL Metals	TBD[b]	EPA SW-846 Method 6010, 7060, 7470, and 7740 (Inductively Coupled Plasma Emission Spectroscopy, Graphite Furnace Atomic Absorption Spectroscopy, and Cold Vapor Atomic Absorption Spectroscopy)	Contaminant Dependent (see Table V.7, LANL 1991, 0412)	III

[a] Trigger levels for nonradionuclides are the proposed RCRA Subpart S action levels (EPA 1990,0432). Trigger levels for radionuclides and nonradioactive hazardous constituents not listed in Subpart S will be provided in the LANL 1992 Installation Work Plan.

[b] TBD: To Be Determined

TABLE 8.1-1 LABORATORY ANALYSES FOR THE TA-45 SWMU INVESTIGATIONS (CONT'D)

SWMU	DESCRIPTION	CONTAMINANTS OF CONCERN	TRIGGER LEVELS[a]	METHOD OF ANALYSIS	DETECTION LIMIT	QUALITY LEVEL
45-004	Sanitary Sewer Outfall	Radioactive Materials	TBD[b]	Gamma and Alpha Spectroscopy, Liquid Scintillation Counting, and Gas Proportional Counting	0.1-2.0 pCi/g	III
		TAL Metals	TBD[b]	EPA SW-846, Method 6010, 7060, 7470 and 7740 (Inductively Coupled Plasma Emission Spectroscopy and Cold Vapor Atomic Absorption Spectroscopy)	Dependent on contaminant (see Table V.7, LANL 1991,0412)	III
		Volatile Organic Compounds	TBD[b]	EPA SW 846, Method 8240 (Gas Chromatography/Mass Spectrometry)	Dependent on contaminant (see Table V.3, LANL 1991,0412)	III
		Semivolatile Organic Compounds	TBD[b]	EPA SW 846, Method 8270 (Gas Chromatography/Mass Spectrometry Capillary Column Technique)	Dependent on contaminant (see Table V.4, LANL 1991,0412)	III

[a] Trigger levels for nonradionuclides are the proposed RCRA Subpart S action levels (EPA 1990,0432). Trigger levels for radionuclides and nonradioactive hazardous constituents not listed in Subpart S will be provided in the LANL 1992 Installation Work Plan.

[b] TBD: To Be Determined

TABLE 8.1-1 LABORATORY ANALYSES FOR THE TA-45 SWMU INVESTIGATIONS (CONT'D)

SWMU	DESCRIPTION	CONTAMINANTS OF CONCERN	TRIGGER LEVELS [a]	METHOD OF ANALYSIS	DETECTION LIMIT	QUALITY LEVEL
1-002	Untreated Waste Outfall	^{238}Pu	TBD[b]	Radiochemical Separation and Alpha Spectroscopy	0.005 pCi/g	III
		^{239}Pu	TBD[b]	Radiochemical Separation and Alpha Spectroscopy	0.005 pCi/g	III
		^{3}H	TBD[b]	Distillation and Liquid Scintillation	400 pCi/L	III
		^{90}Sr	TBD[b]	Gas Flow Proportional Counting	2 pCi/g	III
		^{241}Am	TBD[b]	Radiochemical Separation and Alpha Spectroscopy	0.002 pCi/g	III
		Natural and Depleted Uranium	TBD[b]	Radiochemical Separation and Alpha Spectroscopy	0.01 pCi/g	III
		^{137}Cs	TBD[b]	Gamma Spectroscopy	0.1 pCi/g	III
		Semivolatile Organic Compounds	TBD[b]	EPA SW-846 Method 8270 Gas Chromatography/Mass Spectrometry Capillary Column Technique	Contaminant Dependent (see Table V.4 LANL 1991, 0412)	III
		Volatile Organic Compounds	TBD[b]	EPA SW-846 Method 8240 Gas Chromatography/Mass Spectrometry	Contaminant Dependent (see Table V.3, LANL 1991, 0412)	III
		TAL Metals	TBD[b]	EPA SW-846 Method 6010, 7060, 7470, and 7740 (Inductively Coupled Plasma Emission Spectroscopy, Graphite Furnace Atomic Absorption Spectroscopy, and Cold Vapor Atomic Absorption Spectroscopy)	Contaminant Dependent (see Table V.7, LANL 1991, 0412)	III

[a] Trigger levels for nonradionuclides are the proposed RCRA Subpart S action levels (EPA 1990,0432). Trigger levels for radionuclides and nonradioactive hazardous constituents not listed in Subpart S will be provided in the LANL 1992 Installation Work Plan.

[b] TBD: To Be Determined

TABLE 8.1-1 LABORATORY ANALYSES FOR THE TA-45 SWMU INVESTIGATIONS (CONT'D)

SWMU	DESCRIPTION	CONTAMINANTS OF CONCERN	TRIGGER LEVELS	METHOD OF ANALYSIS	DETECTION LIMIT	QUALITY LEVEL
C-45-001	Parking Lot	Radioactive Materials	TBD[b]	Gamma and Alpha Spectroscopy, Liquid Scintillation Counting, and Gas Proportional Counting	0.1-2.0 pCi/g	III
		TAL Metals	TBD[b]	EPA SW-846, Method 6010 (Inductively Coupled Plasma-Atomic Emision Spectroscopy)	Dependent on contaminant (see Table V.7, LANL 1991,0412)	III
		Volatile Organic Compounds	TBD[b]	EPA SW-846, Method 8240 (Gas Chromatography/Mass Spectrometry)	Dependent on contaminant (see Table V.3, LANL 1991,0412	III
		Semivolatile Organic Compounds	TBD[b]	EPA SW-846, Method 8270 (Gas Chromatography/Mass Spectrometry Capillary Column Technique)	Dependent on contaminant (see Table V.4, LANL 1991,0412)	III

[a] Trigger levels for nonradionuclides are the proposed RCRA Subpart S action levels (EPA 1990,0432). Trigger levels for radionuclides and nonradioactive hazardous constituents not listed in Subpart S will be provided in the LANL 1992 Installation Work Plan.

[b] TBD: To Be Determined

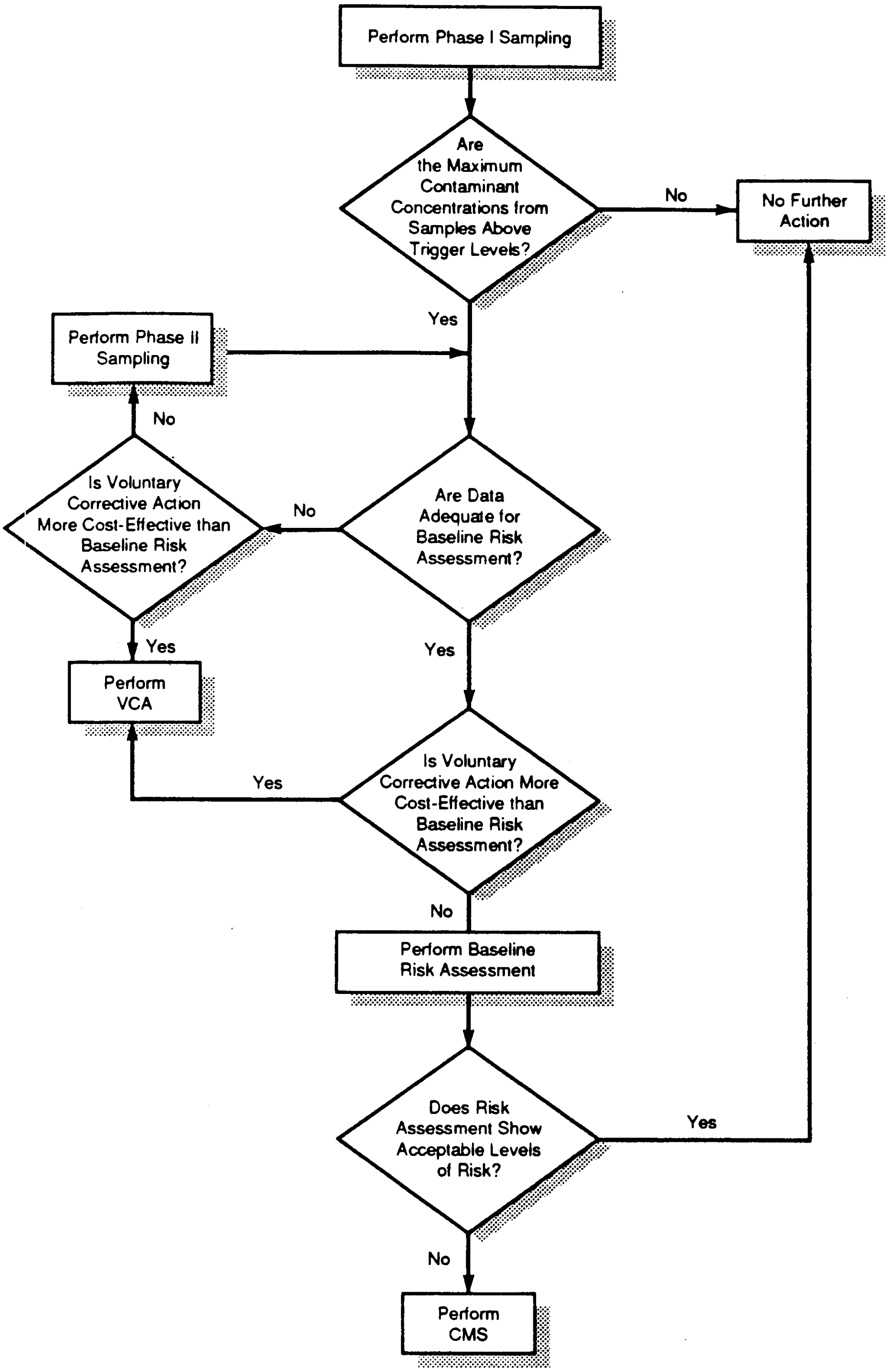


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Figure 8.1-1. TA-45 SWMU Aggregates DQO decision logic flow diagram for sampling plans.

8.1.3.2 Environmental Setting

Risk scenarios for baseline risk assessments include residential, worker, and recreational use. These scenarios can be evaluated with existing environmental data.

8.1.3.3 Potential Receptors

Trigger levels used in the Phase I investigation will be conservatively based on a hypothetical on-site receptor (constant exposure) to determine if there is a potential for adverse human health effects associated with the former industrial waste (acid waste) line location and outfall area, and surface soil/sediment in the Acid Canyon drainage. Baseline risk assessments will include the residential, worker, and recreational use scenarios. These scenarios will incorporate program parameters given in the 1992 IWP, and may require additional information about the activities, behavior, or location of actual receptors.

8.1.4 Decision Logic

8.1.4.1 Domain of the Decision

This area includes the parts of the industrial waste (acid waste) line formerly located within TA-45: the outfall area where the line discharged; and the natural drainage in Acid Canyon, downstream of the discharge point to its confluence with Pueblo Canyon.

8.1.4.2 Logic Statement

The highest contaminant concentrations from the bedrock samples will be compared to trigger levels. If these concentrations are below trigger levels, then no further action will be required. If the concentrations are above trigger levels and background concentrations, then a VCA will be conducted or a risk assessment will be performed using the averages of the data. Laboratory data will be combined with field screening information if the combined analysis reduces the estimation errors.

The highest contaminant concentrations from the surface soil/sediment samples will be also compared to trigger levels. If these concentrations are below trigger levels, then no further action will be required. If these concentrations are above the trigger levels and background concentrations, then a VCA will be conducted or a baseline risk assessment will be performed. The statistic for the baseline risk scenario will be the average risk for an exposure unit.

8.1.5 Design Criteria

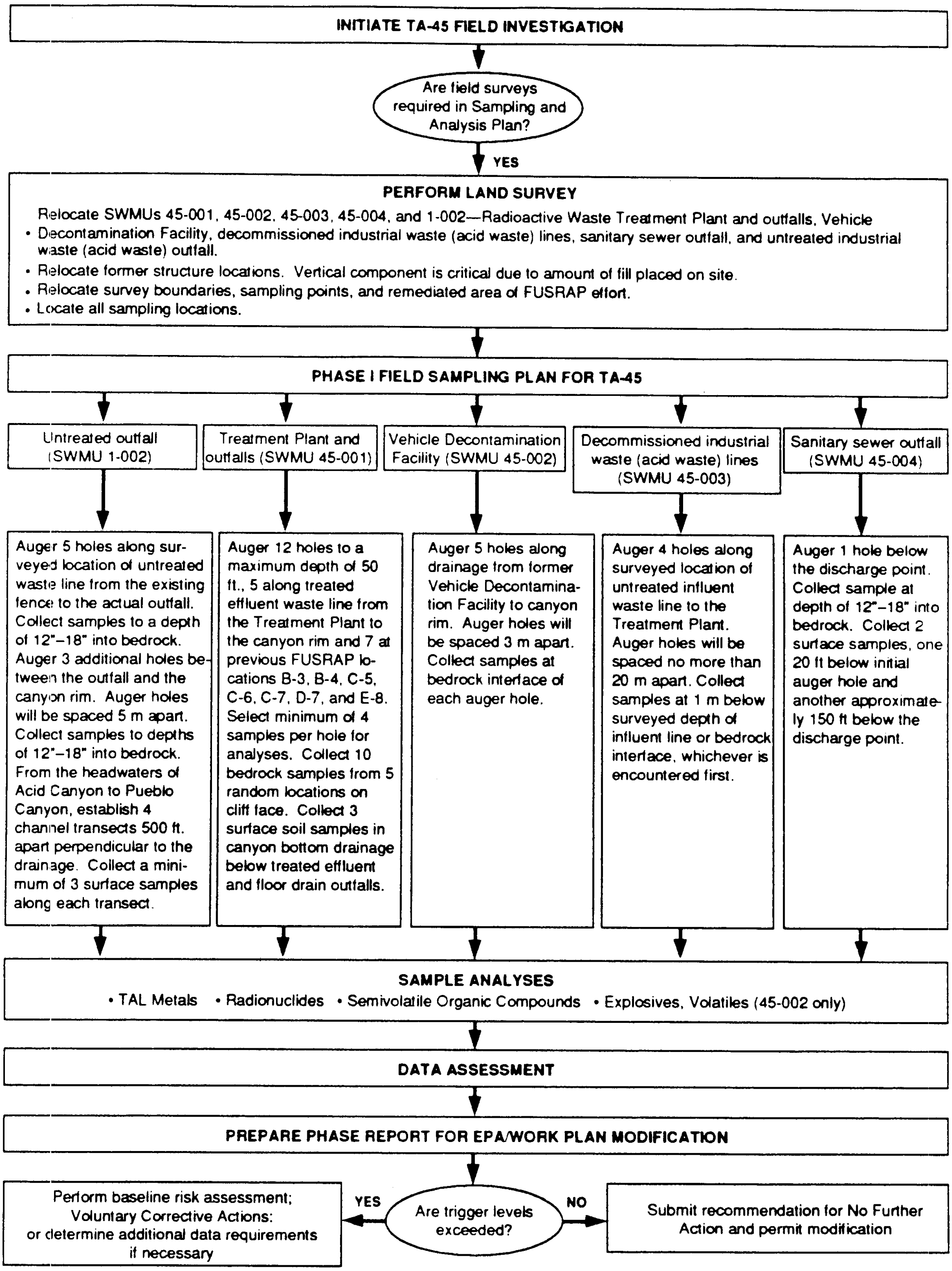
The objective of the design criterion for the auger samples is to bound the levels of contamination. The areas along the industrial waste (acid waste) line to the drop off should provide the area with the highest levels of contamination. The sampling will be systematic (evenly spaced), with a random start. These samples should also provide adequate data for bounding the average levels, if a baseline risk assessment is required.

The design criterion for the soil/sediment sampling will also bound the levels of contamination found in the Acid Canyon drainage. To bound possible contaminant concentrations, data will be collected from the fine-grained sediments of both the channel banks and channel bottom. These fine-grained sediments may serve as natural reservoirs for radionuclides, metals, and semivolatile organic compounds. To capture the possible variability from intermittent sediment transport, samples will be collected along transects every 500 ft. The transects will serve as a guide for where to sample, but actual sampling locations will be selected so that samples are collected from locations containing accumulations of fine-grained sediments.

8.1.6 Sampling Plan

Five holes will be augered into bedrock along the surveyed location of the former untreated industrial waste (acid waste) line, from the existing fenceline to the actual pipe outfall location. At this location, bedrock is exposed at the surface. Of these five holes, three will be placed along the former industrial waste (acid waste) line location and two will be placed on either side of the industrial waste (acid waste) line location. Samples from each hole will be collected to a depth of 12 to 18 in. into bedrock. An additional three holes will be augered to a depth of 18 in., between the pipe outfall and the canyon rim. These holes will be spaced approximately 5 m apart. Samples from each hole will be collected to a depth of 12 to 18 in. into bedrock.

Four channel transects will be established perpendicular to the drainage. Starting from the canyon rim, near the discharge point of the untreated industrial waste (acid waste) line, and ending at the confluence of Acid and Pueblo Canyons, the transects will be spaced approximately 500 ft apart. One of these transects will be in the existing environmental surveillance weir. Three surface soil/sediment samples will be collected along each transect location: one in the bottom of the drainage channel, and one from each side of the channel bank. Locations of transects may be moved slightly in order to collect samples from areas of obvious sediment accumulation. Four transects of three samples each will provide an 86% probability, that if the stream channel has contamination above action levels over 15% of the area, there will be at least one sample above action levels. The sampling plan is summarized in Figure 8.1-2 and sample locations are illustrated on Figure 8.1-3.



INITIATE TA-45 FIELD INVESTIGATION

Are field surveys required in Sampling and Analysis Plan?

YES

PERFORM LAND SURVEY

Relocate SWMUs 45-001, 45-002, 45-003, 45-004, and 1-002—Radioactive Waste Treatment Plant and outfalls, Vehicle

- Decontamination Facility, decommissioned industrial waste (acid waste) lines, sanitary sewer outfall, and untreated industrial waste (acid waste) outfall.
- Relocate former structure locations. Vertical component is critical due to amount of fill placed on site.
- Relocate survey boundaries, sampling points, and remediated area of FUSRAP effort.
- Locate all sampling locations.

PHASE I FIELD SAMPLING PLAN FOR TA-45

Untreated outfall (SWMU 1-002)

Auger 5 holes along surveyed location of untreated waste line from the existing fence to the actual outfall. Collect samples to a depth of 12"–18" into bedrock. Auger 3 additional holes between the outfall and the canyon rim. Auger holes will be spaced 5 m apart. Collect samples to depths of 12"–18" into bedrock. From the headwaters of Acid Canyon to Pueblo Canyon, establish 4 channel transects 500 ft. apart perpendicular to the drainage. Collect a minimum of 3 surface samples along each transect.

Treatment Plant and outfalls (SWMU 45-001)

Auger 12 holes to a maximum depth of 50 ft., 5 along treated effluent waste line from the Treatment Plant to the canyon rim and 7 at previous FUSRAP locations B-3, B-4, C-5, C-6, C-7, D-7, and E-8. Select minimum of 4 samples per hole for analyses. Collect 10 bedrock samples from 5 random locations on cliff face. Collect 3 surface soil samples in canyon bottom drainage below treated effluent and floor drain outfalls.

Vehicle Decontamination Facility (SWMU 45-002)

Auger 5 holes along drainage from former Vehicle Decontamination Facility to canyon rim. Auger holes will be spaced 3 m apart. Collect samples at bedrock interface of each auger hole.

Decommissioned industrial waste (acid waste) lines (SWMU 45-003)

Auger 4 holes along surveyed location of untreated influent waste line to the Treatment Plant. Auger holes will be spaced no more than 20 m apart. Collect samples at 1 m below surveyed depth of influent line or bedrock interface, whichever is encountered first.

Sanitary sewer outfall (SWMU 45-004)

Auger 1 hole below the discharge point. Collect sample at depth of 12"–18" into bedrock. Collect 2 surface samples, one 20 ft below initial auger hole and another approximately 150 ft below the discharge point.

SAMPLE ANALYSES

- TAL Metals
- Radionuclides
- Semivolatile Organic Compounds
- Explosives, Volatiles (45-002 only)

DATA ASSESSMENT

PREPARE PHASE REPORT FOR EPA/WORK PLAN MODIFICATION

Are trigger levels exceeded?

YES

Perform baseline risk assessment; Voluntary Corrective Actions: or determine additional data requirements if necessary

NO

Submit recommendation for No Further Action and permit modification

Figure 8.1-2. TA-45 SWMU Aggregates Phase I field sampling plan flow diagram.

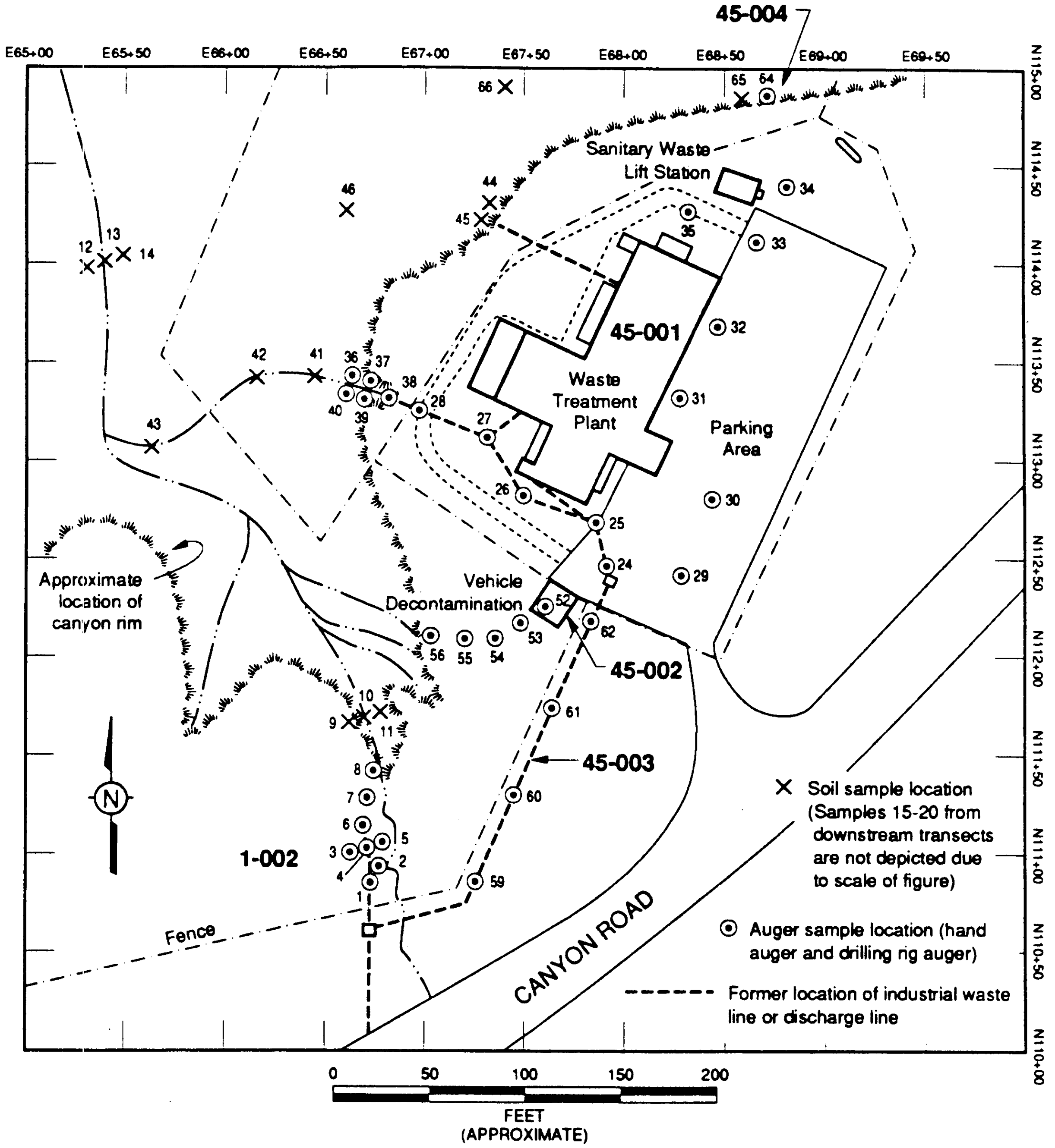


Figure 8.1-3. TA-45 planned sampling locations (modified from LANL 1981, 0141).

8.2 DQO Process for the Treatment Plant Area (SWMU 45-001)

8.2.1 Problem Statement

The area around and under the former treatment plant has undergone extensive remediation. However, current data show that residual gross-alpha concentrations remain along the former untreated and treated industrial waste residual (acid waste) lines.

There are some areas of elevated gross-alpha activity along the fence bordering the former parking lot and in the parking lot area. The gross-alpha levels along the fence are all below 50 pCi/g and the two plutonium sample concentrations are less than 1 pCi/g. However, the levels at two locations in the parking lot area exceed 50 pCi/g at depths below 750 cm (LANL 1981, 0141).

The sampling objective for this area is to resample the locations of the industrial waste (acid waste) lines associated with the former treatment plant and areas in the parking lot to determine current site conditions, to confirm results of previous radiological surveys, and to determine if there is nonradiological contamination that presents an unacceptable health risk.

8.2.2 Decision Process

Boreholes will be augured along the old industrial waste (acid waste) lines and in the parking area, and surface samples will be collected at outfalls and in drainages. All surface samples will be analyzed for radionuclides, TAL metals, and semivolatile organic compounds. All samples from the boreholes will be screened for radionuclides and organics. At least four samples from each borehole will be sent to the laboratory and analyzed for radionuclides, TAL metals, and semivolatile organic compounds. The contaminants of concern for this area, the trigger or action levels for the nonradiological contaminants, the methods of analysis, and the detection limits are given in Table 8.1-1.

8.2.3 Data Needs

8.2.3.1 Source Characterization

A land survey must be conducted to locate positions of all former buildings, industrial waste (acid waste) lines, outfall areas, and drainages. The sampling area must be defined for the treated industrial waste (acid waste) outfall area, and previous sampling locations (B-3, B-4, C-5, C-6, C-7, D-7, and E-8).

Required source data include gross-alpha, gross-beta, and gross-gamma activity, laboratory analyses for radionuclides, TAL metals, and semivolatile organic compounds.

8.2.3.2 Environmental Setting

See Section 8.1.3.2.

8.2.3.3 Potential Receptors

See Section 8.1.3.3.

8.2.4 Decision Logic

8.2.4.1 Domain of the Decision

This area includes the footprint of the former treatment plant; areas occupied by portions of the untreated industrial waste (acid waste) line in close proximity to the building; storm drains to the east and north of the building; the outfalls for the treated industrial waste (acid waste) line and the storm sewer; the former sewer lift station north of the treatment plant; the outfall for the floor drain; and the parking lot (AOC C-45-001). The time domain includes determining possible current and future risk.

8.2.4.2 Logic Statement

The maximum level of contaminant concentrations from the samples will be compared to trigger levels. If the maximum concentrations are below trigger levels, then no further action will be required. If the maximum concentrations are above trigger levels, then a VCA will be conducted or a baseline risk assessment will be performed. If a baseline risk assessment is performed, average concentrations over exposure units will be determined. Computing these averages may require spatial estimation techniques. Field screening data will be used to augment laboratory measurements if the combined analysis reduces the estimation or spatial prediction errors.

8.2.5 Design Criteria

The objective of the design criteria for the auger and surface samples is to bound the levels of contamination, to confirm previous results, and to evaluate current conditions. Reconnaissance sampling is necessary to determine the current conditions because there has been as much as 20 ft of fill placed in the area. The samples along the industrial waste (acid waste) line and at the outfalls should indicate areas with the highest contamination levels. These samples, along with the samples from the parking area and the area east of the treatment facility, will be collected from previous sampling locations and should provide data adequate for bounding the levels of contamination. It is not clear at this time whether the data will be adequate for a baseline risk assessment, but if not, they will guide the Phase II sampling plan.

8.2.6 Sampling Plan

Twelve boreholes will be augered near the treatment plant: five spaced evenly along the treated effluent line leading from the treatment plant to the edge of the mesa top; and seven in the locations of previous FUSRAP samples (LANL 1981, 0141), designated as B-3, B-4, C-5, C-6, C-7, D-7, and E-8 (Figure 8.1-3). A minimum of one sample will be collected from each 5-ft core, either at the midpoint of the core or at the locations of the highest radiological and organic vapor field screening measurement in the core. The holes will be augered to a maximum depth of 50 ft, or two core lengths (10 ft) into bedrock, whichever is encountered first.

At least four samples from each borehole will be sent for laboratory analyses: the 5-ft interval sample, the total depth sample, the sample(s) with the highest field screening levels (these may be different for radionuclides and organic vapor measurements), and a sample selected at random from samples taken below 10 ft. If bedrock is encountered during drilling, two additional samples may be analyzed, one from the alluvium/bedrock interface and the second from the first 5-ft bedrock core interval.

Augering may be difficult because of steel reinforcing rods and other construction debris that may have been disposed of at this site as part of the fill overlying the original site surface. It may be necessary to move the drill rig laterally, if sufficient depth is not achieved.

In the area of the treated effluent outfall, five bedrock locations will be randomly selected from the cliff face, and sample cores will be collected from each location. Samples from the 0 to 1 in. and 5 to 6 in. intervals will be analyzed. Six additional surface soil samples will be collected in the canyon bottom drainage below the treated effluent and floor drain outfalls. Of the three samples, one will be collected at the base of the cliff below the outfall, the second approximately 20 ft down the drainage, and the third approximately 100 ft down the drainage (Fig. 8.1-3). Samples will be collected at areas of obvious sediment accumulation.

8.3 DQO Process for the Vehicle Decontamination Facility - SWMU 45-002

8.3.1 Problem Statement

Previous data indicate that the contamination associated with this site is due to wash water from vehicle cleaning operations that was flushed down the side drainage located due west from the southeast corner of the building. Contaminants of concern include radionuclides, metals, semivolatile and volatile organic compounds, and explosives. This area has been remediated, but there are no post-remediation data available. The former surface is below a layer of fill that has been placed in the area. The sampling objective for this area is to determine if there is any residual contamination, either radiological or nonradiological, that presents a health risk.

8.3.2 Decision Process

Samples collected from the boreholes will be analyzed for radionuclides, TAL metals, volatile and semivolatile organic compounds, and explosives. If field-screening measurements and laboratory analyses are below trigger levels, then no further action will be required. If laboratory analyses indicate levels above trigger levels and above background concentrations, then a VCA will be conducted or a baseline risk assessment will be performed. If data are not adequate to perform a baseline risk assessment, additional Phase II sampling will be performed.

8.3.3 Data Needs

8.3.3.1 Source Characterization

A land survey and geomorphic study will be necessary to determine the location of the former facility, the down gradient slope, and the channel bottom. This task will be complicated due to the infilling and regrading of the area by Los Alamos County.

Concentrations of radionuclides, TAL metals, volatile and semivolatile organic compounds, and explosives are needed to support the decision process. The plan for collecting these data is described in Subsection 8.3.6.

8.3.3.2 Environmental Setting

See Section 8.1.3.2.

8.3.3.3 Potential Receptors

See Section 8.1.3.3.

8.3.4 Decision Logic

8.3.4.1 Decision Domain

This area consists of the site of the former vehicle decontamination facility and the adjacent drainage area (see Figure 3.4-10).

8.3.4.2 Logic Statement

See Section 8.2.4.2.

8.3.5 Design Criteria

Contaminants are expected to be concentrated in the bottom of the drainage from the facility. Therefore, samples will be selected judgmentally from areas containing fine-grained sediments at the bottom of the channel and on those channel banks down-gradient from the facility. It is assumed that the concentrations of contaminants found in these samples will provide an adequate bound for the levels of possible contaminants.

8.3.6 Sampling Plan

The drainage area west of the vehicle decontamination facility will have five shallow boreholes augered to bedrock (Figure 8.1-3). These boreholes will be spaced approximately 3 m apart. One sample will be collected at the bedrock interface of each hole.

8.4 Untreated Waste Line - SWMU 45-003

8.4.1 DQO Process

Existing data indicate that some level of contamination exists along the location of the industrial waste (acid waste) line connected to the former treatment plant. The sampling objective for this area is to resample the former industrial waste (acid waste) line locations to verify results of previous radiological surveys, and to determine if there is nonradiological contamination that presents an unacceptable health risk.

The domain of the decision is the area under the untreated industrial waste line from the outfall area to the edge of the parking lot. The remainder of the DQO sections are identical to those in Section 8.2 addressing the untreated industrial waste (acid waste) line.

8.4.2 Sampling Plan

Four shallow boreholes, spaced no more than 20 m apart, will be augered along the surveyed location of the former industrial waste (acid waste) line leading to the former treatment plant (Figure 8.1-3). These four boreholes will span the distance from the former industrial waste (acid waste) line to the edge of the parking area. The holes will extend to a depth of 5 ft beneath the soil/bedrock interface (near the east side of the site, bedrock is exposed at the surface). Four samples will be collected: one immediately below the surveyed original depth of the industrial waste (acid waste) line, a second at the bedrock interface (if the former effluent line was above the bedrock), a third at the bottom of the hole, and one random core sample. In addition, one duplicate sample will be collected. All samples will be analyzed for radionuclides, TAL metals, and semivolatile organic compounds. The objective of this sampling plan is to determine the presence or absence of potential contamination. If contamination levels are below trigger levels, no further action will be required. If contamination is above trigger levels and background concentrations, a VCA will be conducted or a baseline risk assessment will be performed. If data are insufficient to support a baseline assessment, then additional sampling (Phase II) may be required.

8.5 Sanitary Sewer Outfall (SWMU 45-004)

8.5.1 DQO Process

This area is not expected to have radiological or chemical contamination because it was a sanitary sewer outfall for emergency bypass of the lift station. The area has not been sampled for radiological or nonradiological constituents. The sampling objective is to determine if either type of contamination is present above trigger levels.

Surface samples will be collected in the area of the discharge point and in the lower reach of the drainage. The downgradient channel sediment sample will detect any potential contamination, since runoff may have moved potential contaminants from the upper part of the drainage into the lower reaches of the channel.

The decision domain is the area around the sanitary sewer outfall, including the drainage to Acid Canyon. The remainder of the DQO sections are identical to those in Section 8.2 addressing the outfalls and drainages.

8.5.2 Sampling Plan

The area immediately below the sanitary sewer discharge point from the sewage sewer outfall will have one shallow borehole cored approximately 18 in. into bedrock (Figure 8.1-3), which is exposed at the surface. One sample will be collected to a depth of 12 to 18 in. into bedrock. Two surface soil samples will be collected: one approximately 20 ft below the initial borehole, and another approximately 150 ft below the discharge point. Sample locations may be shifted, if necessary, to ensure that samples are collected from areas where fine-grained sediments have accumulated. Surface soil sample depth will be to a depth of 10 to 15 cm, if possible.

8.6 Field Screening of Samples

All samples will be field screened for radioactivity and volatile organic vapors to identify health and safety concerns, and to provide information on sample selection for further laboratory analysis. Field screening methods are detailed in Appendix D.

8.7 Sample Analyses

The samples will be analyzed for radionuclides, TAL metals, semivolatile organic compounds, volatile organic compounds (45-002), and explosives (45-002 only) (see Table 8.7-1). If volatile organic vapors are detected during field screening, the applicable samples will also be submitted to the laboratory for volatile organic analyses.

8.8 Sample Quality Assurance/Quality Control

Field quality control (QC) samples will be collected during the course of the field investigation. These samples include field duplicates and equipment rinsate blanks. The definition of each kind of sample and its purpose are given in Annex II, Quality Assurance Project Plan (QAPjP) of this work plan.

8.9 Field Operations

The organizational structure for the field investigation team is identified in Figure 8.9-1. The team will have individual responsibilities for health and safety, sample identification, sample handling and chain of custody, and related activities. Facilities such as a field screening laboratory or an equipment decontamination facility may be shared by OU 1079 field teams. Premobilization activities, health and safety, site control, site monitoring, and support service aspects of the field operations are described in Appendix D.

TABLE 8.7-1 SCREENING AND ANALYSIS FOR TA-45 INVESTIGATION

Sample Type/Location	Sample Number	Sample Depth	Sample Identification	Field Screening						Laboratory Analysis										
				Gross Alpha	Gross Beta	Gross Gamma	Combustible Gas/oxygen	Organic Vapor	Lithological Logging	Gamma Spectrometry, ^{137}Cs	Tritium	Strontium-90	Isotopic Plutonium	Isotopic Uranium	TAL Metals	Semivolatiles (SW 8270)	Metals (SW 6010)	PCB (SW 8080)	VOA (SW 8240)	Explosives
SWMU 1-002 Untreated Outfall																				
Shallow Borehole	1–8	12–18 in.		X	X	X		X	X	X	X	X	X	X	X	X			●	
Near Surface Soil	9–20	15 cm		X	X	X		X		X	X	X	X	X	X	X			●	
Field Duplicate	21	12–18 in.		X	X	X		X	X	X	X	X	X	X	X	X			●	
Field Duplicate	22	15 cm		X	X	X		X		X	X	X	X	X	X	X			●	
Equipment Rinsate	23									X	X	X	X	X	X					
SWMU 45-001 Treatment Plant and Outfalls																				
Shallow Borehole	24-35	Variable	4 samples per borehole	X	X	X		X	X	X	X	X	X	X	X	X			●	
Cliff Face	36-40	0-6 in.	2 samples per site	X	X	X		X		X	X	X	X	X	X				●	
Near Surface Soil	41-46	15 cm		X	X	X		X		X	X	X	X	X	X				●	
Field Duplicate	47	Variable		X	X	X		X	X	X	X	X	X	X	X	X			●	
Field Duplicate	48	Variable		X	X	X		X	X	X	X	X	X	X	X	X			●	
Field Duplicate	49	12–18 in.		X	X	X		X		X	X	X	X	X	X				●	
Field Duplicate	50	15 cm		X	X	X		X		X	X	X	X	X	X				●	
Equipment Rinsate	51									X	X	X	X	X	X	X			●	
SWMU 45-002 Vehicle Decontamination Facility																				
Borehole at Soil/bedrock Interface	52-56	Variable		X	X	X		X	X	X	X	X	X	X	X	X			X	X
Field Duplicate	57			X	X	X		X		X	X	X	X	X	X	X			X	X
Equipment Rinsate	58									X	X	X	X	X	X	X			X	X

X Manditory analysis

● Analyze if positive organic vapor measurements in field screening

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TABLE 8.7-1 SCREENING AND ANALYSIS FOR TA-45 INVESTIGATION (CONTINUED)

				Field Screening						Laboratory Analysis											
Sample Type/Location	Sample Number	Sample Depth	Sample Identification	Gross Alpha	Gross Beta	Gross Gamma	Combustible Gas/oxygen	Organic Vapor	Lithological Logging	Gamma Spectrometry, ^{137}Cs	Tritium	Strontium-90	Isotopic Plutonium	Isotopic Uranium	TAL Metals	Semivolatiles (SW 8270)	Metals (SW 6010)	PCB (SW 8080)	VOA (SW 8240)	Explosives
SWMU 45-003 Industrial Waste (Acid Waste) Lines																				
Borehole	59-62	Variable		X	X	X		X	X	X	X	X	X	X	X	X			●	
Field Duplicate	63			X	X	X		X		X	X	X	X	X	X	X			●	
SWMU 45-004 Sanitary Outfall																				
Shallow Borehole	64	12–18 in.		X	X	X		X	X	X	X	X	X	X	X	X			●	
Near Surface Soil	65-66	15 cm		X	X	X		X		X	X	X	X	X	X				●	

X Manditory analysis

● Analyze if positive organic vapor measurements in field screening

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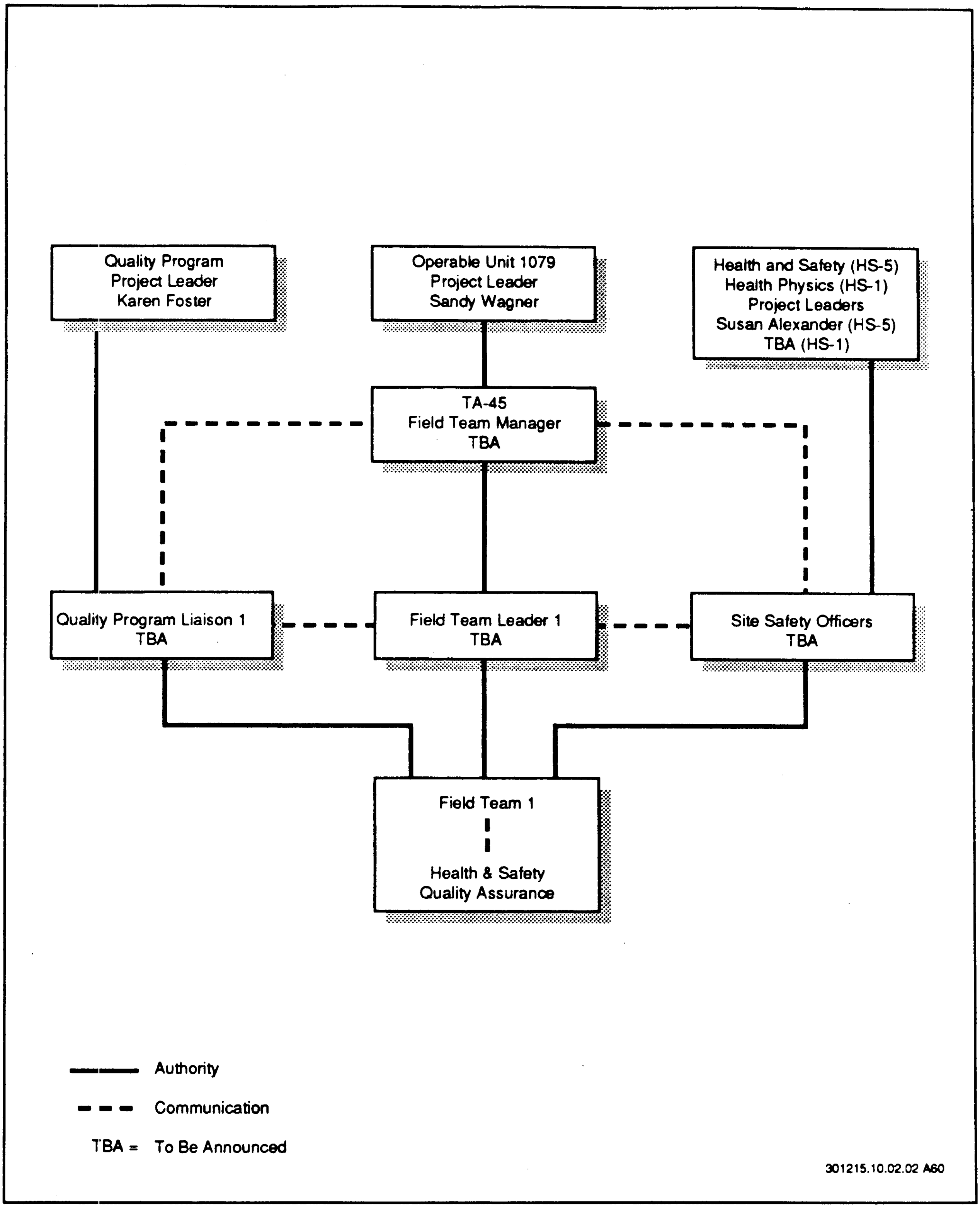

Figure 8.9-1. TA-45 field investigation team.

REFERENCES

EPA (U.S. Environmental Protection Agency), July 27, 1990. "Corrective Action for Solid Waste Management Units (SWMUs) at Hazardous Waste Management Facilities," proposed rule, Title 40 parts 264, 265, 270, and 271, Federal Register, Vol. 55. **(EPA 1990, 0432)**

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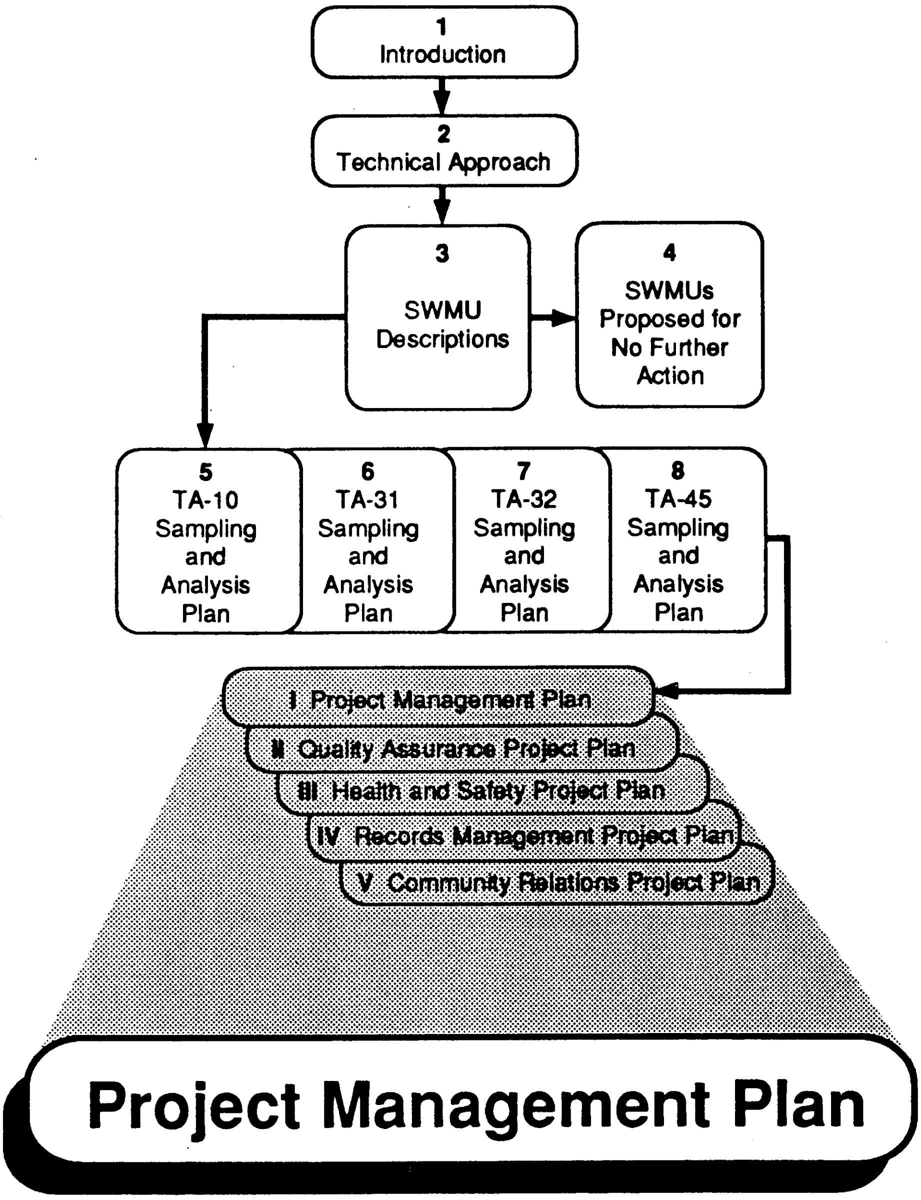
LANL (Los Alamos National Laboratory), November 1991. "Installation Work Plan for Environmental Restoration," Los Alamos National Laboratory Report LA-UR-91-3310, Los Alamos, New Mexico. **(LANL 1991, 0553)**

ANNEX I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1.0 TECHNICAL APPROACH

This annex presents the technical approach, organizational structure, schedule, budget, and reporting milestones for implementation of the Operable Unit (OU) 1079 Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI). The project management plan (PMP) for the OU 1079 RFI is tiered to the Environmental Restoration (ER) Program Management Plan, Annex I of the Installation Work Plan (IWP) (LANL 1991, 0553). This annex addresses the PMP requirements of the Hazardous and Solid Waste Amendments (HSWA) Module (Task II, E., p. 39) of the Los Alamos National Laboratory (Laboratory) RCRA Facility Permit (EPA 1990, 0306) as they apply to OU 1079.

The technical approach employed for the OU 1079 RFI is described in Chapter 2 of this work plan and is based on the ER Program office's overall technical approach to the RFI/corrective measures study (CMS) process as described in Chapter 3 of the IWP (LANL 1991, 0553). The following key features characterize the ER Program office's approach:

- using trigger levels to initiate a Voluntary Corrective Action (VCA), baseline risk assessment, or a CMS;
- sampling to characterize the site;
- employing decision analysis and cost-effectiveness studies to support the selection of remedial alternatives;
- applying the "observational" or "streamlined" approach to the RFI/CMS process to use as a general philosophical framework; and
- integrating RCRA, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the National Environmental Policy Act (NEPA), and other applicable regulations to better implement the investigation.

The ER Program office will use a carefully planned phased investigation and will subsequently interpret the data to ascertain the nature and extent of contamination at OU 1079. An objective of the investigation is to support voluntary or interim corrective actions, baseline risk assessment, or a CMS using the minimum data necessary.

The technical objectives of the phased OU 1079 RFI, detailed throughout this work plan, are to

- identify contaminants present at each Solid Waste Management Unit (SWMU);
- determine the vertical and lateral extent of the contamination at each SWMU;

- identify contaminant migration pathways;
- acquire sufficient information to allow baseline risk assessment, as necessary;
- provide necessary data for the assessment of VCAs or potential remedial alternatives; and
- provide the basis for planning detailed CMSs.

1.1 Technical Implementation Rationale

The scheduling of the investigations at OU 1079 is based on a phased approach, as illustrated in Figure I-1. Because the chemical data available are limited, a phased approach will be used in this work plan to assure that sufficient qualitative and quantitative information supporting the decision-making process is obtained.

1.1.1 Phased Approach

The logic flow diagram in Figure I-1 illustrates how the phased approach will be implemented for OU 1079. This approach is discussed in further detail in Chapters 5 through 8 of this work plan.

The OU 1079 phased approach begins with an extensive archival search. Based on results of the archival search, a determination will be made as to whether any potential risk to human health or the environment exists. If existing archival data indicate that there is no current or future threat to human health or the environment at the site, the SWMU(s) may be proposed for no further action. The rationale for making such a determination is provided in Chapter 4 of this work plan.

Those SWMUs for which archival data suggests a potential risk to human health or the environment will undergo a phased field investigation. If reconnaissance sampling is required due to the lack of existing data, the Phase I sampling strategy will involve OU-wide surface and subsurface investigations that focus on determining the presence or absence of Constituents of Concern (COCs) at OU 1079. Data collected during the Phase I field investigation will be compared to trigger levels. If the contaminant levels in these samples do not exceed trigger levels, then the SWMU(s) may be proposed for no further action. If the presence of COCs is confirmed at concentrations above trigger levels and above background concentrations during the Phase I field investigation, a VCA will be conducted, or a baseline risk assessment will be performed. If the data are insufficient for these efforts, additional sampling (Phase II) will be conducted.

If reconnaissance sampling is not initially required, a Phase I field investigation will be performed to determine the nature and extent of contamination. If contamination exceeds a trigger level and background concentrations, a VCA will

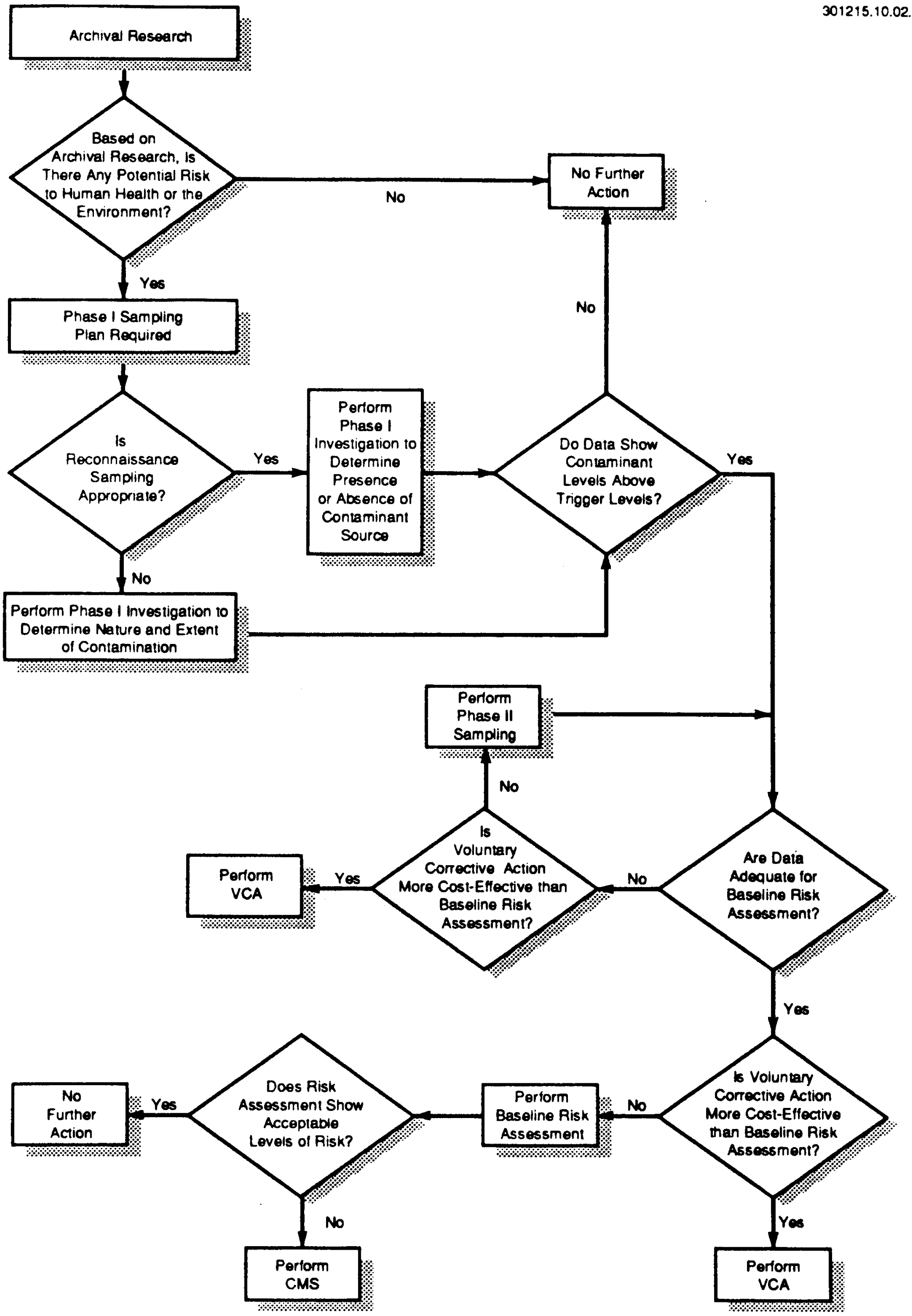

Figure I-1. Logic flow of OU 1079 RFI phased sampling approach.

be conducted, or a baseline risk assessment will be performed. If data are not adequate to perform a baseline risk assessment after the Phase I investigation, additional sampling (Phase II) will be conducted. If the baseline risk assessment indicates that an acceptable level of risk is present, the SWMU(s) may be proposed for no further action.

1.1.2 Data Requirements

The OU 1079 sampling and analysis plans provided in Chapters 5 through 8 of this work plan utilize the phased approach described in Section 1.1.1 above. In this process, archival information was evaluated with respect to the suspected original release location, the source term, migration effects, and contaminant behavior in the media. The Data Quality Objectives (DQO) process was then applied to create a set of data requirements for each SWMU in OU 1079 (See Chapter 2).

Data requirements developed for the OU 1079 field investigations are incorporated into the sampling and analysis plans. With the exception of TA-10, which has a statistically-based sampling plan, all OU 1079 sampling plans are based on expert judgement and existing radiological data. The OU 1079 sampling and analysis plans are designed to bound either the extent of contamination or the level of contamination, and to provide data for additional sampling (Phase II), if necessary.

The proposed OU 1079 field investigations will be conducted such that data needs can be reevaluated after each phase to confirm the site conceptual model sufficiently for VCA, baseline risk assessment, or corrective measures studies. Data collected during both the Phase I and Phase II sampling will be used for risk assessment and treatability studies during CMS, if required.

A summary of sampling requirements for the OU 1079 Phase I field investigation is presented in Table I-1. Table I-1 lists the number and type of samples (i.e., surface soil etc.) to be collected at each SWMU or SWMU Aggregate. The depth of the sample or boring, total feet drilled, required laboratory analyses for the collected samples, and proposed implementation dates for the field sampling is also listed in Table I-1.

1.1.3 Field Methods

Field methods for the OU 1079 phased RFI include five general categories. Each of these methods, summarized below, is discussed in detail in Chapters 5, 6, 7, and 8 of this work plan.

1. Field-Survey Methods for Radiological Constituents
    - general-area radiation surveys
    - gross-contamination surveys

TABLE I-1 SUMMARY OF PHASE I FIELD INVESTIGATION ACTIVITIES AT OU 1079

TA	SWMU #	SWMU Aggregate/ SWMU Description	Cliff Face	Channel Seds.	Surface Soil	Surf. Sam. Depth	Subsurf. Soil	Boring Depth	Total Ft. Drilled	Other Method	Field Duplic.	Rinsate Blank	Analyses			Implement. Date(s)
													Chem.	Rad.	HE	
TA-10	10-001(a-d)	**Firing Sites Aggregate:**														
		Firing Sites 1-4/Sand Pile Deton. Area	----	----	73	5-10 cm	----	----	----	----	6	4	x	x	x	FY-94
			----	28	----	5-10 cm	----	----	----	----	2	2	x	x	x	FY-94
		Subsurf. Disp. Aggregate (Known):														
	10-002(a)	Disposal Pit	----	----	----	----	16	0-50 ft.	200 ft.	----	1	----	x	x		FY-94
	10-002(b)	Disposal Pit	----	----	----	----	16	0-100 ft.	400 ft.	----	2	1	x	x		FY-94
	10-003(a-o)	Liquid Waste Disposal Complex	----	----	----	----	80	0-100 ft.	2000 ft.	----	8	4	x	x	x	FY-94
	10-004(b)	Septic Tank	----	----	----	----	16	0-100 ft.	400 ft.	----	1	0	x	x		FY-94
	10-007	Landfill	----	----	----	----	----	----	----	----	----	----				FY-94
	10-004(a)	**Subsurf. Disp. Aggregate (Unknown):**														
	10-005	Septic Tank	----	----	----	----	16	0-50 ft.	200 ft.	----	2	1	x	x		FY-94
		Surface Disposal/Open Burning Area	---	----	----	----	16	0-50 ft.	200 ft.	----	2	1	x	x	x	FY-94
TA-31		**TA-31 Aggregate:**														
	31-001	Septic Tank	----	----	----	----	4	0-5 ft.	20 ft.	----	1	----	x			FY-93
	•	Septic Tank Line	----	----	----	----	6	----	----	Trenches	----	----	x			FY-93
	•	Septic Tank Outfall	----	7	----	15 cm	----	----	----	----	2	1	x			FY-93
TA-32		**TA-32 Aggregate:**														
	32-001	Incinerator	----	----	----	----	1	0-3 ft.	3 ft.	----	----	----	x			FY-93
	32-002(a-b)	Septic Tank	----	----	----	----	4	0-5 ft.	20 ft.	----	1	----	x			FY-93
	•	Septic Tank Line	----	----	----	----	6	----	----	Trenches	----	----	x			FY-93
	•	Septic Tank Outfall	----	10	----	15 cm	----	----	----	----	2	1	x			FY-93
TA-45		**Treatment Plant Aggregate:**														
	1-002	Untreated Waste Outfall	----	12	----	15 cm	8	12-18 in.	12 ft.	----	2	1	x	x		FY-92
	45-001	Waste Treatment Facility & Outfalls	5	6	----	----	12	0-50 ft.	600 ft.	----	4	1	x	x		FY-92/93
	45-003	Industrial Waste (Acid Waste) Lines	----	----	----	----	4	•	?	----	1	----	x	x		FY-92
		Vehicle Decontamination Aggregate:														
	45-002	Decontamination Facility	----	----	----	----	5	••	?	----	1	1	x	x	x	FY-92
		Sanitary Sewer Outfall Aggregate:														
	45-004	Sanitary Sewer Outfall	----	2	----	15 cm	1	12-18 in.	12 ft.	----	----	----	x	x		FY-92
		TOTAL	5	65	73	----	195	----	4067 ft.	----	37	17	---	--	---	----

Footnotes:
- • - 5 ft. beneath soil/rock interface.
- •• - Bedrock interface.

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2. Field-Screening Methods for Radiological Constituents
   - contact-radiation surveys
   - low-energy-gamma surveys
   - contact-radiation surveys of packaged samples
   - contamination surveys of packaged samples
3. Field-Screening Methods for Nonradiological Constituents
   - organic-vapor monitoring (active)
4. Sample Collection Methods
   - surface soil samples
   - subsurface soil samples
   - sediment or drainage channel samples
   - bedrock samples

2.0 SCHEDULE

The start date for the OU 1079 RFI/CMS process was set in the IWP Program Management Plan (Annex I, Table I-3), and the schedule for the entire process was detailed in the IWP Appendix S (LANL 1991, 0553). The projected schedule for the RFI/CMS is provided here in Table I-2.

A detailed schedule of work planned for TA-45 during the OU 1079 RFI conducted in 1992 is presented in Figure I-2. The schedule is organized by each SWMU Aggregate-specific sampling plan (Chapter 8) to be implemented during 1992.

The DOE approved baseline for October, 1992 (LANL 1992, 06-0065) will be modified to reflect the accelerated schedule for OU 1079. All modifications to the schedule and costs must be processed through the DOE Change Control Board.

Implementation of RFI activities is contingent upon regulatory review and approval of this work plan, and upon available funding. This schedule was generated on the following assumptions:

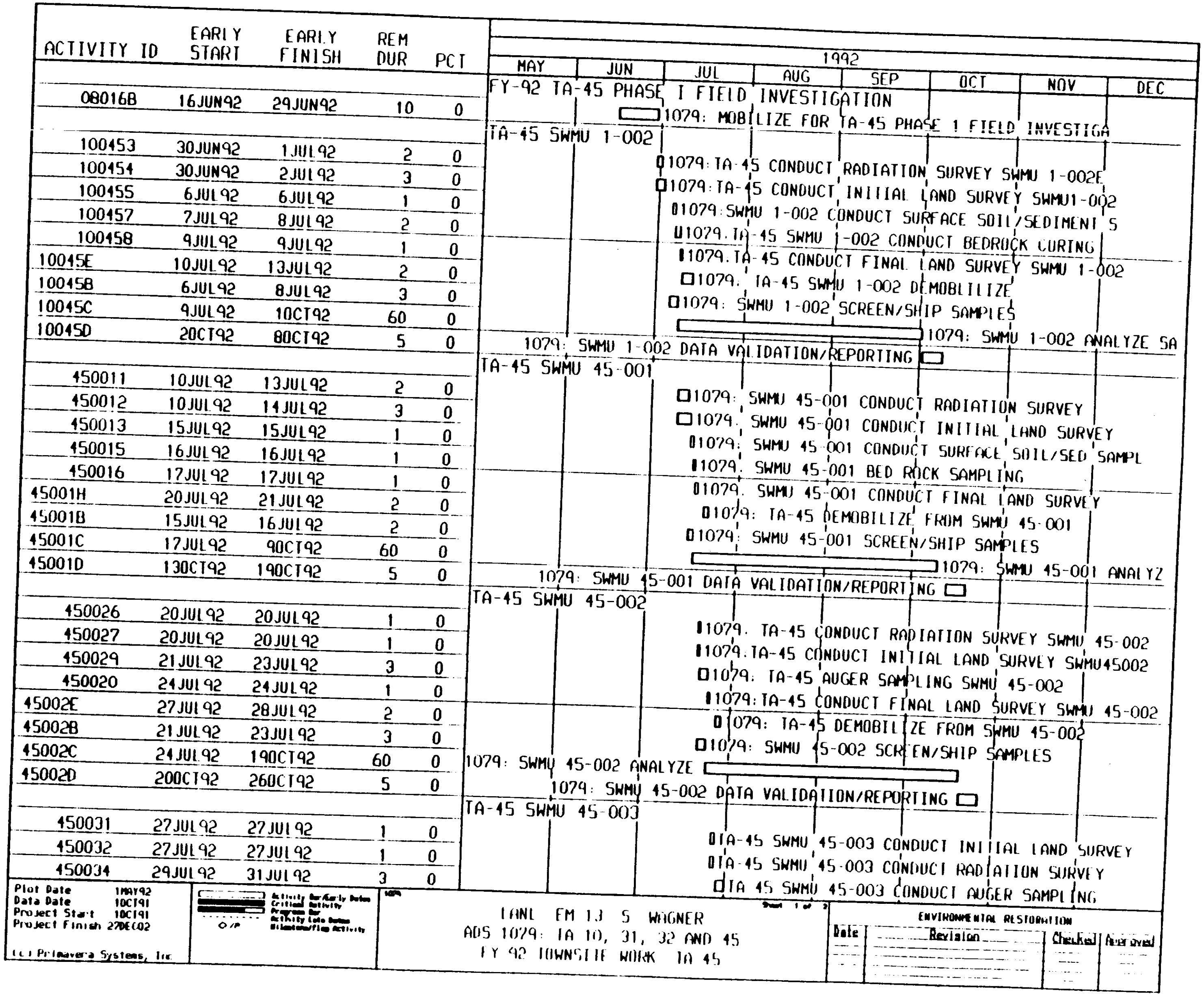
- regulatory agencies review and approve the OU 1079 RFI work plan and supporting project plans by September 1992 (see Table I-1);

TABLE I-2

PROJECTED SCHEDULE FOR OU 1079 RFI/CMS PROCESS[a]

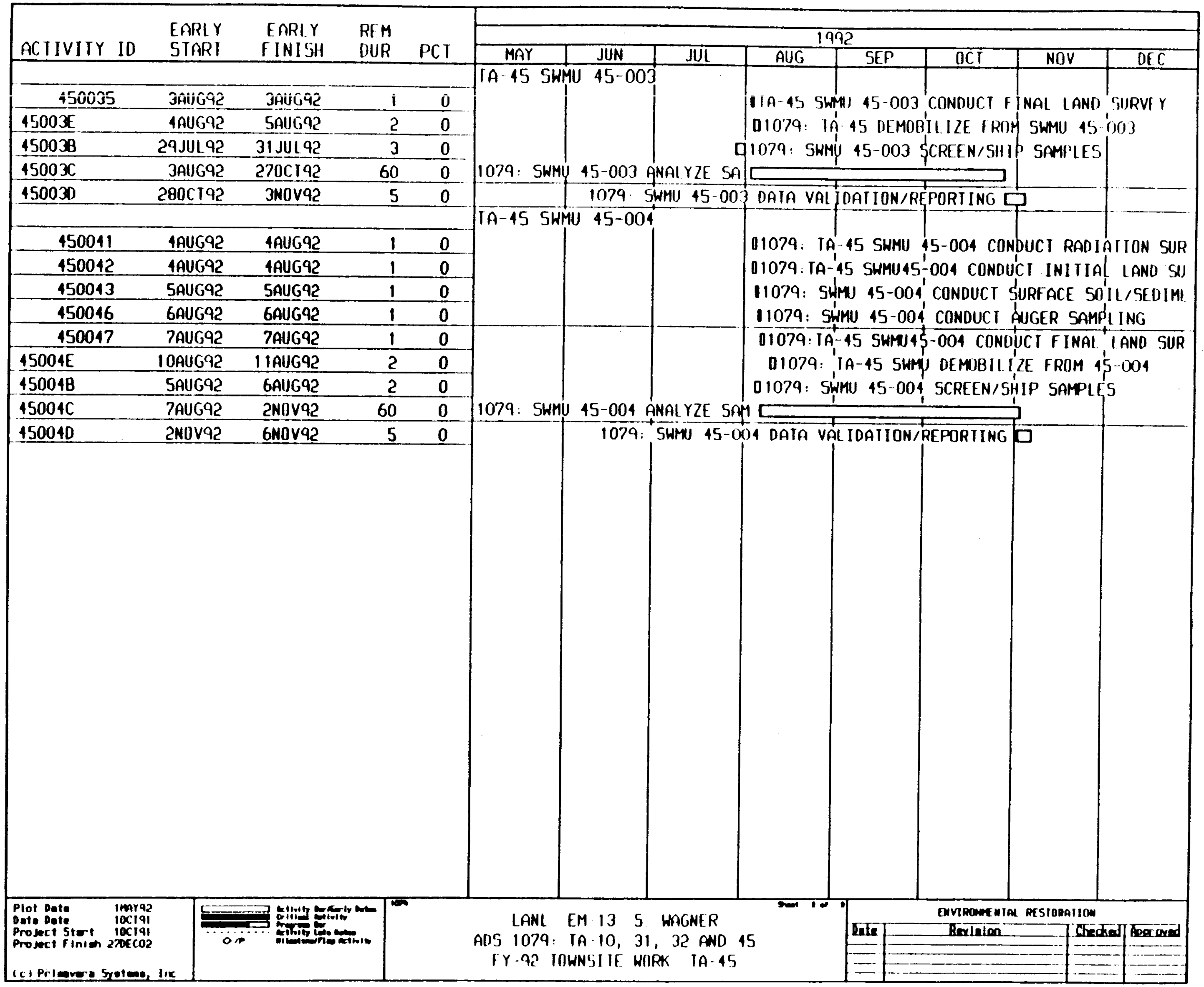
Activity	Date
Start OU 1079 Draft RFI Work Plan	1 Oct 90
Start OU 1079 RFI	30 Mar 92
Finish OU 1079 Draft RFI Work Plan	27 Apr 92
Finish OU 1079 Final RFI Work Plan	24 Sept 92
Start OU 1079 Draft RFI Report	23 Feb 93
Finish OU 1079 Draft RFI Report	27 May 97
Start OU 1079 Draft CMS Plan	28 May 97
Finish OU 1079 Final RFI Report	24 Sept 97
Finish OU 1079 RFI	24 Sept 97
Finish OU 1079 Draft CMS Plan	20 Feb 98
Finish OU 1079 Final CMS Plan	19 Jun 98
Start OU 1079 CMS	22 Jun 98
Start OU 1079 Draft CMS Report	22 Jun 98
Finish OU 1079 Draft CMS Report	15 Sept 99
Finish OU 1079 Final CMS Report	15 Sept 99
Finish OU 1079 CMS	6 Jan 00

[a] ADS 1079, FY 92, Baseline and Outyear Plan (LANL 1992, 06-0065).



ACTIVITY ID	EARLY START	EARLY FINISH	REM DUR	PCT	
					FY-92 TA-45 PHASE I FIELD INVESTIGATION
08016B	16JUN92	29JUN92	10	0	1079: MOBILIZE FOR TA-45 PHASE 1 FIELD INVESTIGA
					TA-45 SWMU 1-002
100453	30JUN92	1JUL92	2	0	1079: TA-45 CONDUCT RADIATION SURVEY SWMU 1-002E
100454	30JUN92	2JUL92	3	0	1079: TA-45 CONDUCT INITIAL LAND SURVEY SWMU1-002
100455	6JUL92	6JUL92	1	0	1079: SWMU 1-002 CONDUCT SURFACE SOIL/SEDIMENT S
100457	7JUL92	8JUL92	2	0	1079: TA-45 SWMU 1-002 CONDUCT BEDROCK CORING
100458	9JUL92	9JUL92	1	0	1079: TA-45 CONDUCT FINAL LAND SURVEY SWMU 1-002
10045E	10JUL92	13JUL92	2	0	1079: TA-45 SWMU 1-002 DEMOBLILIZE
10045B	6JUL92	8JUL92	3	0	1079: SWMU 1-002 SCREEN/SHIP SAMPLES
10045C	9JUL92	1OCT92	60	0	1079: SWMU 1-002 ANALYZE SA
10045D	2OCT92	8OCT92	5	0	1079: SWMU 1-002 DATA VALIDATION/REPORTING
					TA-45 SWMU 45-001
450011	10JUL92	13JUL92	2	0	1079: SWMU 45-001 CONDUCT RADIATION SURVEY
450012	10JUL92	14JUL92	3	0	1079: SWMU 45-001 CONDUCT INITIAL LAND SURVEY
450013	15JUL92	15JUL92	1	0	1079: SWMU 45-001 CONDUCT SURFACE SOIL/SED SAMPL
450015	16JUL92	16JUL92	1	0	1079: SWMU 45-001 BED ROCK SAMPLING
450016	17JUL92	17JUL92	1	0	1079: SWMU 45-001 CONDUCT FINAL LAND SURVEY
45001H	20JUL92	21JUL92	2	0	1079: TA-45 DEMOBILIZE FROM SWMU 45-001
45001B	15JUL92	16JUL92	2	0	1079: SWMU 45-001 SCREEN/SHIP SAMPLES
45001C	17JUL92	9OCT92	60	0	1079: SWMU 45-001 ANALYZ
45001D	13OCT92	19OCT92	5	0	1079: SWMU 45-001 DATA VALIDATION/REPORTING
					TA-45 SWMU 45-002
450026	20JUL92	20JUL92	1	0	1079: TA-45 CONDUCT RADIATION SURVEY SWMU 45-002
450027	20JUL92	20JUL92	1	0	1079: TA-45 CONDUCT INITIAL LAND SURVEY SWMU45002
450029	21JUL92	23JUL92	3	0	1079: TA-45 AUGER SAMPLING SWMU 45-002
450020	24JUL92	24JUL92	1	0	1079: TA-45 CONDUCT FINAL LAND SURVEY SWMU 45-002
45002E	27JUL92	28JUL92	2	0	1079: TA-45 DEMOBILIZE FROM SWMU 45-002
45002B	21JUL92	23JUL92	3	0	1079: SWMU 45-002 SCREEN/SHIP SAMPLES
45002C	24JUL92	19OCT92	60	0	1079: SWMU 45-002 ANALYZE
45002D	20OCT92	26OCT92	5	0	1079: SWMU 45-002 DATA VALIDATION/REPORTING
					TA-45 SWMU 45-003
450031	27JUL92	27JUL92	1	0	TA-45 SWMU 45-003 CONDUCT INITIAL LAND SURVEY
450032	27JUL92	27JUL92	1	0	TA-45 SWMU 45-003 CONDUCT RADIATION SURVEY
450034	29JUL92	31JUL92	3	0	TA 45 SWMU 45-003 CONDUCT AUGER SAMPLING

Figure I-2. OU 1079 RFI schedule for 1992.



ACTIVITY ID	EARLY START	EARLY FINISH	REM DUR	PCT
450035	3AUG92	3AUG92	1	0
45003E	4AUG92	5AUG92	2	0
45003B	29JUL92	31JUL92	3	0
45003C	3AUG92	27OCT92	60	0
45003D	28OCT92	3NOV92	5	0
450041	4AUG92	4AUG92	1	0
450042	4AUG92	4AUG92	1	0
450043	5AUG92	5AUG92	1	0
450046	6AUG92	6AUG92	1	0
450047	7AUG92	7AUG92	1	0
45004E	10AUG92	11AUG92	2	0
45004B	5AUG92	6AUG92	2	0
45004C	7AUG92	2NOV92	60	0
45004D	2NOV92	6NOV92	5	0

Figure I-2 (Continued). OU 1079 RFI schedule for 1992.

- the Laboratory may initiate certain tasks (e.g., interim corrective measures) before the regulatory agencies grant final approval of the work plan;
- an adequate number of support personnel (e.g., Laboratory technicians, trained drilling contractors, etc.) is available for conducting necessary tasks;
- Environmental Protection Agency (EPA) approval of phase reports/work plan modifications (including EPA comments, Laboratory revisions, and final EPA approval) takes ten weeks, of which four weeks are allowed for EPA review and comment, and six weeks for Laboratory revisions;
- the Laboratory schedules SWMUs expected to require Phase II sampling earlier in the Phase I RFI to allow time for data assessment and subsequent investigations;
- planned Department of Energy (DOE) budgets for OU 1079 for fiscal years (FYs) 1992 and 1993 constrain the work scheduled in the first two years of investigation; and
- when possible, field work is not scheduled between November 15 and March 15 each year because of inclement weather.

3.0 COST ESTIMATION

The schedule presented earlier is based on fixed budgets for the first two years of the RFI. The fixed budgets in FYs 1992 and 1993 are based on expected DOE-funding levels. DOE-funding requests are set two years in advance; thus past budget estimates will no longer constrain the OU 1079 RFI in FY 1994. Funding requests for FY 1994 and beyond will reflect the cost and schedule that most efficiently complete the RFI plans. Table I-3 presents a summary cost estimate for the OU 1079 RFI with cost for each SWMU Aggregate-specific sampling plan (Chapters 5, 6, 7, and 8). The cost estimates reflect DOE guidance regarding appropriate contingency assumptions (LANL 1992, 06-0065).

4.0 REPORTING

The Laboratory will present the results of RFI field work in three principal documents: quarterly technical progress reports, phase reports/work plan modifications, and the RFI report. The purpose of each of these reports is detailed in the following sections. A schedule for submission of draft and final reports is presented in Table I-4.

TABLE I-3
ESTIMATED BUDGET FOR OU 1079

```
----------------------------------------------------------------------------------------------------------------------------
LANL  EM-13  S. WAGNER                                FINEST HOUR                               ADS 1079: TA-10, 31, 32 AND 45

REPORT DATE 18FEB92  RUN NO.  138              ENVIRONMENTAL RESTORATION                       START DATE   1OCT91  FIN DATE  6JAN0
            22:58
SCHEDULE REPORT ACTIVITY WITH BUDGET                                                           DATA DATE    1OCT91  PAGE NO.     1

 ----- -----  ---- ---- - --- ---------  ------------------------------------------- -------- -------- -------- -------- ----
  ACTIVITY    ORIG REM                                  ACTIVITY DESCRIPTION                 SCHEDULED
     ID       DUR  DUR      %                                        BUDGET       EARNED     START   FINISH
 ----- -----  ---- ---- - --- ---------  ------------------------------------------- -------- -------- -------- -------- ----
     080000    55   55      0            1079: Develop Internal Draft Work Plan             1OCT91  20DEC91

                                                                   269509.00        .00

     080005    12   12      0            1079: Conduct LANL/VE Rev of Int Draft Work Plan 23DEC91  10JAN92

                                                                    49520.00        .00

     080010    10   10      0            1079: Incorp. LANL Comments & Dev.DOE Dft RFI WP 14JAN92  27JAN92

                                                                   112684.00        .00

     080015    19   19      0            1079: Conduct DOE Review of DOE Draft RFI WP     28JAN92  24FEB92

                                                                     4696.00        .00

     080020    25   25      0            1079: Incorporate DOE Comments into DOE RFI WP   18FEB92  23MAR92

                                                                    44672.00        .00

     080025    25   25      0            1079: Publish EPA/NMED Draft for RFI WP          24MAR92  27APR92

                                                                    42216.00        .00

     080030    58   58      0            1079: Conduct EPA Review of RFI WP               28APR92  20JUL92

                                                                     4696.00        .00

     080035    58   58      0            1079: Conduct NMED Review of RFI WP              28APR92  20JUL92

                                                                     4696.00        .00

     080040   246  246      0           1079:Conduct Bench/Pilot Studies for RFI WP(LOE)  1OCT92*  27SEP93

                                                                   314295.80        .00

     080045   246  246      0           3079:Conduct Voluntary C.Actions for RFI WP(LOE)  1OCT92*  27SEP93

                                                                   278582.15        .00

     080055   246  246      0           1079: Develop NEPA Documentation for RFI WP      23OCT91*  16OCT92

                                                                    69947.61        .00
```

TABLE I-3
ESTIMATED BUDGET FOR OU 1079 (Continued)

```
--------------------------------------------------------------------------------------------------------------------------
LANL  EM-13  S. WAGNER                              FINEST HOUR                              ADS 1079: TA-10, 31, 32 AND 45

REPORT DATE 18FEB92  RUN NO.  138           ENVIRONMENTAL RESTORATION                        START DATE  1OCT91  FIN DATE  6JAN00
            22:58
SCHEDULE REPORT ACTIVITY WITH BUDGET                                                         DATA DATE   1OCT91  PAGE NO.    2

 ----- -----  ---- ---- - --- ---------- ------------------------------------------- -------- -------- -------- -------- -----
  ACTIVITY    ORIG REM                              ACTIVITY DESCRIPTION              SCHEDULED
     ID       DUR  DUR     %                                      BUDGET      EARNED   START   FINISH
 ----- -----  ---- ---- - --- ---------- ------------------------------------------- -------- -------- -------- -------- -----
     080090    20   20     0               E079: Develop Data Quality Objectives for RFI WP  1OCT93* 28OCT93

                                                                  227971.92         .00

     080130    10   10     0               1079: Publish DOE Draft of RFI WP                14JAN92  27JAN92

                                                                   44899.00         .00

     080160    64   64     0               1079: Mobilize for RFI                            3FEB92   1MAY92

                                                                    7276.00         .00

     080170   105  105     0               1079: Conduct RFI PH1 Field Work                  4MAY92  30SEP92

                                                                   81252.00         .00

     080175    40   40     0               1079: Conduct RFI PH1 Sample Analysis             1OCT92   1DEC92

                                                                  461332.00         .00

     080180    55   55     0               1079: Conduct RFI PH1 Data Assessment             2DEC92  23FEB93

                                                                   13453.16         .00

     080185    44   44     0               1079: Write RFI PH1 Tech Memo/WP Modification   24FEB93  26APR93

                                                                    8294.89         .00

     080190   100  100     0               1079: Conduct RFI Report Facility Investigation  11OCT95   8MAR96

                                                                  101947.25         .00

     080195   110  110     0               1079: Conduct RFI Report Investigation Analysis  11OCT95  22MAR96

                                                                  416005.29         .00

     080200   132  132     0               1079: Prepare Internal Draft of RFI Report       25MAR96  27SEP96

                                                                  353374.72         .00

     080205    20   20     0               1079: LANL/VE Review Internal Draft of RFI Rpt   30SEP96  28OCT96

                                                                   18605.86         .00
```

TABLE I-3
ESTIMATED BUDGET FOR OU 1079 (Continued)

LANL EM-13 S. WAGNER FINEST HOUR ADS 1079: TA-10, 31, 32 AND 45

REPORT DATE 18FEB92 RUN NO. 138 ENVIRONMENTAL RESTORATION START DATE 1OCT91 FIN DATE 6JAN0C
22:58

SCHEDULE REPORT ACTIVITY WITH BUDGET DATA DATE 1OCT91 PAGE NO. 3

ACTIVITY ID	ORIG DUR	REM DUR	%	ACTIVITY DESCRIPTION	BUDGET	EARNED	SCHEDULED START	FINISH
080210	40	40	0	1079: Incorp. LANL Rev.Commts Intern Dft RFI Rpt	17799.98	.00	29OCT96	30DEC96
080215	20	20	0	1079: Publish DOE Draft of RFI Report	62001.70	.00	31DEC96	29JAN97
080220	22	22	0	1079: Conduct Review of DOE Draft of RFI Report	8398.94	.00	30JAN97	3MAR97
080225	40	40	0	1079: Incorp. DOE Rev. Commts. DOE Draft RFI Rpt	8398.94	.00	4MAR97	28APR97
080230	20	20	0	1079: Publish EPA/NMED Draft of RFI Report	64290.88	.00	29APR97	27MAY97
080235	44	44	0	1079: Conduct EPA Review of RFI Report	8676.83	.00	28MAY97	29JUL97
080240	44	44	0	1079: Conduct NMED Review of RFI Rpt	8676.83	.00	28MAY97	29JUL97
080245	245	245	0	1079: Cond Bench/Pilot Studies for CMS Pl (LOE)	.00	.00	28MAY97	20MAY98
080250	35	35	0	1079: Establish Current Situation for CMS Plan	4076.36	.00	28MAY97	16JUL97
080255	35	35	0	1079: Establish CA Objectives for CMS Plan	6154.65	.00	28MAY97	16JUL97
080260	35	35	0	1079: Develop Screening Technologies for CMS Pl	5261.04	.00	28MAY97	16JUL97

TABLE I-3
ESTIMATED BUDGET FOR OU 1079 (Continued)

LANL EM-13 S. WAGNER FINEST HOUR ADS 1079: TA-10, 31, 32 AND 45

REPORT DATE 18FEB92 RUN NO. 138 ENVIRONMENTAL RESTORATION START DATE 1OCT91 FIN DATE 6JAN0C
22:58

SCHEDULE REPORT ACTIVITY WITH BUDGET DATA DATE 1OCT91 PAGE NO. 4

ACTIVITY ID	ORIG DUR	REM DUR	%	ACTIVITY DESCRIPTION	BUDGET	EARNED	SCHEDULED START	SCHEDULED FINISH
080265	35	35	0	1079: Develop Alternatives for CMS Plan	5261.04	.00	17JUL97	4SEP97
080270	35	35	0	1079: Develop Internal Draft of CMS Plan	2897.12	.00	5SEP97	24OCT97
080275	10	10	0	1079: LANL/VE Review Internal Draft of CMS Pl	1091.45	.00	27OCT97	7NOV97
080280	10	10	0	1079: Incorp. LANL REV Commts Intern Dft CMS Pln	1091.45	.00	11NOV97	26NOV97
080285	5	5	0	1079: Publish DOE Draft of CMS Plan	1772.72	.00	27NOV97	3DEC97
080290	22	22	0	1079: Conduct Review of DOE Draft of CMS Plan	824.94	.00	4DEC97	7JAN98
080295	20	20	0	1079: Incorp. DOE Rev.Comments DOE Dft.of CMS Pl	824.94	.00	8JAN98	5FEB98
080300	10	10	0	1079: Publish EPA/NMED Draft of CMS Plan	1690.72	.00	6FEB98	20FEB98
080305	44	44	0	1079: Conduct EPA Review of CMS Plan	824.94	.00	23FEB98	23APR98
080310	44	44	0	1079: Conduct NMED Review of CMS Plan	824.94	.00	23FEB98	23APR98
080315	245	245	0	1079: Conduct CMS Bench/Pilot Studies (LOE)	913130.00	.00	22JUN98	15JUN99

TABLE I-3
ESTIMATED BUDGET FOR OU 1079 (Continued)

```
-------------------------------------------------------------------------------------------------------------------------------
LANL  EM-13  S. WAGNER                                    FINEST HOUR                              ADS 1079: TA-10, 31, 32 AND 45

REPORT DATE 18FEB92  RUN NO.  138               ENVIRONMENTAL RESTORATION                          START DATE  1OCT91  FIN DATE  6JAN00
            22:58
SCHEDULE REPORT ACTIVITY WITH BUDGET                                                               DATA DATE   1OCT91  PAGE NO.    5

 ----- -----  ---- ---- - --- ----------  ---------------------------------------------- -------- -------- -------- -------- -----
  ACTIVITY    ORIG REM                                     ACTIVITY DESCRIPTION                SCHEDULED
     ID       DUR  DUR       %                                       BUDGET        EARNED     START   FINISH
 ----- -----  ---- ---- - --- ----------  ---------------------------------------------- -------- -------- -------- -------- -----
      080320   30   30      0              1079: Conduct Technical Evaluation for CMS Rpt  22JUN98   3AUG98

                                                              26605.06          .00

      080325   30   30      0              1079: Conduct Environmental Eval for CMS Report 22JUN98   3AUG98

                                                              26155.14          .00

      080330   30   30      0              1079: Conduct Human Health Eval for CMS Report  22JUN98   3AUG98

                                                              25057.44          .00

      080335   30   30      0              1079: Cond Community Relations Eval.for CMS Rpt 22JUN98   3AUG98

                                                              22748.25          .00

      080340   30   30      0              1079: Conduct Cost Evaluation for CMS Report    22JUN98   3AUG98

                                                              23990.97          .00

      080345  163  163      0              1079: Prepare Internal Draft of CMS Report       4AUG98   1APR99

                                                              21484.51          .00

      080350   10   10      0              1079: LANL/VE Review Internal Draft of CMS Rpt   2APR99  15APR99

                                                               1611.72          .00

      080355   35   35      0              1079: Incorp. LANL Rev Commts Intern. Dft CMS Rp 27APR99  15JUN99

                                                               1611.72          .00

      080360   10   10      0              1079: Publish DOE Draft of CMS Report           16JUN99  29JUN99

                                                               4819.66          .00

      080365   22   22      0              1079: Conduct Review of DOE Draft of CMS Report 30JUN99  30JUL99

                                                               1299.81          .00

      080370   22   22      0              1079: Incorp. DOE Rev Comments DOE Dft CMS Rpt   2AUG99  31AUG99

                                                               1299.81          .00
```

TABLE I-3
ESTIMATED BUDGET FOR OU 1079 (Continued)

```
-----------------------------------------------------------------------------------------------------------------------
LANL  EM-13  S. WAGNER                              FINEST HOUR                           ADS 1079: TA-10, 31, 32 AND 45

REPORT DATE 18FEB92  RUN NO.  138            ENVIRONMENTAL RESTORATION                    START DATE  1OCT91  FIN DATE  6JAN00
            22:58
SCHEDULE REPORT ACTIVITY WITH BUDGET                                                      DATA DATE   1OCT91  PAGE NO.    6

----- -----  ---- ---- - --- ----------  ---------------------------------------- -------- -------- -------- -------- -----
  ACTIVITY   ORIG REM                                  ACTIVITY DESCRIPTION                SCHEDULED
     ID      DUR  DUR       %                                    BUDGET      EARNED      START   FINISH
----- -----  ---- ---- - --- ----------  ---------------------------------------- -------- -------- -------- -------- -----
    080375    10   10       0            1079: Publish EPA/NMED Draft of CMS Report       1SEP99  15SEP99

                                                          3756.20        .00

    080380    44   44       0            1079: Conduct EPA Review of CMS Report          16SEP99  18NOV99

                                                          1299.81        .00

    080385    44   44       0            1079: Conduct NMED Review of CMS Rpt            16SEP99  18NOV99

                                                          1299.81        .00

    080390   246  246       0            1079: Manage ADS During FY-92 (LOE)              1OCT91  24SEP92

                                                        351135.00        .00

    080395    20   20       0            1079: Demobilize RFI PH1 Field Work             15FEB94  15MAR94

                                                              .00        .00

    080400    22   22       0            1079: EPA/NMED Rev PH1 Tech Memo/WP Modification 27APR93  26MAY93

                                                          8188.89        .00

    080405    22   22       0            1079: DOE Review PH1 Tech Memo/WP Modification  27APR93  26MAY93

                                                          8188.89        .00

    080410    84   84       0            1079: Write PH2 Contract; Mobilize for RFI     24SEP92* 29JAN93

                                                         33126.55        .00

    080415   105  105       0            1079: Conduct RFI PH2 Field Work                 1SEP93*  4FEB94

                                                        563033.17        .00

    080420    40   40       0            1079: Conduct RFI PH2 Sample Analysis            7FEB94   4APR94

                                                       6838688.00        .00

    080425    56   56       0            1079: Conduct RFI PH2 Data Assessment            5APR94  22JUN94

                                                        120134.70        .00
```

TABLE I-3
ESTIMATED BUDGET FOR OU 1079 (Continued)

```
-----------------------------------------------------------------------------------------------------------------------------
LANL  EM-13  S. WAGNER                            FINEST HOUR                              ADS 1079: TA-10, 31, 32 AND 45

REPORT DATE 18FEB92  RUN NO.  138           ENVIRONMENTAL RESTORATION                     START DATE  1OCT91  FIN DATE  6JAN0
            22:58
SCHEDULE REPORT ACTIVITY WITH BUDGET                                                      DATA DATE   1OCT91  PAGE NO.    7

 ----- -----  ---- ---- - --- ---------- ----------------------------------------------- -------- -------- -------- -------- -----
  ACTIVITY    ORIG REM                                   ACTIVITY DESCRIPTION                 SCHEDULED
     ID       DUR  DUR     %                                      BUDGET        EARNED      START    FINISH
 ----- -----  ---- ---- - --- ---------- ----------------------------------------------- -------- -------- -------- -------- -----
     080430    20   20     0            1079: Demobolize RFI PH2 Field Work                   7FEB94   7MAR94

                                                                  7276.00          .00

     080435   100  100     0            1079: Develop NEPA Documentation for RFI Report     23FEB93  14JUL93

                                                                 66916.39          .00

     080445   245  245     0            1079: Develop NEPA Documentation for CMS Plan       28MAY97  20MAY98

                                                                  3476.28          .00

     080450    30   30     0            1079: Develop NEPA Documentation for CMS Report     22JUN98   3AUG98

                                                                 46318.73          .00

     080455   245  245     0            1079: Manage ADS During FY-93 (LOE)                  1OCT92*  24SEP93

                                                                141280.64          .00

     080460   246  246     0            1079: Manage ADS During FY-94 (LOE)                 27SEP93  20SEP94

                                                                148921.70          .00

     080465   244  244     0            1079: Manage ADS During FY-95 (LOE)                 21SEP94  14SEP95

                                                                156982.86          .00

     080470   246  246     0            1079: Manage ADS During FY-96 (LOE)                 15SEP95  10SEP96

                                                                165515.28          .00

     080475   245  245     0            1079: Manage ADS During FY-97 (LOE)                 11SEP96   4SEP97

                                                                174497.62          .00

     080480   245  245     0            1079: Manage ADS During FY-98 (LOE)                  5SEP97  28AUG98

                                                                175018.56          .00

     080485   245  245     0            1079: Manage ADS During FY-99 (LOE)                  7OCT98  30SEP99*

                                                                175018.56          .00
```

TABLE I-3
ESTIMATED BUDGET FOR OU 1079 (Continued)

```
--------------------------------------------------------------------------------------------------------------------------------------
LANL  EM-13  S. WAGNER                             FINEST HOUR                                ADS 1079: TA-10, 31, 32 AND 45

REPORT DATE 18FEB92  RUN NO.  138           ENVIRONMENTAL RESTORATION                         START DATE  1OCT91  FIN DATE  6JAN00
           22:58
SCHEDULE REPORT ACTIVITY WITH BUDGET                                                          DATA DATE   1OCT91  PAGE NO.    8

----- -----  ---- ---- - --- --------- ----------------------------------------------- ------- ------- -------- -------- -----
 ACTIVITY    ORIG REM                                    ACTIVITY DESCRIPTION              SCHEDULED
    ID       DUR  DUR        %                                     BUDGET      EARNED    START   FINISH
----- -----  ---- ---- - --- --------- ----------------------------------------------- ------- ------- -------- -------- -----
    080510    61   61      0          1079: Write Ph1  Contracts for RFI                    2JAN92* 30MAR92

                                                                  24580.00         .00

    080515    30   30      0          1079: Incorporate EPA/NMED Comments for RFI WP   21JUL92  31AUG92

                                                                   2442.00         .00

    080520    17   17      0          1079: Publish Final RFI Work Plan                  1SEP92  24SEP92

                                                                    950.00         .00

    080540    20   20      0          1079: Incorporate EPA/NMED Comments on RFI Rpt   30JUL97  26AUG97

                                                                   2997.52         .00

    080545    20   20      0          1079: Publish Final RFI Report                    27AUG97  24SEP97

                                                                   3623.63         .00

    080550    20   20      0          1079: Incorporate EPA/NMED Comments on CMS Plan  24APR98  21MAY98

                                                                   1691.70         .00

    080555    10   10      0          1079: Publish Final CMS Plan                      22MAY98   5JUN98

                                                                    248.32         .00

    080560    10   10      0          1079: EPA Approves CMS Plan                        8JUN98  19JUN98

                                                                   3147.99         .00

    080565    20   20      0          1079: Incorporate EPA/NMED Comments on CMS Rpt   19NOV99  20DEC99

                                                                   1309.33         .00

    080570    10   10      0          1079: Publish Final CMS Report                    21DEC99   6JAN00

                                                                   1241.60         .00

    080580    20   20      0          1079: Demobilize RFI PH1 Field Work                1OCT92  29OCT92

                                                                   7276.00         .00
```

TABLE I-3
ESTIMATED BUDGET FOR OU 1079 (Continued)

```
-----------------------------------------------------------------------------------------------------------------------------
LANL  EM-13  S. WAGNER                         FINEST HOUR                            ADS 1079: TA-10, 31, 32 AND 45

REPORT DATE 18FEB92  RUN NO.  138        ENVIRONMENTAL RESTORATION                    START DATE  1OCT91  FIN DATE  6JAN00
            22:58
SCHEDULE REPORT ACTIVITY WITH BUDGET                                                  DATA DATE   1OCT91  PAGE NO.    9

 ----- -----  ---- ---- - --- ---------- ------------------------------------------ -------- -------- -------- -------- -----
  ACTIVITY    ORIG REM                                ACTIVITY DESCRIPTION              SCHEDULED
     ID       DUR  DUR     %                                 BUDGET        EARNED     START   FINISH
 ----- -----  ---- ---- - --- ---------- ------------------------------------------ -------- -------- -------- -------- -----
    080585     36   36     0            1079: Write RFI PH2 Tech Memo/WP Modification    8MAR94  26APR94

                                                             64396.77         .00

    080590     61   61     0            1079: Write PH3 Contract; Mobilize for RFI     27APR94* 22JUL94

                                                             34633.44         .00

    080595    105  105     0            1079: Conduct RFI PH3 Field Work               25JUL94  28DEC94

                                                             67983.45         .00

    080600     40   40     0            1079: Conduct RFI PH3 Sample Analysis          29DEC94  27FEB95

                                                           4878960.00         .00

    080605     56   56     0            1079: Conduct RFI PH3 Data Assessment          28FEB95  16MAY95

                                                             24381.49         .00

    080610     20   20     0            1079: Demobilize RFI PH3 Field Work            17MAY95  14JUN95

                                                              7276.00         .00

    080620     23   23     0            1079: EPA/NMED Rev Ph2 Tech Memo               25OCT93  29NOV93

                                                              8412.60         .00

    080625     20   20     0            1079: DOE Review Ph2 Tech Memo                 27SEP93* 22OCT93

                                                              8367.85         .00

    530000    189  189     0            1079: CONDUCT VCA (LOE) FY-97                   2JAN97* 30SEP97

                                                             64135.00         .00

    530005    249  249     0            1079: Conduct VCA (LOE) FY-98                   1OCT97  30SEP98

                                                             85916.00         .00

    600330    245  245     0            1079: VCA FY-93                                 1OCT92* 24SEP93

                                                            100000.00         .00
```

TABLE I-3
ESTIMATED BUDGET FOR OU 1079 (Continued)

```
------------------------------------------------------------------------------------------------------------------------------------
LANL  EM-13  S. WAGNER                              FINEST HOUR                                ADS 1079: TA-10, 31, 32 AND 45

REPORT DATE 18FEB92  RUN NO.  138           ENVIRONMENTAL RESTORATION                          START DATE  1OCT91  FIN DATE  6JAN00
             22:58
SCHEDULE REPORT ACTIVITY WITH BUDGET                                                           DATA DATE   1OCT91  PAGE NO.   10

 ----- -----  ---- ---- - --- ---------- ---------------------------------------------- -------- -------- -------- -------- -----
  ACTIVITY    ORIG REM                                ACTIVITY DESCRIPTION                    SCHEDULED
     ID       DUR  DUR      %                                   BUDGET       EARNED      START    FINISH
 ----- -----  ---- ---- - --- ---------- ---------------------------------------------- -------- -------- -------- -------- -----
      600334   246  246     0           1079: VCA FY-94                                  27SEP93  20SEP94

                                                                100000.00         .00

      600338   245  245     0           1079: VCA FY-95                                  21SEP94  15SEP95

                                                                100000.00         .00

      600342   245  245     0           1079: VCA FY-96                                   6OCT95  30SEP96*

                                                                100000.00         .00

 08M000          0    0     0           1079: DOE DRAFT RFI WORK PLAN COMPLETED                    27JAN92

                                                                      .00         .00

 08M005          0    0     0           1079: EPA/NMED DRAFT OF RFI WORK PLAN COMPLETED            27APR92

                                                                      .00         .00

 08M010          0    0     0           1079: START RFI WORK PLAN REVIEW                 20JAN92*

                                                                      .00         .00

 08M030          0    0     0           1079: START RFI                                  30MAR92*

                                                                      .00         .00

 08M035          0    0     0           1079: RFI FIELD WORK COMPLETED                             30SEP91

                                                                      .00         .00

 08M040          0    0     0           1079: START DEVELOPING RFI REPORT                23FEB93

                                                                      .00         .00

 08M045          0    0     0           1079: EPA/NMED DRAFT OF RFI REPORT COMPLETED               27MAY97

                                                                      .00         .00

 08M050          0    0     0           1079: RFI COMPLETED                                        24SEP97

                                                                      .00         .00
```

TABLE I-3
ESTIMATED BUDGET FOR OU 1079 (Continued)

```
-----------------------------------------------------------------------------------------------------------------------
LANL  EM-13  S. WAGNER                         FINEST HOUR                        ADS 1079: TA-10, 31, 32 AND 45

REPORT DATE 18FEB92  RUN NO.  138        ENVIRONMENTAL RESTORATION                START DATE  1OCT91  FIN DATE  6JAN0
            22:58
SCHEDULE REPORT ACTIVITY WITH BUDGET                                              DATA DATE   1OCT91  PAGE NO.   11

----- -----  ---- ---- - --- ---------- ------------------------------------------- -------- -------- -------- -------- -----
 ACTIVITY    ORIG REM                                ACTIVITY DESCRIPTION           SCHEDULED
    ID       DUR  DUR      %                                BUDGET        EARNED    START   FINISH
----- -----  ---- ---- - --- ---------- ------------------------------------------- -------- -------- -------- -------- -----
 08M055         0    0     0         1079: START DEVELOPMENT OF CMS PLAN              28MAY97

                                                            .00           .00

 08M060         0    0     0         1079: EPA/NMED DRAFT OF CMS PLAN COMPLETED                20FEB98

                                                            .00           .00

 08M065         0    0     0         1079: START CMS WORK                             22JUN98

                                                            .00           .00

 08M070         0    0     0         1079: CMS WORK COMPLETED                                  15JUN99

                                                            .00           .00

 08M075         0    0     0         1079: START DEVELOPMENT OF CMS REPORT            22JUN98

                                                            .00           .00

 08M080         0    0     0         1079: EPA/NMED DRAFT OF CMS REPORT COMPLETED              15SEP99

                                                            .00           .00

 08M085         0    0     0         1079: ASSESSMENT COMPLETED                                 6JAN00

                                                            .00           .00

 08M090         0    0     0         1079: EPA NOTIFICATION OF CMS REQUIREMENTS                24SEP97

                                                            .00           .00

 08M095         0    0     0         1079: EPA APPROVED CMS PLAN                               19JUN98

                                                            .00           .00

 08M100         0    0     0         1079: RFI WORK PLAN COMPLETED                             24SEP92

                                                            .00           .00

 08M105         0    0     0         1079: EPA/NMED DRAFT OF PH1 TECH/MEMO COMPLETED           26APR93

                                                            .00           .00
```

TABLE I-3
ESTIMATED BUDGET FOR OU 1079 (Continued)

```
-----------------------------------------------------------------------------------------------------------------
LANL  EM-13  S. WAGNER                        FINEST HOUR                                ADS 1079: TA-10, 31, 32 AND 45

REPORT DATE 18FEB92  RUN NO.  138       ENVIRONMENTAL RESTORATION                        START DATE  1OCT91  FIN DATE  6JAN(
            22:58
SCHEDULE REPORT ACTIVITY WITH BUDGET                                                     DATA DATE   1OCT91  PAGE NO.   12

----- -----  ---- ---- - --- --------- ------------------------------------------- -------- -------- -------- -------- ---
  ACTIVITY   ORIG REM                                ACTIVITY DESCRIPTION                SCHEDULED
     ID      DUR  DUR      %                                    BUDGET        EARNED     START   FINISH
----- -----  ---- ---- - --- --------- ------------------------------------------- -------- -------- -------- -------- ---
 08M110         0    0     0           1079: EPA/NMED DRAFT OF PH2 TECH                           22OCT93

                                                                    .00           .00


                                                           ============= ============
  REPORT TOTAL                                              19094625.48           .00
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$ X 1000

EST TO COMPLETION	$19,095
ESCALATION	$209
PRIOR YEARS	$1,048
TOTAL AT COMPLETION	$20,352

TABLE I-4
REPORTS PLANNED FOR THE OU 1079 RFI

Report Type and Subject	Draft Date	Final Date
Monthly Technical Progress Reports		Due 25th of the following month
Quarterly Technical Progress Reports Summary of Technical Activities/Data		February 15, yearly May 15, yearly August 15, yearly
Annual Technical Progress Report		November 15, yearly
Phase Reports/Work Plan Modifications		
1. Surface/Subsurface Investigations TA-10 Firing Sites SWMU Aggregate	May 1995	September 1994
2. Surface/Subsurface Investigations TA-10 Subsurface Disposal SWMU Aggregate	May 1995	September 1995
3. Surface/Subsurface Investigations TA-31 SWMU Aggregate	May 1994	September 1994
4. Surface/Subsurface Investigations TA-32 SWMU Aggregate	May 1994	September 1994
5. Surface Investigations TA-45 SWMU Aggregates	May 1993	September 1993
6. Subsurface Investigations TA-45 SWMU Aggregates	May 1994	September 1994
RFI Report Final RFI Report	27 May 1997	24 Sept 1997

4.1 Quarterly Technical Progress Reports

As the OU 1079 RFI is implemented, the Laboratory will summarize technical progress in quarterly technical progress reports, as required by the HSWA Module of the Laboratory's RCRA Facility Permit (Task V, C, page 46). The Laboratory will provide detailed technical assessments in phase reports/work plan modifications.

4.2 Phase Reports/Work Plan Modifications

The Laboratory will submit phase reports/work plan modifications for work conducted on aggregates of SWMUs or on individual SWMUs. These documents will function as interim reports on portions of the RFI because this work plan addresses too many SWMUs to include every one in each interim report, and the five-year time frame required for completion of RFI field work is not long enough to finish all investigations at once. In other words, these phase reports will serve as partial RFI Phase I reports summarizing the results of initial site characterization activities, and as partial RFI Phase II work plans describing the follow-up activities being planned (including any modifications to field-sampling plans suggested by initial findings).

The standard outline for a phase report/work plan modification is given in Table I-5. This outline may be modified as needed for a given phase report/work plan modification.

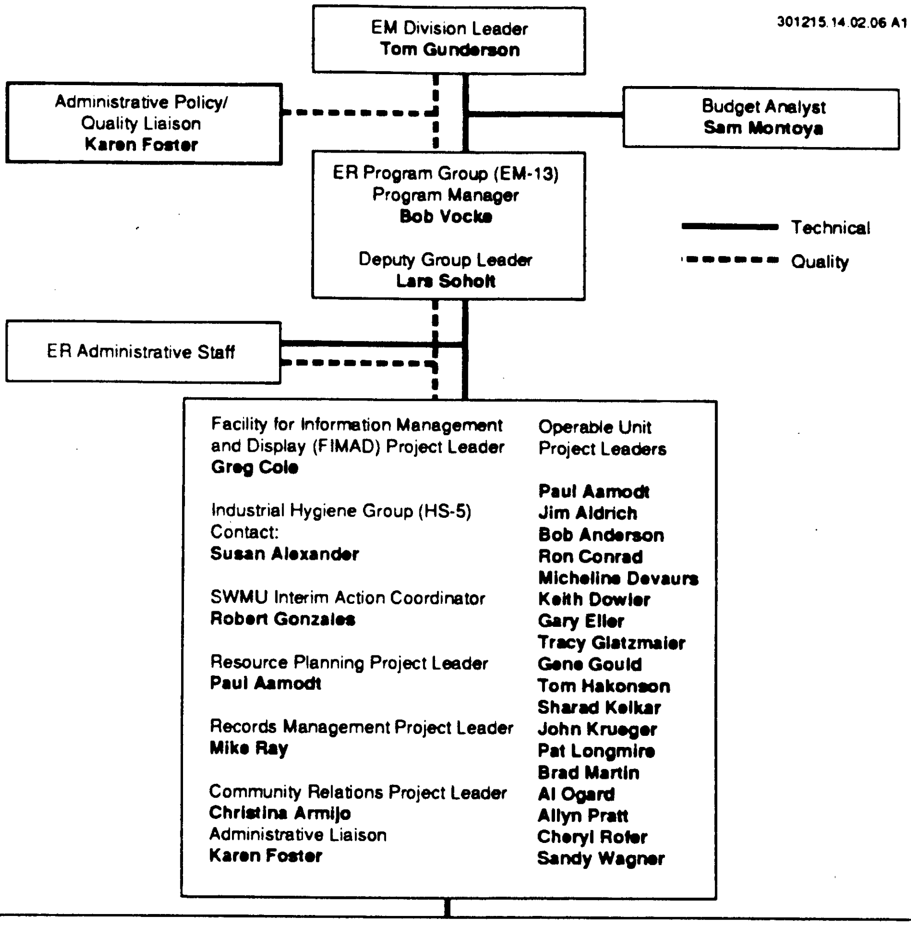
The RFI report will summarize all field work conducted during its five-year duration. As required by the HSWA Module of the Laboratory's RCRA Facility Permit (Task V, D, Page 46), the Laboratory will submit an RFI report within 60 days of completion of the RFI. As stated in IWP Chapter 3.5.3 (LANL 1991, 0553), the RFI Report will describe the procedures, methods, and results of field investigations, and will include information on type and extent of contamination, sources and migration pathways, and actual and potential receptors. The report will also contain adequate information to support the petition of no further action (NFA) sites and corrective action decisions.

5.0 ORGANIZATION

The organizational structure for the ER Program is presented in Chapter 2 of the Laboratory ER Program Quality Program Plan (QPP) (Annex II of the IWP, LANL 1991, 0553). The QPP identifies ER Program personnel down to the Technical Team Leader and OU Project Leader level in Figure II-1, which is reproduced here as Figure I-3. Chapter 2 of the QPP identifies line authority and personnel responsibilities for each position identified in the figure.

TABLE I-5 OUTLINE OF PHASE REPORTS/WORK PLAN MODIFICATION

1. Executive Summary
2. Introduction
3. SWMU Descriptions
4. Summary of Investigation
5. Methods and Procedures
    - 5.1 Data Quality Summary
    - 5.2 Source Term
    - 5.3 Nature and Extent of Contamination
    - 5.4 Contaminant Migration
6. Subsequent Investigation Sampling Plans
7. Permit Modification



Technical Teams	Groups/Divisions **(Proposed Lead Group)**	Technical Team Leader	QA Representative	ER Program Office Tech. Team Coord.
Air Quality	**EM-8**, EES-5	Craig Eberhart	Lars Soholt	Lars Soholt
Applied Analytical Chemistry Instrumentation and Methods Development	**EM**, A, CLS, EES, ENG, INC, M, N, NMT, AET	Harry Ettinger	Harry Ettinger	Sandy Wagner
Community Relations	**PA-3**, -1	TBD	TBD	TBD
Corrective Meas. Implem. and Remediation	**ENG**, EM-7	Bill Foley	Lars Soholt	Lars Soholt
Decision Analysis and Cost Benefit	**A-1**, -4	Elizabeth Kelly	Kathy Campbell	Micheline Devaurs
Document Preparation	IS-9, 11, 12	Betsy Barnett	Karen Foster	Lars Soholt
Drilling/Borehole Geophys. Logging/Curation	**EES**, EM	Sue Goff	Paul Aamodt	Paul Aamodt
Engineering	**ENG**, MEE	Bill Foley	Paul Aamodt	Paul Aamodt
Environmental Assessment	EM-8, EES-2	Doris Garvey	Doris Garvey	Paul Aamodt
FIMAD	**EES**	Greg Cole	Greg Cole	Greg Cole
Framework Studies	**EES**, EM, INC	Jamie Gardner	Jamie Gardner	Micheline Devaurs
Geochemistry	**INC**, CLS, EES	Clarence Duffy	Terry Morgan	Sandy Wagner
Health and Safety	**EM-13**, HS-1, 2, 3, EM-8	Susan Alexander	Susan Alexander	Lars Soholt
Hydrology	**EES**, EM-8	Bruce Gallaher	Bruce Gallaher	Micheline Devaurs
Mixed-Waste Storage and Disposal Facility	**MEE**, ENG, EM-7	Dean Nelson	Don York	Paul Aamodt
Planning/Scheduling/Cost Estimating/Rptg.	EM-13, MEE-4, contractors	Don York	Don York	Bob Vocke
Quality Assurance	**EM-13**, MEE-9	Karen Foster	Karen Foster	Lars Soholt
Records Management	EM-13	Mike Ray	Mike Ray	Mike Ray
Regulatory Compliance	EM-8	Dave McInroy	Dave McInroy	John Krueger
Risk Assessment	**EM**, EES, A, UC Los Angeles	Ted Norris	Ted Norris	Ted Norris
Site Assessment and Remediation Technologies Development	**EM**, A, CLS, EES, ENG, INC, M, N, NMT, AET	Harry Ettinger	Harry Ettinger	Paul Aamodt
SWMU Review and Interim Rem. Actions	**EM-8**, EM-13, HS-3	Philip Fresquez	Mary Salisbury	Robert Gonzales
Statistics and Data Quality Objectives	**A-1**	Kathy Campbell	Kathy Campbell	Micheline Devaurs

Figure I-3. Organization of the Environmental Restoration Program at Los Alamos National Laboratory.

Figure I-4 is a work organization chart showing responsibilities for implementation of the OU 1079 Work Plan. Specific personnel who will act in these roles for OU 1079 are identified in Table I-6. The following is a discussion of the responsibilities associated with the positions identified in Figure I-4.

5.1 Operable Unit Project Leader

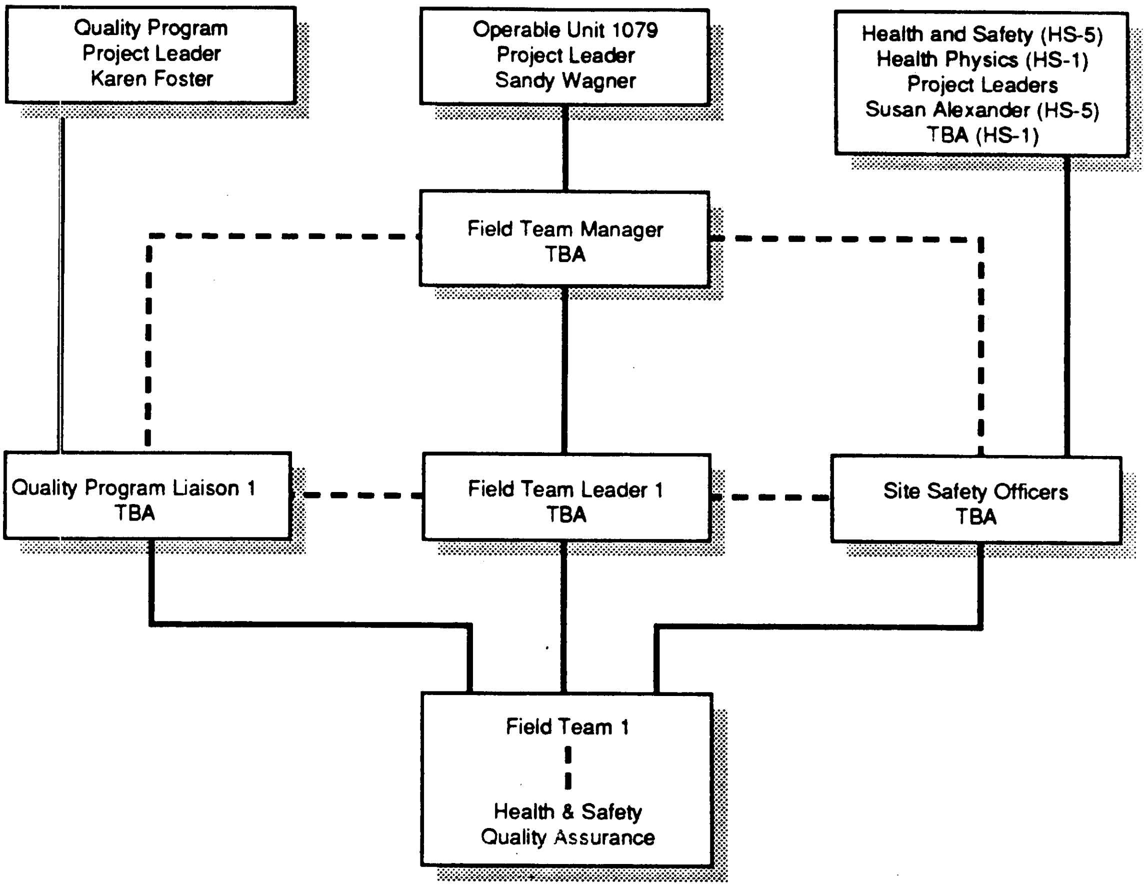
The Operable Unit Project Leader (OUPL) reports to the ER Program Group Program Manager. The OUPL will

- oversee day-to-day operations, including planning, scheduling, and reporting technical and related administrative activities;
- ensure preparation of planning documents and procedures for scientific investigations;
- prepare monthly and quarterly reports;
- oversee subcontractors, as necessary;
- coordinate with technical team leaders;
- conduct technical reviews of milestones and final reports;
- interface with the University of California (UC) Quality Programs Project Leader (QPPL) to resolve quality concerns and to coordinate audits;
- ensure compliance with the ER Program health and safety, community relations, and records management plans; and
- ensure compliance with the technical and QA requirements of the Laboratory's ER Program.

5.2 Health and Safety/Health Physics Project Leaders

The Health and Safety/Health Physics Project Leaders report to the Health and Safety Division Leaders. The Health and Safety/Health Physics Project Leaders will

- prepare the ER health and safety program and ensure its implementation;
- review OU-specific health and safety plans prepared by subcontractor or UC personnel;
- coordinate with Laboratory personnel to use resources as appropriate for the ER health and safety program;



▬▬ Authority

▬ ▬ ▬ Communication

TBA = To Be Announced

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Figure I-4. OU 1079 field work organization chart showing health and safety and quality assurance responsibility.

TABLE 1-6
OU 1079 RFI PERSONNEL[a]

Operable Unit Project Leader	Sandra Wagner, EM-13
Assistant to OUPL	TBD[b]
Field Teams Manager	TBD[b]
Field Team Leaders	TBD[b]
Field Team Members	TBD[b]
Technical Team Members	TBD[b] (geology)
	TBD[b] (statistics)
	TBD[b] (radiation ecology)
	TBD[b] (hydrology)
	TBD[b] (geochemistry)

[a] Current as of May 1, 1992. All personnel are located at the Laboratory, unless otherwise indicated. Note that additional laboratory and contractor personnel will be added as needed to implement the RFI.

[b] TBD - To Be Determined.

- ensure that the ER Program complies with applicable environmental regulations, DOE orders, Laboratory requirements, and applicable state regulations;
- oversee the maintenance of the health and safety data base for the ER Program in such areas as worker training and medical surveillance; and
- prepare monthly and quarterly reports.

5.3 Quality Program Project Leader

The QPPL is responsible for directing and managing the Laboratory's ER quality program. The QPPL operates independently of the cost and schedule of project management. The QPPL is not assigned duties that preclude full attention to QA responsibilities or that conflict with the reporting and resulting of QA issues. The QPPL reports to the ER Program Manager on day-to-day activities and to the Environmental Management deputy division leader when necessary to resolve QA issues. The QPPL will

- ensure that the adequacy and effectiveness of the ER quality program are evaluated by independent organizations;
- ensure that UC and its subcontractors implement the ER quality program;
- resolve disputes regarding quality;
- oversee a QA staff;
- assist project leaders in the development of QAPjPs;
- review and approve all ER QA programs and project plans and implement procedures;
- ensure that QA audits are conducted; and
- serve as liaison between the Laboratory's ER QA program and EPA's regional QA office.

5.4 Field Team Manager

The Field Team Manager reports to the OUPL. The Field Team Manager will

- oversee day-to-day field operations of all field teams;
- ensure the health and safety of all field team members;

- conduct planning and scheduling for implementation of the RFI field activities for all field teams; and
- manage and assign work to Field Team Leaders (FTLs).

5.5 Field Team Leader

The Field Team Leader (FTL) will report to the Field Team Manager. The FTL is responsible for directing the execution of field sampling activities using crews of Field Team Members appropriate for the activity. The FTL is responsible for implementing the Health and Safety Project Plan (HSPjP), and the project-specific Quality Assurance Project Plan (QAPjP). FTLs may be contractors. The FTL will

- oversee daily field operations for the Field Team including planning, scheduling, and implementing RFI field activities for the OU 1079 Work Plan;
- assign a Site Safety Officer (SSO) to ensure compliance with the HSPjP;
- be familiar with emergency response procedures and notification requirements and their implementation;
- act as back-up to the SSO in an emergency; and
- coordinate with Field and Technical Team Members which may include sampling personnel, a SSO, Laboratory personnel, contractors, and staff members with technical knowledge of geology, hydrology, statistics, and other applicable disciplines.

5.6 Site Safety Officer

The Site Safety Officer (SSO) reports to the Health and Safety/Health Physics Project Leaders, and acts as a liaison to the Field Team Manager and the FTL on health and safety issues. The SSO will ensure that the ER Program Work Plan is implemented during the field operations. Each SSO will direct a Field Team Leader in executing site safety procedures. SSOs may be contractors.

The SSO will be trained in first aid procedures and in cardiopulmonary resuscitation (CPR) and will ensure that first aid supplies are available at the site. The SSO will know the locations of facilities for emergency medical care, including those for injuries that might involve contamination by radioactive material or hazardous chemicals. The SSO will

- perform and document initial inspections for all on-site equipment;
- evaluate the potential hazards at a site;

- be informed about the results of sample analysis pertaining to health and safety as the ER site investigation and remediation work progresses;
- concur with the FTLs about the location of exclusion area boundaries;
- present safety briefing to workers;
- determine protective clothing requirements for workers;
- determine personal dosimetry requirements for workers;
- maintain a current list of telephone numbers for emergency situations;
- have an operating radio transmitter/receiver in case telephone service is not available;
- maintain an up-to-date copy of the HSPjP for work at the site;
- maintain an up-to-date copy of the emergency plan and procedures for the site;
- establish the safety requirements to be followed by visitors;
- provide visitors with a safety briefing;
- maintain a logbook of workers and visitors within the exclusion area at a site;
- determine whether works can perform their job safely under prevailing weather conditions;
- take control of an emergency situation;
- ensure that all personnel have been trained in the appropriate safety procedures and have read and understood this OU HSPjP, and that all requirements are followed during OU activities;
- conduct daily health and safety briefings for the FTLs and Field Team Members;
- conduct daily health and safety audits of the work activities; and
- have authority and require that field work be terminated if unsafe conditions develop or an imminent hazard is perceived.

5.7 Quality Program Liaison

The Quality Program Liaison reports to the QPPL on day-to-day activities. The Quality Program Liaison will ensure that the ER Quality Program, the Generic QAPjP, and the OU 1079 QAPjP are followed during field operations. Each Quality Program Liaison will act as a liaison between the FTL and the QPPL when executing site quality procedures. Quality Program Liaisons may be contractors.

5.8 Field and Technical Team Members

Field and Technical Team Members report to the FTLs, SSOs, and Quality Program Liaisons, as applicable. Field Team Members are responsible for conducting the assigned work in a manner that ensures that the data collected are technically valid and legally defensible. All field teams will have, at a minimum, a SSO and a qualified field sampler. Teams are responsible for conducting the work detailed in the sampling and analysis plans and are under the direction of the FTLs. Field team members may be contractors.

Technical Team Members are responsible for providing technical input for their discipline throughout the RFI/CMS process. During the OU 1079 RFI, they have participated in the development of the work plan and may participate in field work, data analysis, report preparation, work plan modifications, and planning of subsequent investigations as necessary. The primary disciplines currently represented on the OU 1079 technical team are hydrogeology, statistics, geochemistry, and health physics. The composition of the technical team may change with time as the technical expertise needed to implement the OU 1079 RFI changes.

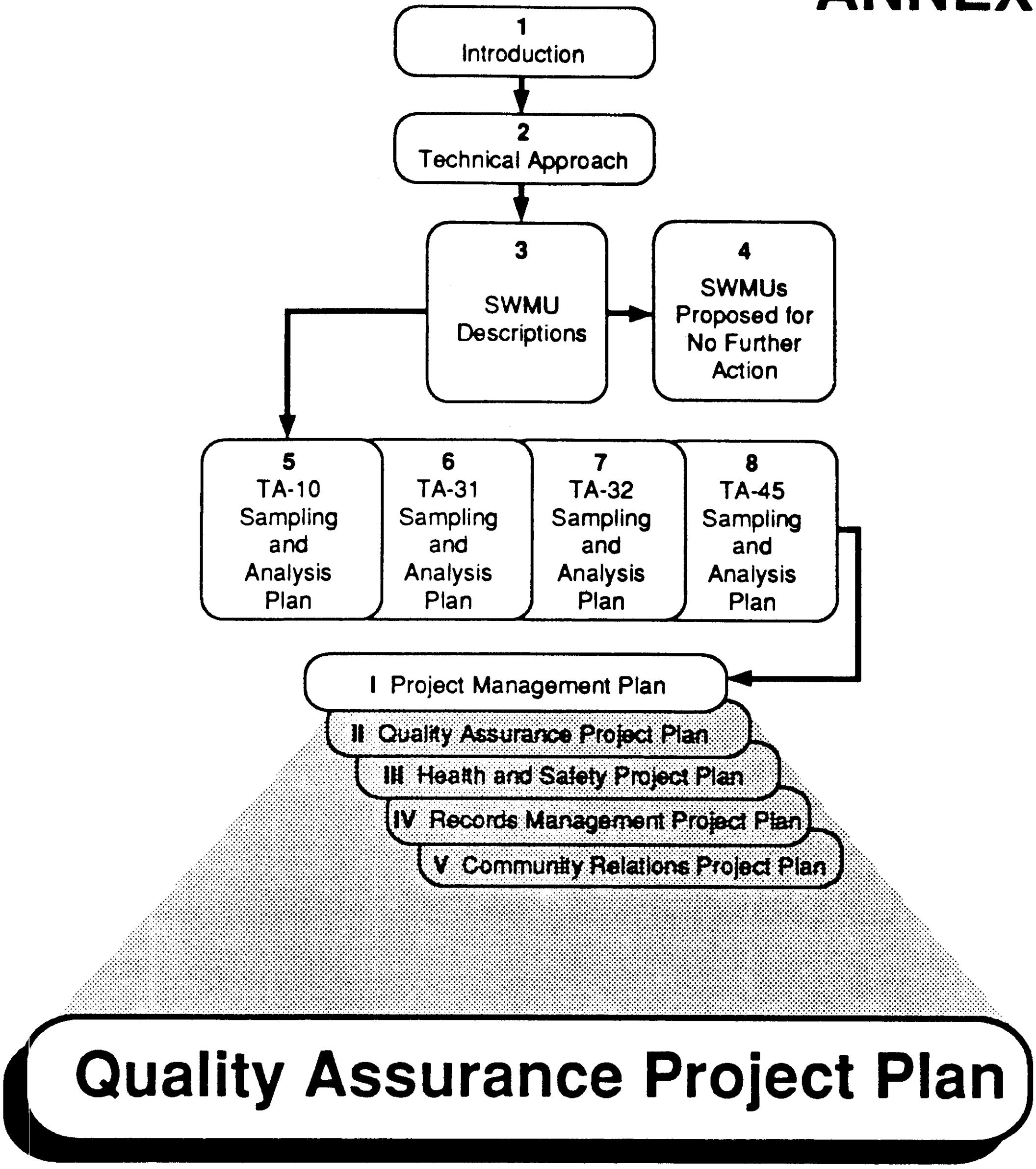
REFERENCES

EPA (U.S. Environmental Protection Agency) 1990. RCRA Permit No. NM0890010515, EPA Region VI, issued to Los Alamos National Laboratory, Los Alamos, New Mexico, effective May 23, 1990, Dallas, Texas. **(EPA 1990, 0306).**

LANL (Los Alamos National Laboratory) November 1991. "Installation Work Plan for Environmental Restoration," Los Alamos National Laboratory Report LA-UR-91-3310, Los Alamos, New Mexico. **(LANL 1991, 0553).**

LANL (Los Alamos National Laboratory), February 12, 1992. "OU 1079 Activity Data Sheet, FY92, Baseline & Outyear Plan," Los Alamos National Laboratory Report, Los Alamos, New Mexico. **(LANL 1992, 06-0065).**

ANNEX II



Quality Assurance Project Plan

1.0 APPROVAL FOR IMPLEMENTATION

1. NAME: Robert Vocke
TITLE: ER Program Manager (EM-13), Los Alamos National Laboratory

SIGNATURE: ______________________ DATE: ____________

2. NAME: Karen Foster
TITLE: Quality Assurance Project Leader, ER Program (EM-13), Los Alamos National Laboratory

SIGNATURE: ______________________ DATE: ____________

3. NAME: Craig Leasure
TITLE: Group Leader, Environmental Chemistry Group (EM-9), Los Alamos National Laboratory

SIGNATURE: ______________________ DATE: ____________

4. NAME: Margaret Gautier
TITLE: Quality Assurance Officer, Environmental Chemistry Group (EM-9), Los Alamos National Laboratory

SIGNATURE: ______________________ DATE: ____________

5. NAME: Sandy Wagner
TITLE: Project Leader, ER Program (EM-13), Los Alamos National Laboratory

SIGNATURE: ______________________ DATE: ____________

6. NAME: Charles Ritchey
TITLE: Acting Chief of Office of Quality Assurance, Region VI, Environmental Protection Agency

SIGNATURE: ______________________ DATE: ____________

TABLE OF CONTENTS

3.0 PROJECT DESCRIPTION

3.1 Introduction

This Operable Unit (OU) 1079 RCRA Facility Investigation (RFI) Quality Assurance Project Plan (QAPjP) is tiered to the Los Alamos National Laboratory (the Laboratory) Environmental Restoration (ER) Programs Generic QAPjP for RCRA Facility Investigations (LANL 1991, 0412). Information that is specific to the OU 1079 RFI QAPjP, or presented elsewhere, has been referenced to that document chapter. This QAPjP has been prepared as an exceptions document; i.e., only those areas that deviate from the generic QAPjP have been described in detail in this QAPjP. Chapters 5 through 8 of this work plan describe the OU 1079 RFI Data Quality Objectives (DQOs) and field sampling tasks. The section titles and numbers in this QAPjP correspond directly with those contained in the Generic QAPjP for the Laboratory ER Program to facilitate referencing between documents.

This QAPjP integrates the Environmental Protection Agency (EPA) 16-point Quality Assurance Management Staff (QAMS)-005/80 guidance (EPA 1980, 0552), as well as the American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ANSI/ASME 1989, 0018) Nuclear Quality Assurance (NQA)-1-1989 edition of "Quality Assurance (QA) Program Requirements for Nuclear Facilities" (ASME 1989), as specified in Department of Energy (DOE) Order 5700.6C. The integration of these programs is described in Section 3.0, Quality Assurance Program, of the Laboratory's ER Quality Program Plan (QPP), which was published as Annex II of the Laboratory's Installation Work Plan (IWP) (LANL 1991, 0553).

3.2 Facility Description

A facility description of the Laboratory is presented in Chapter 2 of the IWP (LANL 1991, 0553). Chapter 3 of this work plan presents specific historical information regarding the sites comprising OU 1079.

3.3 Environmental Restoration Program

A description of the Laboratory's ER Program is presented in Chapter 3 of the IWP (LANL 1991, 0553).

3.4 Project Description

3.4.1 Project Objectives

Project objectives are outlined in Chapter 2 of this work plan.

3.4.2 Project Schedule

Project activity dates are presented in Annex I, Project Management Plan, of this work plan.

3.4.3 Project Scope

Project scope is presented in Chapter 2 of this work plan.

3.4.4 Background Information

Background information is presented in Chapters 3 and 4 of this work plan.

3.4.5 Records Management

Annex IV of this work plan provides an overview of important aspects of data management for OU 1079. Data collected during the RFI will be input into the Facility for Information Management, Analysis and Display (FIMAD), following ER Records Management Administrative Procedure (AP)-02.1, and then analyzed. Investigators will use the data to define the nature and extent of contamination at Solid Waste Management Units (SWMUs) or SWMU Aggregates, as detailed in the sampling and analysis plans in Chapters 5, 6, 7, and 8 of this work plan.

4.0 PROJECT ORGANIZATION AND RESPONSIBILITY

The overall organizational structure of the ER Program is presented in Annex II, Section 2.0 of the IWP (LANL 1991, 0553) in which ER Program personnel are identified to the Technical Team Leader (TTL) and OU Project Leader (PL) level, and personnel responsibilities and line authority are detailed. In addition, the QA organizational structure is presented and personnel qualifications are detailed.

Detailed information pertinent to the management organization for the OU 1079 RFI is provided in Annex I. Records of qualifications and training of personnel performing OU 1079 RFI field work will be kept as ER records and can be obtained from the FIMAD. Refer to the Records Management Project Plan, Annex IV, for detailed information on the management of OU 1079 ER Records. Additional information on general personnel responsibilities is also in the Project Management Plan, Annex I.

QA responsibilities for the OU 1079 PL are as follows:

- oversees daily operations, including planning, scheduling, and reporting on various aspects of ER Program implementation;

- ensures preparation of scientific-investigation-planning documents and procedures;
- prepares monthly and quarterly reports for the Program Manager (PM);
- oversees subcontractors, as appropriate;
- coordinates with TTLs;
- conducts technical reviews of the milestones and final reports;
- interfaces with ER Quality Program Project Leader (QPPL) to resolve quality concerns and to coordinate with the QA staff for audits;
- complies with the Laboratory ER Program health and safety, field sampling, and records management procedures;
- oversees RFI field work and manages the Field Team Leader (FTL); and
- complies with the technical and QA requirements for the Laboratory ER Program.

QA responsibilities for the OU 1079 FTL are as follows:

- oversees daily field operations including planning, scheduling, and implementing RFI field activities of the OU 1079 Work Plan; and
- manages field team members, who, depending upon the sampling activity being conducted, include sampling personnel, a Site Safety Officer (SSO), and staff members with technical knowledge of geology, hydrology, statistics, and other applicable disciplines.

5.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA IN TERMS OF PRECISION, ACCURACY, REPRESENTATIVENESS, COMPLETENESS, AND COMPARABILITY

5.1 Level of Quality Control

5.1.1 Field Sampling

A discussion of quality control (QC) samples for the ER Program is presented in Subsections 5.1 and 6.1, and depicted on Table V.1 of the Generic QAPjP (LANL 1991, 0412). Refer to Section 6.0 of the Generic QAPjP, Field Sampling and Analysis Plans, and to the Laboratory ER Program Standard Operating Procedure (SOP)-01.05, "Field Quality Control Samples," for details on the appropriate QC sample requirements (LANL 1991, 0688).

Soil samples for geotechnical analyses may be collected during the OU 1079 RFI. These analyses will use conventional laboratory procedures specified by the American Society for Testing and Materials (ASTM). Many of these procedures are detailed by the SOPs. In contrast to samples submitted for chemical analyses, field quality control samples are not routinely associated with geotechnical samples.

5.1.2 Field Measurements

The quality control level for field measurements performed during the OU 1079 RFI will follow the recommendations presented in Subsection 5.1.2 of the Generic QAPjP (LANL 1991, 0412).

5.1.3 Analytical Laboratory

The quality control level for Laboratory analysis for the OU 1079 RFI will follow the recommended frequency specified by EPA and presented in Table V.2 of Subsection 5.1.3 of the Generic QAPjP (LANL 1991, 0412).

5.2 Precision, Accuracy, and Sensitivity of Analyses

The quality control acceptance criteria for Laboratory analysis for precision, accuracy, and sensitivity of analyses for the OU 1079 RFI will use the methods and detection limits specified for EPA and DOE, presented in the Generic QAPjP, particularly in Subsection 5.2 (LANL 1991, 0412), and in the following tables:

- Table V.3 for volatile organic compounds;
- Table V.4 for semivolatiles;
- Tables V.5 and V.6 for polychlorinated biphenyls (PCBs) and pesticides;
- Table V.7 for inorganics;
- Table V.8 for radionuclides; and
- Table V.9 for miscellaneous analytes.

Any specific analyte identified in the tables listed above may be included in the RFI at OU 1079.

5.3 Quality Assurance Objectives for Precision

The QA objectives for precision of laboratory matrix spike analyses for OU 1079 RFI samples will follow the EPA guidance specified in Section 5.3 and Table V.11 of the Generic QAPjP (LANL 1991, 0412).

5.4 Quality Assurance Objectives for Accuracy

The QA objectives for accuracy of laboratory analyses for OU 1079 RFI samples will follow the EPA guidance specified in Subsection 5.4 and Tables V.11 and V.12 of the Generic QAPjP (LANL 1991, 0412).

5.5 Representativeness, Completeness, and Comparability

The sampling and analysis plans in Chapters 5 through 8 of this work plan were developed to meet the sample representativeness criteria described in Subsection 14.3 of the Generic QAPjP (LANL 1991, 0412).

Completeness of analytical data from the OU 1079 RFI will be calculated according to the formula presented in Subsection 14.4 of the Generic QAPjP (LANL 1991, 0412). The quality assurance objective for analytical data completeness for the Laboratory ER Program is 90%, which is also the objective for the OU 1079 RFI.

Data comparability for the OU 1079 RFI will be achieved through the use of standard sampling and analytical techniques. Sampling will be performed according to Laboratory ER Program SOPs (LANL 1992, 0688). Sample analyses will be performed according to analytical methods referenced in the Generic QAPjP. Data results will be reported in appropriate units consistent with existing site data and applicable regulatory levels.

5.6 Field Measurements

Field measurements for the OU 1079 RFI will be performed according to the Field Screening Techniques procedure (Section 10.0) described in Laboratory ER Program SOPs (LANL 1992, 0688). Adherence to the SOPs will ensure the accuracy, precision, and completeness of field measurement data.

5.7 Data Quality Objectives

DQO elements and developmental processes are covered in Chapters 5 through 8 of this work plan and in the Generic QAPjP (LANL 1991, 0412).

DQOs and the development process for the OU 1079 RFI are described in Chapter 2 of this work plan. Data analysis, interpretation, statistical representativeness, applicability to conceptual models, and specific objectives for each SWMU or SWMU Aggregate are discussed in Chapters 5 through 8 of this work plan.

OU 1079 RFI budget and schedule information relative to anticipated field and laboratory activities is presented in Annex I of this work plan.

6.0 SAMPLING PROCEDURES

Procedures for collecting soil and aqueous samples will be selected, as applicable to the field investigation, from the Laboratory ER Program SOP Section 6.0, "Sampling Techniques" (LANL 1992, 0688). A general description of all the field investigations is presented in Chapters 5 through 8 of this work plan.

Information on required sample containers, volume, preservation, and holding times is presented in Laboratory ER Program SOP-01.02, "Sample Containers and Preservation," (LANL 1992, 0688) and in Section 6.0 of the Generic QAPjP (LANL 1991, 0412).

The collection, management, and handling of ER Program environmental media samples is detailed in Laboratory ER Program SOP-01.04, "Sample Control and Field Documentation," and SOP-01.03, "Handling, Packaging, and Shipping of Samples" (LANL 1992, 0688). Also refer to Section 6.0 and Subsection 7.5 of the Generic QAPjP (LANL 1991, 0412) for additional information on proper sample management and coordination.

6.1 Quality Control Samples

A discussion of quality control samples for the ER Program is presented in Subsection 6.1 of the Generic QAPjP (LANL 1991, 0412) and Laboratory ER Program SOP-01.05, "Field Quality Control Samples" (LANL 1992, 0688). For chemical analyses of samples during the OU 1079 RFI, investigators will use the type of field quality control samples at the same frequency as identified in the Generic QAPjP (LANL 1991, 0412).

Soil samples for geotechnical analyses may be collected during the OU 1079 RFI. In contrast to samples submitted for chemical analyses, field quality control samples are not routinely associated with geotechnical samples. Quality control for geotechnical sample analysis results is prescribed in the specific laboratory procedure. An additional measure of quality control for geotechnical samples is achieved by the collection and submittal to the laboratory of a larger-than-sufficient volume of sample. A large sample volume may provide for reanalysis of an individual sample in the event that results from the initial aliquot did not meet specific method requirements.

6.2 Sample Preservation During Shipment

Information on sample preservation during shipment is presented in the Laboratory ER Program SOP-01.02 (LANL 1992, 0688) and in Subsection 6.2 of the Generic QAPjP (LANL 1991, 0412).

6.3 Equipment Decontamination

Equipment decontamination is described in Subsection 6.3 of the Generic QAPjP (LANL 1991, 0412). The Laboratory ER Program SOP-01.06, "Management of RFI-Generated Waste," provides information for proper handling and disposition of wash water and other materials generated during equipment decontamination and other RFI field activities (LANL 1992, 0688).

6.4 Sample Designation

Samples will be assigned a unique alphanumeric identifier to provide chain-of-custody control while they are being transferred from the time of collection through analysis and reporting. This information is detailed in the Laboratory ER Program SOP-01.04 (LANL 1992, 0688).

7.0 SAMPLE CUSTODY

7.1 Overview

Field and laboratory sample chain-of-custody procedures are described in Section 7.0 of the Generic QAPjP (LANL 1991, 0412). Sampling activities during the OU 1079 RFI will follow those procedures. The Laboratory ER Program SOP-01.04 also provides guidance for chain-of-custody procedures, including examples of chain-of-custody records and tags (LANL 1992, 0688).

7.2 Field Documentation

A sample numbering system developed for the Laboratory ER Program uniquely identifies each boring location, monitor well, and collected sample. The numbering system, including identifiers for standard samples, identifiers for quality control samples, and the code for the system, is detailed in the Laboratory ER Program SOP-01.04 (LANL 1992, 0688).

Subsection 7.2 of the Generic QAPjP provides sample documentation guidance for field personnel involved with sample collection (LANL 1991, 0412). All sampling activities conducted during the OU 1079 RFI will follow the Laboratory ER Program numbering system. The OU 1079 FTL or a technical reviewer designee will review all field data collection forms before submitting them to the Laboratory ER Records Processing Facility. The person originating the entry and the OU 1079 FTL or a technical reviewer designee will cross out with a single line, sign, and date incorrect entries.

7.3 Sample Control Facility

Subsection 7.3 of the Generic QAPjP provides a discussion of the ER Program activities coordinated by the Laboratory ER Program's Sample Coordination Facility (SCF) (LANL 1991, 0412). The OU 1079 RFI effort will accomplish the described activities.

7.4 Laboratory Documentation

Laboratory custody procedures associated with sample receipt, storage, preparation, analysis, and general security are described in Subsection 7.4 of the Laboratory ER Program Generic QAPjP (LANL 1991, 0412). All laboratories participating in chemical analysis of samples generated during the OU 1079 RFI will follow those procedures. Laboratories providing radiological and geotechnical analyses of OU 1079 RFI samples will also follow chain-of-custody and record-keeping procedures as described in Subsection 7.4 of the Generic QAPjP (LANL 1991, 0412). Sample storage will be in accordance with requirements described in the analysis procedure or in the Laboratory's QA Plan. Sample tracking will be in accordance with requirements described in the QA plan for the Laboratory.

Acquisition of appropriate QA manuals for all OU 1079 RFI participating laboratories, including the Laboratory's Health and Environmental Chemistry Group (EM-9) in the Environmental Management (EM) Division, is the responsibility of the Laboratory SCF.

7.5 Sample Handling, Packaging, and Shipping

Sample handling, packaging, and shipping procedures are referenced in Subsection 7.5 of the Generic QAPjP (LANL 1991, 0412) and in the Laboratory ER Program SOP-01.03 (LANL 1992, 0688).

7.6 Final-Evidence File Documentation

Final-evidence file documentation is described in Subsection 7.6 of the Generic QAPjP (LANL 1991, 0412) and in the Records Management Program Plan, Annex IV, of the IWP (LANL 1991, 0553).

OU 1079 RFI activities will follow the ER Program-wide procedures outlined in Subsection 7.6 of the Generic QAPjP (LANL 1991, 0412) and in Annex IV of this work plan.

8.0 CALIBRATION PROCEDURES AND FREQUENCY

8.1 Overview

Section 8.0 of the Generic QAPjP contains information on the calibration procedures and frequency of calibration for field and laboratory equipment (LANL 1991, 0412).

8.2 Field Equipment

A list of analytical and health and safety screening procedures that may be used in the field during environmental investigations is presented in Appendix L of the IWP (LANL 1991, 0553).

Field instruments will be calibrated, daily if necessary, according to manufacturer's specifications before and after each field use.

Maintenance and calibration records will be maintained for each field instrument used as part of environmental investigations at the Laboratory. Tracking of instrument records will be accomplished by assigning a unique number to each instrument that will correspond to its record file.

8.3 Laboratory Equipment

Subsection 8.3 of the Laboratory ER Program Generic QAPjP (LANL 1991, 0412) contains general information on the calibration procedures and frequency of calibration for laboratory equipment. The Laboratory SCF is responsible for acquiring appropriate QA manuals that describe specific instrument calibration procedures for various analytical instruments for all OU 1079 participating laboratories, including Laboratory EM-9.

The Laboratory ER Program SOPs (LANL 1992, 0688) have been provided to EPA Region VI separately and are not attached to this QAPjP.

9.0 ANALYTICAL PROCEDURES

9.1 Overview

Investigators will perform field and laboratory analytical measurements for OU 1079 RFI samples according to the Laboratory ER Program SOPs.

9.2 Field Testing and Screening

Field testing and screening of samples during the OU 1079 RFI will follow the Laboratory ER Program SOP-06.02, "Field Analytical Measurements of Groundwater Samples" (LANL 1992, 0688).

9.3 Laboratory Methods

The analytical methods for aqueous and soil/sediment samples for the OU 1079 RFI are those presented in Subsection 9.3 of the Generic QAPjP. All of the analytical methods presented in the Generic QAPjP are applicable to the OU 1079 RFI, except for analytes appearing in Tables IX.1 and IX.2 of Section 9.0 (LANL 1991, 0412).

Additional QA/QC information for the methods applicable to this investigation is presented in Section 5.0 of this annex.

10.0 DATA REDUCTION, VALIDATION, AND REPORTING

10.1 Data Reduction

Field and laboratory data reduction for the OU 1079 RFI will follow the protocols described in Subsection 10.1 of the Generic QAPjP (LANL 1991, 0412).

10.2 Data Validation

Field- and laboratory-data validation for the OU 1079 RFI will follow the protocols described in Subsection 10.2 of the Generic QAPjP (LANL 1991, 0412).

10.3 Data Reporting

Subsection 10.3 of the Generic QAPjP (LANL 1991, 0412) described field- and laboratory-data reporting for the OU 1079 RFI.

11.0 INTERNAL QUALITY CONTROL CHECKS

11.1 Field Sampling Quality Control Checks

A discussion of field quality control samples for the ER Program is presented in Subsection 6.1 of the Generic QAPjP. For chemical analyses of samples during the OU 1079 RFI, investigators will use the type of field quality control samples at the same frequency as those identified in the Generic QAPjP (LANL 1991, 0412).

11.2 Laboratory Analytical Activities

The types and frequency of internal QC samples that apply to OU 1079 RFI laboratory activities will follow those that are presented in Subsection 11.2 of the Generic QAPjP (LANL 1991, 0412).

12.0 PERFORMANCE AND SYSTEM AUDITS

Performance and system audits for field and laboratory operations will be conducted during the OU 1079 RFI. These audits will be performed as identified and referenced in Section 12.0 of the Generic QAPjP (LANL 1991, 0412).

13.0 PREVENTIVE MAINTENANCE

13.1 Field Equipment

Preventive maintenance requirements for OU 1079 RFI field equipment will follow specifications described in Subsection 13.1 of the Generic QAPjP (LANL 1991, 0412). The checks required for each type of field equipment are detailed in the owner's manual for the equipment. The Laboratory's ER Program SOPs have been provided to EPA Region VI separately and are not attached to this QAPjP.

13.2 Laboratory Equipment

OU 1079 RFI preventive maintenance requirements for laboratory equipment will follow the specifications described in Subsection 13.2 of the Generic QAPjP (LANL 1991, 0412). The elements of the Laboratory EM-9 Environmental Chemistry laboratory preventive maintenance program are discussed in Sections 12.0 and 14.0 of the "Health and Environmental Chemistry Laboratory Quality Assurance Program Plan" (Gladney and Gautier 1991, 0410).

14.0 SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY, REPRESENTATIVENESS, AND COMPLETENESS

14.1 Precision

Analytical precision for OU 1079 RFI data will be calculated according to the formula presented in Subsection 14.1 of the Generic QAPjP (LANL 1991, 0412).

14.2 Accuracy

Analytical accuracy of OU 1079 RFI data will be calculated according to the formula presented in Subsection 14.2 of the Generic QAPjP (LANL 1991, 0412).

14.3 Sample Representativeness

The sampling and analysis plans in Chapters 5 through 8 of this work plan were developed to meet the sample representativeness criteria described in Subsection 14.3 of the Generic QAPjP (LANL 1991, 0412).

14.4 Completeness

Completeness of analytical data from the OU 1079 RFI will be calculated according to the formula presented in Subsection 14.4 of the Generic QAPjP (LANL 1991, 0412).

The QA objective for analytical data completeness for the Laboratory ER Program is 90%; this will also be the objective for the OU 1079 RFI.

15.0 CORRECTIVE ACTION

15.1 Overview

The procedures, reporting requirements, and authority for initiating corrective action during the OU 1079 RFI will follow those defined in Section 15.0 of the Generic QAPjP (LANL 1991, 0412) and in LANL-ER-QP-01.3Q, "Deficiency Reporting."

15.2 Field Corrective Action

Field corrective actions required during the OU 1079 RFI will follow the process defined in Subsection 15.2 of the Generic QAPjP.

15.3 Laboratory Corrective Action

Laboratory corrective actions required during the OU 1079 RFI will follow the process defined in Subsection 15.3 of the Generic QAPjP.

16.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

16.1 Field Quality Assurance Reports to Management

The OU 1079 FTL, or a designee, will provide a monthly progress report to the Laboratory's ER PL. This report will consist of the information identified in Subsection 16.1 of the Generic QAPjP.

16.2 Laboratory Quality Assurance Reports to Management

The Laboratory QA Reports identified in Subsection 16.2 of the Generic QAPjP will be prepared during the OU 1079 RFI.

16.3 Internal Management Quality Assurance Reports

Internal management QA Reports, identified in Subsection 16.3 of the Generic QAPjP, will be prepared during the OU 1079 RFI.

REFERENCES

ANSI/ASME (American National Standards Institute/American Society of Mechanical Engineers) 1989. "Quality Assurance Requirements for Nuclear Facilities," NQA-1-1989, 345 East 47th Street, New York, New York. **(ANSI/ASME 1989, 0018)**

EPA (U.S. Environmental Protection Agency), December 29, 1980. "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans," QAMS-005/80, Office of Monitoring Systems and Quality Assurance, Office of Research and Development, Washington, DC. **(EPA 1980, 0552)**

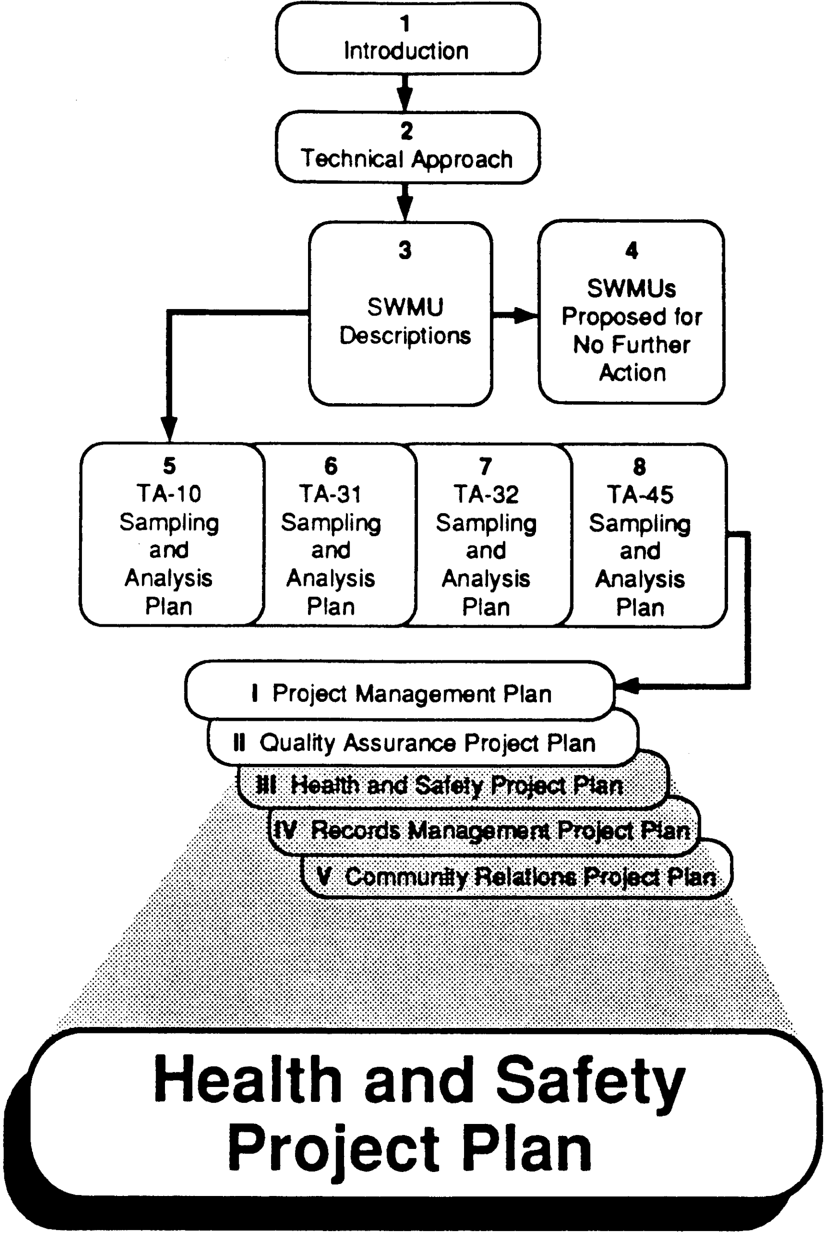
Gladney, E.S., and M.A. Gautier, January 1991. "Health and Environmental Chemistry Quality Assurance Program Plan," Los Alamos National Laboratory, Los Alamos, New Mexico. **(Gladney and Gautier 1991, 0410)**

LANL (Los Alamos National Laboratory), March 1992. "Environmental Restoration Standard Operating Procedures," Vols. I and II, Los Alamos, New Mexico. **(LANL 1992, 0688)**

LANL (Los Alamos National Laboratory), May 1991. "Generic Quality Assurance Project Plan," Rev. 0, Environmental Restoration Program, Los Alamos, New Mexico. **(LANL 1991, 0412)**

LANL (Los Alamos National Laboratory), November 1991. "Installation Work Plan for Environmental Restoration," Revision 1, Los Alamos National Laboratory Report LA-UR-91-3310, Los Alamos, New Mexico. **(LANL 1991, 0553)**

ANNEX III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1.0 INTRODUCTION

1.1 Purpose

This Health and Safety Project Plan (HSPjP) has been developed for the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) to be conducted within Operable Unit (OU) 1079. Implementation of this HSPjP, and the task specific health and safety plans which will be prepared prior to initiating field tasks, will lead to a safe environment for workers. This HSPjP and the task specific health and safety plans will establish health and safety procedures and guidelines for activities specified under the sampling and analysis plans for OU 1079 presented in Chapter 5 through 8 of this work plan. This HSPjP includes an assessment of hazards, provisions for personnel protection requirements, and emergency response procedures. Because personnel involved in field investigations have not been identified, only general responsibilities are described in this HSPjP. As field investigations progress, more effective measures for personnel protection may be identified than are presented here. Deviations from the HSPjP will be documented in the task-specific plan along with the reasons for that deviation. As changes are required, this plan will be updated.

The tasks specific health and safety plans will spell out the specific measures to be taken for personnel protection during implementation of the task and identify evacuation routes and relevant Material Safety Data Sheets. They will also define individual responsibilities for personnel protection during the field investigation.

This document is tiered to Annex III of the Los Alamos National Laboratory (the Laboratory) Installation Work Plan (IWP) (LANL 1991, 0553). Therefore, the IWP must accompany the field team during all operations of the sampling phase.

1.2 Organization of the Plan

This plan addresses all aspects of sampling conducted for the RFI. General responsibilities, as well as individual roles in the implementation of this HSPjP are provided in Section 2.0. The prerequisites for personnel involved in the OU investigation are outlined in Section 3.0. Brief descriptions of the scope of the OU 1079 RFI and the required sampling tasks are reviewed in Section 4.0. The assessment of hazards associated with the sampling tasks and the specific Solid Waste Management Units (SWMUs) are summarized in Section 5.0. To determine hazards requiring personnel protection, air monitoring will be performed during the sampling phase of the investigation, as prescribed in Section 6.0. Personnel protection will be accomplished by implementing a combination of engineering controls, work practices, and use of Personal Protective Equipment (PPE) on a task-specific basis. Personnel protection and safety requirements are discussed in Section 7.0. The delineation of work zones as well as provisions for site control are recommended in Section 8.0. Decontamination procedures for both personnel and equipment are presented in Section 9.0. The emergency response plan and requirements for notification and documentation are included in Section 10.0.

1.3 Basis for the Plan

In addition to the general guidance within the IWP, this HSPjP is based on Laboratory policies; the Laboratory's Environment, Safety, and Health (ES&H) Manual (LANL 1990, 0335); Department of Energy (DOE) orders; Occupational Safety and Health Administration (OSHA) regulations; National Institute for Occupational Safety and Health (NIOSH) recommendations; American Conference of Governmental Industrial Hygienists (ACGIH) recommendations; Nuclear Regulatory Commission (NRC) regulations; and Environmental Protection Agency (EPA) guidance. These regulations and guidelines have been established to protect workers on sites that contain hazardous and/or radioactive contaminants, and therefore apply to personnel engaged in the investigation of OU 1079. A listing of requirements governing this HSPjP is presented in Table III-1, Annex III, of the IWP (LANL 1991, 0553).

2.0 OU FIELD WORK ORGANIZATION

This section describes general responsibilities for health and safety prescribed by the Laboratory's Environmental Restoration (ER) Program, and the specific responsibilities of individuals implementing this HSPjP for the OU 1079 investigation. Included in this section is a listing of the roles within the field organization, an organizational chart, provisions for health and safety audits, and a mechanism for requesting variances from the HSPjP.

2.1 General Responsibilities

The Laboratory ES&H Manual delineates managers' and employees' responsibilities for conducting safe operations and providing for the safety of contract personnel and visitors. The general safety responsibilities are summarized in Section 5.0, Annex III, of the IWP (LANL 1991, 0553). Specific safety responsibilities for personnel involved in this OU investigation are listed in this section.

2.2 Individual Responsibilities

Both Laboratory employees and contractors have health and safety responsibilities for ER Program activities. Attachment III-1 is a field work organization chart depicting the responsibilities of the line organization.

2.2.1 Operable Unit Project Leader

The Operable Unit Project Leader (OUPL) reports to the ER Program Manager. The OUPL will

- oversee day-to-day operations, including planning, scheduling, and the reporting of technical and related administrative activities;
- ensure preparation of planning documents and procedures for scientific investigations;
- prepare monthly and quarterly reports;
- oversee subcontractors, as necessary;
- coordinate with technical team leaders;
- conduct technical reviews of milestones and final reports;
- interface with the University of California (UC) Quality Program Project Leader (QPPL) to resolve quality concerns and coordinate audits;
- ensure compliance with the ER Program health and safety, community relations, and records management plans; and
- ensure compliance with the technical and quality assurance (QA) requirements of the Laboratory's ER Program.

2.2.2 Health and Safety/Health Physics Project Leaders

The Health and Safety/Health Physics Project Leaders report to the Health and Safety Division Leaders. The Health and Safety/Health Physics Project Leaders will

- prepare the ER health and safety program and ensure its implementation;
- review OU-specific health and safety plans prepared by subcontractor or UC personnel;
- coordinate with Laboratory personnel to use resources as appropriate for the ER health and safety program;
- ensure that the ER Program complies with applicable environmental regulations, DOE orders, Laboratory requirements, and applicable state regulations;
- oversee the maintenance of the health and safety data base for the ER Program in such areas as worker training and medical surveillance; and
- prepare monthly and quarterly reports.

2.2.2 Quality Program Project Leader

The Quality Program Project Leader (QPPL) is responsible for directing and managing the Laboratory's ER quality program. The QPPL operates independently of the cost and schedule of project management. The QPPL is not assigned duties that preclude full attention to QA responsibilities or that conflict with the reporting and resolution of QA issues. The QPPL reports to the ER Program Manager on day-to-day activities and to the EM deputy division leader when necessary to resolve QA issues. The QPPL will

- ensure that the adequacy and effectiveness of the ER quality program are evaluated by independent organizations;
- ensure that UC and its subcontractors implement the ER quality program;
- resolve disputes regarding quality;
- oversee a QA staff;
- assist project leaders in the development of QAPjPs;
- review and approve all ER QA program and project plans and implement procedures;
- ensure that QA audits are conducted; and
- serve as a liaison between the Laboratory's ER QA program and EPA's regional QA office.

2.2.4 Field Team Manager

The Field Team Manager reports to the OUPL. The Field Team Manager will

- oversee day-to-day field operations of all field teams;
- ensure the health and safety of all field team members;
- conduct planning and scheduling for implementation of the RFI field activities for all field teams; and
- manage and assign work to Field Team Leaders (FTLs).

2.2.5 Field Team Leader

The FTL will report to the Field Team Manager. The FTL is responsible for directing the execution of field sampling activities using crews of field team members appropriate for the activity. The FTL is responsible for implementing the sampling and analysis plans, the HSPjP, and the project-specific Quality Assurance Project Plan (QAPjP) (Annex II of this work plan). FTLs may be contractors. The FTL will

- oversee daily field operations for the Field Team including planning, scheduling, and implementing RFI field activities for the OU 1079 Work Plan;
- assign a Site Safety Officer (SSO) to ensure compliance with the HSPjP;
- be familiar with emergency response procedures and notification requirements and their implementation;
- act as back-up to the SSO in an emergency; and
- coordinate with field and technical team members which may include sampling personnel, a SSO, Laboratory personnel, contractors, and staff members with technical knowledge of geology, hydrology, statistics, and other applicable disciplines.

2.2.6 Site Safety Officer

The SSO reports to the Health and Safety/Health Physics Project Leaders, and acts as a liaison to the Field Team Manager and the FTL on health and safety issues. The SSO will ensure that the OU 1079 Work Plan is implemented during the field operations. Each SSO will direct a Field Team Leader in executing site safety procedures. SSOs may be contractors.

The SSO will be trained in first aid procedures and in cardiopulmonary resuscitation (CPR), and will ensure that first aid supplies are available at the site. The SSO will know the location of facilities for emergency medical care, including those for injuries that might involve contamination by radioactive materials or hazardous chemicals. The SSO will

- perform and document initial inspections for all on-site equipment;
- evaluate the potential hazards at a site;
- be informed about the results of sample analysis pertaining to health and safety as the ER site investigation and remediation work progresses;
- concur with the FTL(s) about the location of exclusion area boundaries;

- present safety briefings to workers;
- determine protective clothing requirements for workers;
- determine personal dosimetry requirements for workers;
- maintain a current list of telephone numbers for emergency situations;
- have an operating radio transmitter/receiver in case telephone service is not available;
- maintain an up-to-date copy of the HSPjP for work at the site;
- maintain an up-to-date copy of the emergency plan and procedures for the site;
- establish the safety requirements to be followed by visitors;
- provide visitors with a safety briefing;
- maintain a logbook of workers and visitors within the exclusion area at a site;
- determine whether workers can perform their job safely under prevailing weather conditions;
- take control of an emergency situation;
- ensure that all personnel have been trained in the appropriate safety procedures and have read and understood this HSPjP, and that all requirements are followed during OU activities;
- conduct daily health and safety briefings for the FTLs and field team members;
- conduct daily health and safety audits of the work activities; and
- have authority and require that field work be terminated if unsafe conditions develop or an imminent hazard is perceived.

2.2.7 Quality Program Liaison

The Quality Program Liaison reports to the QPPL on day-to-day activities. The Quality Program Liaison will ensure that the ER Quality Program, the Generic QAPjP (LANL 1991, 0412), and the OU 1079 QAPjP (Annex II of this work plan) are followed during field operations. Each Quality Program Liaison will act as a liaison between the FTL and the QPPL when executing site quality procedures. Quality Program Liaisons may be contractors.

2.2.8 Field and Technical Team Members

Field and technical team members report to the FTLs, SSOs, and Quality Program Liaisons, as applicable. Field team members are responsible for conducting the assigned work in a manner that ensures that the data collected are technically valid and legally defensible. All field teams will have, at a minimum, a SSO and a qualified field sampler. Teams are responsible for conducting the work detailed in the sampling and analysis plans, and are under the direction of the FTLs. Field team members may be contractors.

Technical team members are responsible for providing technical input for their discipline throughout the RFI/CMS process. During the OU 1079 RFI, they have participated in the development of the work plan and the sampling and analysis plans, and will participate in field work, data analysis, report preparation, work plan modifications, and planning of subsequent investigations as necessary. The primary disciplines currently represented on the OU 1079 technical team are hydrogeology, statistics, geochemistry, and health physics. The composition of the technical team may change with time as the technical expertise needed to implement the OU 1079 RFI changes.

2.3 Health and Safety Audits

Health and safety audits will be performed during activities associated with this plan. The frequency of these audits will depend on the characteristics of the site and the equipment used.

The SSO will perform an audit of the work area daily, or as conditions change, and will document the audit on the Health and Safety Check List form (Attachment III-2). The SSO will work with the FTL to correct any deficiencies. The completed audit form should be retained at the work site and be available for inspection by the Environmental Management (EM) and Health and Safety (HS) divisions or other inspectors. In addition, OU readiness check lists must be completed before starting work.

The Laboratory EM and HS Divisions may also conduct health and safety audits separately or concurrently with the internal ER audits to ensure compliance with the Laboratory's ES&H Manual (LANL 1990, 0335).

2.4 Variances from Health and Safety Requirements

Where special conditions exist, the SSO may submit a written request for a variance from a specific health and safety plan requirement from the Health and Safety/Health Physics Project Leader. If the FTL and the Health and Safety/Health Physics Project Leader agree with the request, it will be reviewed by the OUPL or a designee. Higher levels of management may be consulted as appropriate. The Health and Safety/Health Physics Project Leader will evaluate the condition of the request and, if appropriate, grant a written variance specifying the conditions under which the requirements may be modified. The variance will become part of this HSPjP and will be documented in the task-specific health and safety plan.

3.0 PERSONNEL PREREQUISITES

This section describes the prerequisites for all personnel involved in site work for OU 1079. Further guidance is provided in Sections 10.0, 11.0, 12.0, and 13.0, Annex III, of the IWP (LANL 1991, 0553).

3.1 Training Requirements

The training requirements for ER Program workers at hazardous sites are established in Section 11.0, Annex III, of the IWP (LANL 1991, 0553). The requirements include health and safety training for hazardous waste sites, respiratory protection, radiation safety, and specialized areas such as CPR, first aid, and recognition of high explosive (HE) materials and ordnance.

All site workers must be trained according to Code of Federal Regulations Title 29 (29 CFR) Part 1910.120 before their initial assignment to any project. All site workers, including subcontractors, shall receive a minimum of 40 hours of training off site and a minimum of 3 days of actual field experience directly managed by a trained, experienced supervisor. All field team members will be provided with copies of all pertinent SOPs and briefed on their uses. Field team members, including subcontractors, whose work is limited to nonhazardous activities must complete 24 hours of off-site training and 8 hours of on-site training. All personnel assigned to Laboratory emergency response units/teams are required to participate in specialized emergency response training to demonstrate proficiency. Emergency Response training requirements are summarized in the Los Alamos National Laboratory Emergency Response Plan (LANL 1990, 0753).

The FTL must receive a minimum of 8 hours of additional training on program supervision. Each site worker must receive 8 hours of refresher training annually. Certification that the training has been completed shall be maintained with the project files. Subcontractors must provide certificates of training for the project files for all field team members assigned to the project. Records of training shall also be kept at the job site.

3.2 Employee Medical Surveillance Program

Field team members who are potentially exposed to hazardous materials during ER program investigations shall participate in a medical surveillance program provided by the Laboratory in accordance with 29 CFR Part 1910.120 and DOE Order 5480.8 (DOE 1987, 0731). According to 29 CFR Part 1910.120, a medical examination is required for all employees who are exposed or who may be exposed to substances at or greater than the established Permissible Exposure

Limits (PELs) for more than 30 days per year; for all employees who wear a respirator for 30 days or more per year; and for members of hazardous materials teams. Such examinations must occur

- before the employee begins the assignment to establish base-line conditions;
- at least every 12 months, unless the attending physician believes a longer interval (not greater than biennially) is appropriate;
- at termination of employment or reassignment to an area where the employee would not receive an examination within the next 6 months;
- upon notification that the employee has developed symptoms of exposure;
- upon the exposure of an unprotected employee; and
- at more frequent times, if the examining physician determines that an increased frequency is medically necessary.

Further details of the medical surveillance program are provided in Section 12.0, Annex III, of the IWP (LANL 1991, 0553). In addition, the program must comply with the Laboratory's Administrative Requirement (AR) 2-1, "Occupational Medicine Program"; AR 3-6, "Personnel Radiation Dosimetry"; AR 6-4, "Biological Monitoring for Hazardous Materials"; and Laboratory Technical Bulletin (TB) 606, "Biological Sample Monitoring."

3.3 Documentation

The training and medical records of all ER Program workers will be maintained, and access to the records can be made through the ER Program Office, as stated in Annex III in the IWP (LANL 1991, 0553). Because of their confidential nature, the Laboratory's Occupational Medicine Group (MS-2) will maintain medical records. The Laboratory Training Office (LTO) within the Human Resources Division (HRD) will maintain training records. In addition, DOE Orders 5484.1, "Summary of Exposure Resulting in Internal Body Depositions of Radioactive Materials" and DOE Order 5484.6, "Annual Summary of Whole Body Exposure to Ionizing Radiation," will be submitted for monitored employees. Preparation of these reports will be coordinated with the Laboratory Health Physics Operations Group (HS-1). Reporting requirements for injuries, exposures, accidents, releases, and unplanned occurrences will be addressed in Section 10.0 of this HSPjP.

4.0 SCOPE OF WORK

This section describes the SWMUs within OU 1079 and the tasks to be performed during the sampling phase of the RFI.

4.1 Purpose

The sampling effort supports the RFI by determining the nature and extent of contamination in the SWMUs within OU 1079. This determination includes the identification of source points and environmental receptors associated with each SWMU area. The tasks and activities within the sampling phase are described in Chapters 5 through 8 of this work plan. This HSPjP establishes procedures for performing activities in a safe manner.

4.2 OU Description

As described in Chapter 2 of this work plan, OU 1079 consists of Technical Areas (TAs) -10, -31, -32, and -45. Properties on which OU 1079 SWMUs are located are owned by both Los Alamos County and private citizens. County-owned properties include TA-10 in Bayo Canyon, which is used for recreational purposes; TA-32, which is a vehicle- and highway-maintenance yard; and TA-45, which is a materials storage yard. TA-31 comprises properties owned by both Los Alamos County and private citizens. The SWMUs represent a wide range of locations and potential contaminants that must be considered in this HSPjP. Potential waste materials in these areas include radioactive materials, metals, fuels, organic solvents, high explosives (HE), and sanitary waste. Parts of this HSPjP are generic to the ER Program, but guidance will be provided to address the hazards specific to the potential contaminants, localities, and tasks for OU 1079.

4.2.1 SWMU Sampling Locations

The sampling locations for the OU 1079 SWMUs are specified in Chapters 5 through 8 of this work plan.

4.2.2 Topographical Considerations

The environmental setting for OU 1079 is described in Chapter 3 of this work plan. Because some of the SWMUs are located near the edges of mesa tops, in canyon bottoms, or on hillslope benches, accessibility and logistics will be difficult. These activities will require special precautions as outlined in Section 7.0 of this HSPjP.

4.2.3 Meteorological Considerations

The climatology of Los Alamos County is reviewed in Chapter 2 of the IWP (LANL 1991, 0553). Because of the semiarid mountain climate in Los Alamos, the field teams must prepare for a wide variety of weather conditions during sampling activities. Field team members may experience heat stress, cold stress, and exposure to lightning and slippery surfaces. These hazards and the equipment necessary to minimize them are detailed in Section 7.0 of this HSPjP.

4.3 Description of Tasks

Various tasks may be performed to characterize the nature and extent of contamination depending on the conditions within a particular SWMU. These tasks and activities are separated into three categories: field surveys, surface sampling, and subsurface sampling. Field surveys may include topographic and radiological surveys, geomorphologic mapping, geophysical surveys, and soil/gas surveys. Surface sampling may include soil or sediment collection from former firing sites, outfall points, drainage areas, and sediment traps. Subsurface sampling may consist of soil and sediment collection using both shallow- and deep-auguring techniques. Subsurface sampling may also include sampling beneath the former locations of drain lines/storm sewers, septic tanks, and sumps. The sampling may include augering, coring, and trenching. Each task is analyzed for its specific hazards and associated protective measures in Sections 5.0, 6.0, and 7.0 of this HSPjP.

5.0 HAZARD ASSESSMENT

This section presents potential hazards that may be encountered by site workers during the field tasks and activities scheduled for OU 1079.

5.1 Types of Hazards

The types of hazards that may be encountered during field work in OU 1079 are discussed in the following subsections.

5.1.1 Oxygen Deficiency

The oxygen content of normal atmospheres is approximately 21% by volume. Oxygen-deficient atmospheres are defined in 29 CFR 1910.120 as atmospheres in which oxygen-per-volume is less than 19.5%. As the percentage of oxygen approaches a deficient level, workers exhibit symptoms of oxygen deprivation that include impaired attention, coordination, and judgment, as well as an increase in breathing and heart rate.

Oxygen-deficient atmospheres may result from the displacement of oxygen by another gas or from the consumption of oxygen during a chemical reaction. Because the sampling activities for OU 1079 will be conducted outdoors, oxygen-deficient atmospheres are not expected. However, the field team must be aware of the potential for oxygen deficiency in confined spaces or low-lying areas such as natural depressions, excavations, or trenches.

5.1.2 Explosivity/Flammability

The following are potential sources of explosive or flammable hazards within OU 1079:

- disturbance of HE, ordnance, or shock- or friction-sensitive compounds;
- ignition of explosive or flammable chemicals;
- ignition of materials due to oxygen enrichment;
- sudden release of materials under pressure; and
- chemical reactivity that may result in explosion, fire, or heat.

These conditions may result in hazards of intense heat, open flame, smoke inhalation, flying debris, and the release of toxic chemicals. Field team members must be aware of materials specific to each SWMU that may contribute to the aforementioned conditions.

Each explosive or flammable gas or vapor has a range of concentrations at which it will explode or burn in the presence of an ignition source. The explosive or flammable limit represents this range for each chemical and is, therefore, a useful indicator of explosive or flammable hazards.

5.1.3 Radiological Hazards

Radiological constituents emit one or more of the three types of ionizing radiation: alpha, beta, and gamma. Because ionizing radiation can cause biological harm, field team members must be aware of any areas in which radiological hazards exist. The presence of radiological wastes has been documented or is suspected based on historical evidence from several SWMUs in OU 1079 (see Chapter 3 of this work plan).

The primary pathways by which field team members may be exposed to radiological hazards during sampling are

- inhalation of contaminated particulates or vapors;
- inadvertent ingestion of contaminated materials;
- dermal absorption of contaminated particulates or vapors through wounds;
- injection of contaminated particulates into the body through puncture wounds and unbroken skin; and
- direct exposure to gamma radiation from contaminated materials.

Indicators for radiological exposures are exposure rates and concentration of radiation in soil, water, and air. These rates are expressed in rems or millirems (mrem), and milliroentgens (mR) per hour and can be used to estimate biological harm. Radiation monitoring is discussed in Section 6.3 of this HSPjP.

5.1.4 Toxicological Hazards

Exposure to toxic chemicals can result in a wide range of adverse effects that depend on the specific toxicological action of the chemical, the concentration, the route(s) of exposure, the duration and frequency of exposure, and personal factors.

Historical evidence from OU 1079 indicates the presence of chemical wastes in several of the SWMUs. Potential toxicological wastes include radioactive materials, metals, organic solvents, HE, and sanitary waste. The primary pathways for chemical exposure include the following:

- inhalation of toxic gases, vapors, or contaminated particulates;
- inadvertent ingestion of contaminated materials;
- dermal absorption through contact with vapor, contaminated liquids, or contaminated particulates through wounds and unbroken skin; and
- injection of contaminated liquids or contaminated particulates through puncture wounds.

Information for known contaminants includes published exposure limits (PELs) and symptoms of exposure. The published exposure limits consist of the PELs established by OSHA in 29 CFR Part 1910.120, Subpart Z; the recommended exposure limits (RELs) set forth in NIOSH Recommendations for Occupational Health Standards (NIOSH et al. 1985, 0414); and the Threshold Limit Values (TLVs) developed by the ACGIH in Threshold Limit Values and Biological Exposure Indices for 1990-91 (ACGIH 1990, 0726).

TLVs refer to airborne concentrations of substances to which nearly all employees may be repeatedly exposed on a daily basis without adverse effects. They are based on the best available information from industrial experience and animal or human studies. Because of the wide variation in individual susceptibility, a small percentage of workers may experience discomfort from some substances at concentrations lower than recommended values. Policy has been to use these TLVs as base guidelines for good hygienic practices; however, whenever applicable, stricter guidelines may be used.

Currently, exposure guidelines to pesticides and other chemical substances are regulated by OSHA. These exposures are based on the Time-Weighted Average (TWA) concentration for a normal 8 hr workday and a 40 hr workweek. Several chemical substances have Short-Term Exposure Limits (STELs) or ceiling values that allow a maximum concentration to which workers can be exposed continuously for a short time without suffering irritation, chronic or irreversible tissue damage, or narcosis of a degree sufficient to result in accidental injury, impair self-rescue, or substantially reduce work efficiency.

The STEL is defined by ACGIH and OSHA as a 15 min TWA exposure that should not be exceeded within a 2 hr period during a workday, even if the 8 hr TWA is within applicable limits. OSHA requires that the 15 min ceiling concentration never be exceeded for a particular chemical constituent. The ceiling concentration notation appears as the letter "C" following the chemical name.

A "skin" notation may appear under certain chemical-substance listings. This notation refers to the potential contribution to the overall exposure by the cutaneous route, including mucous membranes and eyes, by either airborne or direct contact. Little quantitative data are available describing absorption as a function of the concentration to which the skin is exposed. Biological monitoring may be considered to determine the relative contribution of dermal exposure to the total dose.

ACGIH and OSHA have recognized from epidemiological studies, toxicology studies, and to a lesser extent, case histories that certain chemical substances have the potential to be carcinogenic in humans. Because of the long latency period for many carcinogens, timely risk-management decisions on the results of such information are often impossible. Two categories of carcinogens, confirmed human carcinogens, and suspected human carcinogens, are designated on the basis of the most current literature. These chemical categories are derived from either limited epidemiologic studies and clinical reports of single exposure, or through test methods of carcinogens in one or more animal species. The worker potentially exposed to a known human carcinogen must be properly equipped to ensure virtually no contact with the chemical constituents. In the case of a suspected human carcinogen, worker exposure by all routes must be carefully controlled by using personal and respiratory protection, and administrative or engineering controls.

The symptoms associated with exposure will depend on the chemical and the conditions of exposure. Table III-1 lists many of the suspected contaminants present at the SWMUs within the confines of OU 1079. Any adverse physiological reaction should be considered extremely serious and will be reported to the FTL immediately.

5.1.5 Corrosive Hazards

Corrosive materials such as acids and bases can destroy tissues on contact. Depending on the strength of the corrosive, symptoms range from skin or eye irritation to severe burns. Corrosives can also damage equipment and protective gear. One indicator of the corrosive nature of a material is its pH. Another indicator is its strength or concentration.

TABLE III-1 SUMMARY OF POTENTIAL WASTE MATERIALS AND REQUIRED INITIAL LEVELS OF PROTECTION FOR OU 1079

		Required Levels of Protection[a]		
Technical Area/Site Name/ SWMU /SWMU Type	**Suspected Contaminants**	**Field Survey**	**Surface Sampling**	**Subsurface Sampling**
TECHNICAL AREA 10, BAYO CANYON				
SWMU 10-001(a-d) Firing Sites	HE, Natural and Depleted Uranium, ^{90}Sr, Beryllium, Lead, Barium	TBD	TBD	TBD
SWMU 10-001(e) Sand Pile Detection Area	HE, Natural and Depleted Uranium, ^{90}Sr, Beryllium, Lead, Barium	NFA	NFA	NFA
SWMU 10-002(a-b) Disposal Pits	^{90}Sr, Natural and Depleted Uranium, Metals, Barium, Organic Compounds	TBD	TBD	TBD
SWMU 10-003(a-o) Liquid Disposal Complex	Natural and Depleted Uranium, ^{90}Sr, Organic Compounds, Metals	TBD	TBD	TBD
SWMU 10-004(a-b) Septic Tanks	^{90}Sr, Organic Compounds, Natural and Depleted Uranium, Metals	TBD	TBD	TBD
SWMU 10-005 Surface Disposal Sites	Natural and Depleted Uranium, Lead, HE, Beryllium, Barium, ^{90}Sr	TBD	TBD	TBD
SWMU 10-006 Open Burning Area	Natural and Depleted Uranium, Lead, HE, Beryllium, Barium, ^{90}Sr	NFA	NFA	NFA
SWMU 10-007 Landfill	^{90}Sr, Natural and Depleted Uranium, Barium, Beryllium, Lead, Organic Compounds	TBD	TBD	TBD
TECHNICAL AREA 31, EAST RECEIVING YARD				
SWMU 31-001 Septic System	Radionuclides, Metals, Organic Compounds	TBD	TBD	TBD
AOC C-31-001	No releases to the environment are suspected.	NFA	NFA	NFA

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[a] Level of protection refers to Levels A, B, C, and D as described in Section 7.2 of this HSPjP. TBD means To Be Determined and that the required levels of protection will be specified in the task specific health and safety plans prepared prior to initiating any field task. NFA means that the SWMU or AOC is being recommended for No Further Action, and will not be involved in OU 1079 RFI activities.

TABLE III-1 SUMMARY OF POTENTIAL WASTE MATERIALS AND REQUIRED INITIAL LEVELS OF PROTECTION FOR OU 1079 (CONTINUED)

		Required Levels of Protection[a]		
TECHNICAL AREA 32, MEDICAL RESEARCH LABORATORY				
SWMU 32-001 Incinerator	^{238,239}Pu, ^{241}Am, ^{3}H, Organic Compounds, Metals, ^{14}C	TBD	TBD	TBD
SWMU 32-002(a-b) Septic Systems	^{238,239}Pu, Metals, Organic Compounds, ^{3}H, ^{241}Am, ^{14}C	TBD	TBD	TBD
AOC C-32-001 Potential soil contamination beneath former structure locations	No releases to the environment are suspected	NFA	NFA	NFA
TECHNICAL AREA 45, WASTE TREATMENT FACILITY				
SWMU 45-001 Waste Treatment Facility & Outfalls	^{238,239}Pu, ^{3}H, Natural and Depleted Uranium, Metals, ^{137}Cs, ^{90}Sr, ^{241}Am, Organic Compounds	TBD	TBD	TBD
SWMU 45-002 Decontamination Facility	Metals, Organic Compounds, Natural and Depleted Uranium, ^{238,239}Pu, ^{241}Am, HE, ^{137}Cs, ^{90}Sr, ^{3}H	TBD	TBD	TBD
SWMU 45-003 Industrial Waste (Acid Waste) Lines	^{90}Sr, ^{3}H, ^{238,239}Pu, Organic Compounds, ^{37}Cs, ^{241}Am, Metals, Natural and Depleted Uranium	TBD	TBD	TBD
SWMU 45-004 Sanitary Sewer Outfall	Unknown	TBD	TBD	TBD
SWMU 1-002 Untreated Waste Outfall	^{238,239}Pu, ^{3}H, ^{90}Sr, ^{241}Am, Metals, ^{137}Cs, Natural and Depleted Uranium, Organic Compounds	TBD	TBD	TBD
AOC C-45-001 Treatment Facility Parking Lot	Unknown	TBD	TBD	TBD

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[a] Level of protection refers to Levels A, B, C, and D as described in Section 7.2 of this HSPjP. TBD means To Be Determined and that the required levels of protection will be specified in the task specific health and safety plans prepared prior to initiating any field task. NFA means that the SWMU or AOC is being recommended for No Further Action, and will not be involved in OU 1079 RFI activities.

Historical evidence indicates the disposal of acids in several of the SWMUs. Field personnel must be cognizant of opportunities for exposure to corrosive materials through generation of vapor/gas clouds, splashing of contaminated liquids, or contact with contaminated soils and sludges.

5.1.6 Biological Hazards

Field team members are likely to encounter biological hazards in some areas of OU 1079. Evidence indicates that sanitary waste was discharged through septic tanks and outfalls into OU 1079. Contact with reptiles, animals, and insects such as rattlesnakes, rodents, mosquitoes, ticks, spiders, and fleas may be hazardous. Infectious agents can be transmitted as a result of abrasions or puncture wounds from objects such as broken glass, scrap metal, and other debris. Field team members must also be aware of hazardous biological agents conveyed through unhygienic practices such as failing to sanitize respirators or drinking and eating on site.

5.1.7 Physical Hazards

OU 1079 sampling activities may present a number of potential physical hazards, including the following:

- general physical hazards;
- noise;
- working in confined spaces;
- working around potentially energized electrical equipment;
- working around heavy equipment and machinery;
- inadequate housekeeping;
- slip, trip, and fall hazards;
- using mechanical and flame cutting equipment;
- materials handling;
- temperature extremes;
- excavations;
- underground hazards;
- traffic;

- compressed gases and systems;
- breaking concrete;
- topography; and
- lightning.

5.1.7.1 General Physical Exposures

Field team members will handle a variety of chemicals and materials during sampling. The primary physical hazards will be exposure to acids, caustics, and various waste streams that may contain petroleum or solvent sludge. Field team members may be exposed to these materials through inhalation, skin absorption, and ingestion of contaminants. Physical hazards also include personnel encounters with energized and pressurized equipment, waste materials, and work conditions that may cause slips, trips, falls, or cuts.

5.1.7.2 Noise

The operation of the vehicles, machinery, and equipment necessary to conduct the sampling activities can create noise levels exceeding 85 decibels (dB). This noise level may lead to temporary or permanent hearing loss.

5.1.7.3 Working in Confined Spaces

A confined space is defined as a work location that has limited access/egress or inadequate natural ventilation. Sampling activities may require personnel to enter such areas for inspection and sampling. Potential hazards associated with confined spaces include higher-than-normal concentrations of chemical contaminants, flammable atmospheres, possible asphyxiation, and physical exposures.

5.1.7.4 Working around Potentially Energized Electrical Equipment

The human body conducts electricity. Contact with an electric circuit combined with simultaneous contact with a grounded object, such as damp concrete, steel, or other metal, will cause the current to flow through the body. Current will also flow through the body if any two body parts come in contact with any two wires that are part of the same electrical system. In addition to burning skin, electric current frequently interferes with the normal rhythm of the heart and can cause it to stop beating. The heart does not automatically start beating even after the body is removed from the electric current; therefore, cardiopulmonary resuscitation (CPR) must be administered.

The effects of electric shock on the human body are as follows:

- 1 milliampere is barely perceptible, there is no real danger;
- 3 to 9 milliamperes may cause involuntary muscle reactions that could result in bruises, fractures, or even death if the reaction causes a collision or fall;
- 9 to 75 milliamperes may cause involuntary muscle reactions or possible respiratory paralysis;
- 75 milliamperes to 4 amperes can cause possible fibrillation (ineffective, erratic pumping of the heart); and
- 4 amperes or greater can cause immediate cardiac arrest (heart stoppage).

Shock from high voltage current sources can also cause severe external and internal burns. A potential ignition source from sparking electrical contacts exists.

5.1.7.5 Working around Heavy Equipment and Machinery

The size of the equipment, the driver's limited range of vision, and underfoot and overhead hazards can lead to crushing, tripping, falling, cutting, or puncturing. The high noise levels created by the equipment can also cause injury.

5.1.7.6 Inadequate Housekeeping

Inadequate housekeeping can lead to congestion, disorder, dirt, waste, trash, and obstacles and can cause slipping, tripping, and falling, which in turn can result in strains, sprains, broken bones, bumped heads, and fatalities.

5.1.7.7 Using Mechanical and Flame Cutting Equipment

Welding and cutting operations can create sources of ignition and airborne-contaminants. Cutting equipment and compressed-gas cylinders present potential physical, electrical, and flammable hazards such as welding flash and welding burns.

5.1.7.8 Materials Handling

Handling materials manually can lead to cuts, bruises, splinters, mashed fingers and toes, fractures, and a variety of strains and sprains from lifting, handling, and/or dropping loads. Wire rope used in rigging and lifting may have broken strands and frayed ends, leading to punctures and cuts. Banding wraps used to secure loads could snap, leading to crushing, lacerations, and puncture wounds.

5.1.7.9 Temperature Extremes

Site activities may take place during either excessively hot or cold weather. Such conditions could potentially create heat or cold stress for personnel. The following are heat-related problems:

- HEAT RASH causes irritation and decreases a person's ability to tolerate heat. It is aggravated by chafing clothing.
- HEAT CRAMPS are caused by a chemical electrolyte imbalance brought on by profuse perspiration combined with inadequate water intake that results in muscle spasm and pain in the extremities and abdomen.
- HEAT EXHAUSTION occurs when stress on various organs to meet increasing demands to cool the body results in shallow breathing; pale, cool, moist skin; profuse sweating; dizziness; and lassitude.
- HEAT STROKE is the most severe form of heat stress. It must be treated immediately by cooling the body or death may result. Symptoms include red, hot, dry skin; no perspiration; nausea; dizziness and confusion; strong, rapid pulse; and coma.

The following are cold-related problems:

- FROSTBITE is characterized by pain, reddening of tissue, loss of dexterity, and tingling or lack of sensation in the affected extremities.
- HYPOTHERMIA symptoms include pain and loss of dexterity in the extremities, severe or uncontrollable shivering, inability to maintain normal rate of activity, and excessive fatigue, drowsiness, or euphoria.
- SEVERE HYPOTHERMIA leads to clouded consciousness, low blood pressure, cessation of shivering, dilated pupils, unconsciousness, and possibly death.

5.1.7.10 Excavations

Excavation will take place at some of the SWMUs to provide access to spaces for soil and water sampling. The hazards of these operations go beyond excavation to include the potential for direct or airborne contact with site contaminants.

Personnel may have to enter an excavation to adequately collect samples. Excavations pose a significant threat to employees if they are not carefully controlled. An excavation that has been improperly dug or shored can collapse, and any excavation presents a fall hazard.

5.1.7.11 Underground Hazards

Underground hazards are those that occur when subsurface structures such as gas utilities, power lines, product lines, concrete vaults, and tanks are encountered during drilling or excavation. Unexpected encounters with these structures creates the potential for electrocution, explosion, contact with hazardous spills, release, or other injuries to the crew.

5.1.7.12 Traffic

The possibility of vehicle-related injury or accident is inherent to all aspects of field work. Vehicle-related accidents may occur during travel to or from the site, as well as during on-site activities. Continuous Laboratory activities and the use of heavy equipment during several of the planned sampling tasks will be a major factor in the occurrence of accidents involving vehicles. Additionally, work may take place on or near areas where there is heavy vehicle traffic.

5.1.7.13 Compressed Gases and Systems

The following hazards are associated with compressed gas cylinders and systems such as compressors:

- flying objects such as dust, dirt discharged from a cylinder-valve opening, or a whipping compressor hose;
- explosion/fire caused by a leaking system; and
- a damaged cylinder valve that causes the cylinder to become a missile.

5.1.7.14 Breaking Concrete

Gaining access to some sampling areas will sometimes require breaking through a concrete pad. The following hazards may be present during this operation:

- possible increase in airborne concentrations of site contaminants, particularly if the ground below is heavily saturated;
- dust exposure from concrete saw use;
- flying debris;
- noise;

- vibration of the hands and body of an employee operating a jackhammer; and
- increased likelihood of electrical shock to an employee operating a jackhammer.

5.1.7.15 Topography

Injuries from slips, trips, and falls in OU 1079 may occur around uneven terrain, slippery surfaces, embankments, cliffs, excavations, heavy equipment, and areas littered with debris.

5.1.7.16 Lightning

Fire is the most common danger associated with lightning, but explosions, falling trees, power outages, and momentary blindness caused by the flash are other examples. Field personnel hit by lightning will almost certainly be severely injured or killed. Lightning is a significant hazard at the Laboratory during the summer.

5.2 Task-Specific Hazard Assessment

Three major sampling tasks will be conducted during this sampling effort: field surveying, surface sampling, and subsurface sampling. Various activities will be performed under each of these tasks, depending on which SWMU is being investigated. Details for the tasks are described in Chapters 5 through 8 of this work plan. Potential hazards associated with the tasks are evaluated in the following text. Protective measures to be employed during the tasks are outlined in Section 7.0 of this HSPjP.

5.2.1 Field Surveys

The following survey activities may be included for the specific sampling and analysis plans in OU 1079:

- topographic survey;
- radiological survey;
- geomorphologic mapping;
- geophysical survey; and
- soil/gas survey.

Topographic surveys, radiological surveys, and geomorphologic mapping are relatively low-risk activities. Geomorphologic mapping and topographic and radiological surveys require walk-through visits to the site using nonintrusive instruments. Geophysical surveys use magnetic and electromagnetic conductivity (EMC) instrumentation. Ground-penetrating radar may also be used for some of the SWMUs. Oxygen-deficient and flammable hazards are not anticipated during these surveys, although field team members should be aware of the potential for such hazards in low-lying areas. It is possible that field team members may encounter radiation and chemical hazards through contact with contaminated surface soil or dust or through inhalation of dust. Biological hazards may be encountered through poisonous or infectious agents and unhygienic practices. Physical hazards include the potential for slips, trips, and falls during surveying of uneven terrain or at the edges of a mesa. Field team members should be aware of the potential for heat and cold stress when working outdoors for a prolonged period of time. Survey personnel should also be cognizant of the possibility of lightning strikes.

The aforementioned cautions, as well as some additional concerns, also apply to soil/gas surveys. A "slam-bar" or similar device will typically be used to drive the soil-gas well into place, and drilling through asphalt or concrete may be necessary at some sampling locations. Potentially contaminated soil will be disturbed, and drilling increases the likelihood of exposure to contaminants in the soil due to the generation of soil cuttings. Contact with soil or dust and inhalation hazards for dust are possible. Electrical hazards also exist in the form of overhead and underground utility lines as well as any electrical connections associated with drill rigs. Other potential hazards involved in drilling activities include noise and pinch points.

5.2.2 Surface Sampling

The surface sampling program may consist of soil/rock or sediment sample collection from the following locations:

- former septic tank system and line locations;
- former solid waste disposal areas;
- outfall points;
- drainage areas; and
- stream channels.

Surface sampling of soil/rock and sediment is typically a low-risk activity. Oxygen deficiency and explosive or flammable vapor/gas hazards will generally not be a problem unless the sampling point is in a low-lying area where gases or vapors can accumulate. Radiological and chemical contaminants may be present in the top 6 in. of soil/rock. Dermal contact with contaminated soil, sediment, and dust, as well as inhalation of dust are possible. Field team members will exercise caution in the presence of biological hazards such as animals, infectious agents, and infectious waste. Physical hazards such as slips, trips, and falls are site-specific. Working extended hours and/or wearing protective clothing on hot days can lead to heat-related hazards. Survey personnel should also be aware of the possibility of lightning strikes.

5.2.3 Subsurface Sampling

The subsurface sampling program may consist of soil and sediment sample collection with the following possible activities:

- sampling beneath drain lines/industrial waste (acid waste) lines;
- sampling of former septic tank locations;
- sampling of former sump locations; and
- coring in trenches and leach fields and in areas near warehouses.

Oxygen deficiency may occur if these activities involve the former locations of drain lines and industrial waste (acid waste) lines, septic tanks, and trenches. Explosive and/or flammable conditions are possible because of the potential for contamination by solvents, gasoline, and fuels. Drilling and excavation activities may enhance volatilization of these materials. The potential for the accumulation of explosive/flammable gases and vapors will be greatest in excavated areas and trenches. In some cases, boreholes may be drilled into the former septic tank locations, releasing contents under pressure.

Because of the history of radionuclide and chemical disposal in the OU 1079 SWMUs, the potential for radiation and toxic hazards exists. Because some of the sampling locations will be chosen on the basis of the results of the radiological survey, soil and sediment samples may contain elevated concentrations of contaminants. Moreover, corrosive hazards may result from disposal of acids in some of the SWMUs. The primary exposure pathways involve potential dermal contact with contaminated soil, sediment, dust, or waste, and inhalation of contaminated dust and volatiles from disturbing the soil during drilling, backhoeing, and excavating.

All of the activities in this task involve potential biological hazards, including contact with animals or insects, infectious agents, and infectious waste.

The use of drill rigs and backhoes presents possible physical hazards such as noise, pinch points, and failure of safety systems. Overhead and underground utilities must be located in advance of such operations. Electrical hazards may involve short circuits within equipment, or shock from using electrical equipment in wet conditions.

Field team members must be aware of slip, trip, and fall hazards around cliffs, slippery surfaces, uneven terrain, excavations, and trenches. In addition, excavated areas and trenches may collapse if they are not properly prepared.

5.3 SWMU-Specific Hazard Assessments

Table III-1 lists the suspected chemical and radiological contaminants in each of the SWMUs for OU 1079. The initial level of protection required is also listed.

6.0 AIR-MONITORING PROGRAM

In accordance with 29 CFR Part 1910.120., an air-monitoring program will be implemented, as appropriate, during the sampling activities under this work plan. The objectives of the air-monitoring program will be to identify and quantify levels of hazardous substances in the air to determine the appropriate level of personnel protection, to delineate the boundaries of work zones, to ensure that decontamination procedures are effective, to determine the need for medical monitoring, and to protect public health and safety. In addition to the initial monitoring at the site, periodic monitoring is required when

- work begins in a different portion of the site;
- contaminants other than those previously identified are being handled;
- a different type of operation is initiated (i.e., monitoring volatile materials at a soil boring versus at a drum opening); and
- working with leaking drums or containers, or in areas with obvious liquid contamination.

Instruments will be read at ground, waist, and head levels as a representation of ambient air. Where applicable, measurements will also be made in enclosed spaces and within boreholes, well heads and drum openings.

This section provides a brief description of the monitoring equipment that may be used to detect various airborne hazards and to determine the action level that will be observed during work in OU 1079. The subsections are listed in order of the most immediate hazards. Additional guidance is available in Sections 8.0 and 9.0, Annex III of the IWP (LANL 1991, 0553).

6.1 Oxygen Deficiency

An oxygen indicator will be used to detect oxygen-deficient conditions in confined spaces, low-lying areas, or in spaces that are not ventilated frequently. The action level for oxygen is 19.5%. Areas in which levels are below 19.5% must be evacuated and ventilated. In addition, oxygen-rich atmospheres create an increased potential for fires; therefore, the affected area will also be evacuated if oxygen levels exceed 25%. If evacuation is necessary, the area will be ventilated and the SSO will continue monitoring the oxygen levels.

6.2 Explosivity/Flammability

A combustible-gas indicator (CGI) will be used to monitor for explosive or flammable atmospheres, where appropriate. The presence of residual flammable and combustible liquids, such as gasoline or solvents, is possible at several SWMUs in OU 1079. The potential for explosion or fire may occur during drilling or trenching. Field team members should also be cautious in any enclosed areas where flammable and combustible gases could collect. Because some SWMUs may contain unknown flammable constituents, combustible-gas monitoring should be performed. The action level for explosive and flammable gases is 20% of the Lower Explosive Limit (LEL). If this action level is exceeded, all activities in the area will cease, the work area will be evacuated, and appropriate safety measures (such as removal of ignition sources and ventilation of the area) will be implemented. The SSO will obtain continuous CGI readings. Because CGI instruments will not detect the presence of HE or ordnance, appropriately trained personnel will need to screen for those hazards.

6.3 Radiological Hazards

A variety of radiation survey detectors and other equipment will be used, as appropriate, to determine the presence of radiological hazards. These instruments are discussed further in Appendix D of this work plan. A microroentgen (gamma scintillator) meter or a Geiger-Müller detector will be used to measure gamma exposure. Alpha scintillators will be used to screen soil cores and to scan personnel leaving the contaminated zone. This monitoring program will also comply with the requirements of DOE/AL Order 5480.1A (DOE/AL 1982, 0729).

Field team members should monitor the area before sampling activities commence. Continuous monitoring should be conducted because objects such as drums, tanks, and scrap metal provide a certain amount of shielding against radioactive emissions. Conditions may change as these objects are moved or otherwise disturbed. Resuspension of contaminated soil can also result in inhalation hazards.

An action level for gamma radiation of 1 mR/h is recommended in the EPA Standard Operating Safety Guide (EPA 1988, 0609). If 1 mR/h is encountered, the area will be evacuated (or isolated) and the assistance of a radiation health physicist will be obtained before work on the site is resumed.

Radiation exposures will be monitored through the use of Thermoluminescent Dosimeters (TLDs); radiation exposures will be As Low As Reasonably Achievable (ALARA) according to DOE policy.

6.4 Toxicological Hazards

Because no single instrument can detect all toxic materials, a variety of instruments may be used to determine the presence of potentially toxic airborne constituents. While some of these instruments can be calibrated to identify and quantify a particular substance, the field team will most likely encounter mixtures of substances within the SWMUs. In these cases, the instruments will be used as survey tools and the measurements will represent a gross indication of the materials present. As more information on the SWMU contents becomes available, chemical-specific detectors and laboratory analysis can be employed for qualitative and quantitative purposes.

6.4.1 Photoionization Detector (PID)

A PID is a portable, nonspecific vapor/gas detector that uses a source of ultraviolet radiation to ionize chemical constituents. The PID is capable of detecting a variety of organic and inorganic chemicals depending on the chemical-specific ionization potential (IP) of each constituent.

For most SWMUs, the PID will be used as a survey tool to indicate total volatile organics/inorganics in the air. The data will be used to indicate possible "hot spots" on the site, to monitor operations such as borehole drilling, and to aid in decisions on PPE. Because the exact concentrations of each constituent in the mixture will not be known, the generic guidelines recommended by EPA for the selection of protective equipment under unknown conditions will be used. These guidelines are discussed in Section 9.1, Annex III of the IWP (LANL 1991, 0553).

In cases where a single constituent has been identified at a SWMU, the PID may be calibrated for that particular chemical and used for quantitative measurements. If specific calibration is not possible, the relative response of the compound can be used to estimate the concentration. Relative response is the instrument response to the chemical of interest compared with the instrument response to the chemical used for calibration. The relative response is expressed as a percentage. Other options for quantitative instrumentation are described in the following text. The action level will be the most protective exposure level for a given chemical.

6.4.2 Flame Ionization Detector (FID)

A FID ionizes organic materials by means of a hydrogen flame. This instrument is capable of detecting a wide range of organic constituents, including methane. As in the case of the PID, it is useful to know the relative response factor for suspected contaminants. A FID can be used in both the survey or the quantitative mode.

6.4.3 Colorimetric Tubes

A colorimetric tube is a glass tube that is typically packed with reagent that has been impregnated with a chemical gas. This chemical reagent is specific for a given chemical or group of chemicals. When a specified volume of air is drawn through the tube, the airborne contaminant reacts with the reagent to produce a stain. The tubes are calibrated so that the length of the stain corresponds to an approximate concentration. These tubes may be used in cases where a chemical has been suggested by the site history or identified by other means. Colorimetric tubes are especially useful for chemicals that are not easily detected by the PID or FID such as cyanides or carbon monoxide. One type of colorimetric tube is the Draeger tube.

6.4.4 Electrochemical Gas Detectors

Electrochemical gas sensors detect toxic inorganic gases. One of the more common types of electrochemical sensors is the mixed oxide semiconductor (MOS). This detector is typically used for inorganic gases that are toxic at relatively low concentrations and cannot be reliably detected by other means. Because of the historical evidence at some of the SWMUs, specific detectors will be used for hydrogen cyanide. Electrochemical gas monitors that are set to give an audible alarm at the prescribed exposure limit for the chemical of interest will be employed by the field team during drilling and excavation.

6.4.5 Real-Time Aerosol Monitors

The real-time aerosol monitor is designed to monitor respirable particulates (< 10 microns). The instrument detects scattered electromagnetic radiation as airborne particles pass through a sensor. The response is converted to concentration units of mg/m^3. The measurements are useful if there are known concentrations of radionuclides, metals, PCBs, or other particulates such as asbestos. Soil samples will be analyzed, and the results will be used to determine action levels for the constituents that are present.

6.5 Personal Monitoring

Personal-exposure data will supplement the ambient air-monitoring results. Monitors will be provided to members whose job functions make then likely to receive the highest doses. TLDs will be issued to field team members as a means of monitoring the radiation exposure of individual team members. Personal monitoring devices will be used as necessary for other materials identified during the course of the sampling efforts.

6.6 Air Samplers

High- and low-volume air samplers are available to measure ambient atmospheres and personal breathing zone concentrations of particulates, vapors, and gases. The selection of the samplers, collection media, and analyses will depend on the presence of materials known or suspected at the site before RFI activities begin, but will be subject to change as the RFI progresses.

7.0 PERSONNEL PROTECTION AND SAFETY REQUIREMENTS

This section establishes the protective measures for site workers to be used during the OU 1079 RFI. These controls are categorized as engineering controls/work practices and PPE.

OSHA regulations state that, wherever feasible, engineering controls and work practices shall be instituted to reduce employee exposure below the PEL and maintain it there. Engineering controls are mechanical means for reducing hazards to workers; work practices are administrative controls for minimizing field team member exposure. If engineering controls and work practices are not successful in bringing exposure below permissible limits, PPE must be used. The OU 1079 investigation will employ a combination of these controls. The potential contaminants at OU 1079 and their associated exposure limits are summarized in Table III-2.

7.1 Engineering Controls/Work Practices

7.1.1 Oxygen Deficiency

Oxygen deficiency is defined as an atmosphere in which oxygen by volume is less than 19.5%. Field team members will not be permitted to work in oxygen-deficient atmospheres. Air-purifying respirators will be worn when the oxygen concentrations are between 19.5% and 21%. The most common means of restoring normal oxygen levels is ventilation. Ventilation can be achieved and maintained mechanically or naturally. Because of logistics in the field, mechanical devices may be difficult to use. Natural ventilation is effective but depends on the current wind speed and direction.

7.1.2 Fire/Explosion Hazards

Explosive or flammable atmospheres are defined as atmospheres in which the concentration of combustible vapors is greater than 20% of the LEL. Site workers will not be permitted to work in any areas where this condition exists. Ventilation will be used to reduce the concentrations of explosive/flammable gases and will be used at OU 1079 where necessary.

TABLE III-2 POTENTIAL CONTAMINANTS, OU 1079
EXPOSURE LIMITS

LOCATION	CONTAMINANTS	OSHA CEILING		OSHA PEL		OSHA STEL		ACGIH TWA		ACGIH STEL	
		ppm	(mg/m^3)	ppm	(mg/m^3)	ppm	(mg/m^3)	ppm	(mg/m^3)	ppm	(mg/m^3)
Technical Area 10											
	Barium	--	--	--	0.5	--	--	--	0.05	--	--
	Beryllium*	--	0.005	--	0.002	--	--	--	0.002	--	--
	HE	--	(--)	--	(--)	--	(--)	--	(--)	--	(--)
	Lead	--	--	--	0.05	--	--	--	0.15	--	--
	Organic Compounds	--	(--)	--	(--)	--	(--)	--	(--)	--	(--)
	Strontium	--	(--)	--	(--)	--	(--)	--	(--)	--	(--)
	Uranium	--	--	--	0.2	--	0.6	--	0.2	--	0.6
Technical Area 31											
	Radionuclides	--	(--)	--	(--)	--	(--)	--	(--)	--	(--)
	Metals	--	(--)	--	(--)	--	(--)	--	(--)	--	(--)
	Organic Compounds	--	(--)	--	(--)	--	(--)	--	(--)	--	(--)
Technical Area 32											
	Plutonium	--	(--)	--	(--)	--	(--)	--	(--)	--	(--)
	Americium	--	(--)	--	(--)	--	(--)	--	(--)	--	(--)
	Tritium	--	(--)	--	(--)	--	(--)	--	(--)	--	(--)
	Metals	--	(--)	--	(--)	--	(--)	--	(--)	--	(--)
	Organic Compounds	--	(--)	--	(--)	--	(--)	--	(--)	--	(--)
	Carbon-14	--	(--)	--	(--)	--	(--)	--	(--)	--	(--)
	Uranium	--	(--)	--	(--)	--	(--)	--	(--)	--	(--)
Technical Area 45											
	Plutonium	--	(--)	--	(--)	--	(--)	--	(--)	--	(--)
	Tritium	--	(--)	--	(--)	--	(--)	--	(--)	--	(--)
	Uranium	--	(--)	--	(0.02)	--	(0.6)	--	(0.2)	--	(0.6)
	Metals	--	(--)	--	(--)	--	(--)	--	(--)	--	(--)
	Cesium	--	(--)	--	(--)	--	(--)	--	(--)	--	(--)
	Strontium	--	(--)	--	(--)	--	(--)	--	(--)	--	(--)
	Americium	--	(--)	--	(--)	--	(--)	--	(--)	--	(--)
	HE	--	(--)	--	(--)	--	(--)	--	(--)	--	(--)
	Unknown Chemicals	--	(--)	--	(--)	--	(--)	--	(--)	--	(--)

*Suspected or known carcinogen.

An additional means of preventing explosion or fire is to ensure that no ignition sources are on site. Intrinsically safe devices and nonsparking tools will be used at all times.

Field team members will be trained to recognize and avoid hazards. Distance and shielding can be used to protect field team members if a fire or explosion occurs. Some activities, such as a drum opening, can be conducted with remote techniques. Shielding for operators of heavy equipment, such as backhoes, can be provided by explosion-proof cabs.

Further guidance for handling flammable materials is available in the Laboratory AR 6-5, "Flammable and Combustible Liquids"; and in Laboratory TB 601, "Flammable Liquids"; TB 602, "Flammable Gases"; TB 603, "Solvents"; and TB 604, "Epoxies." Section 9.4, Annex III of the IWP (LANL 1991, 0553) requires a fire-and-explosion prevention-and-control program at sites with flammable and reactive materials.

Air-monitoring equipment will not detect the presence of HE or ordnance. According to Section 9.4, Annex III of the IWP (LANL 1991, 0553), all field activities in areas potentially contaminated with HE and/or ordnance will be reviewed by UC explosives-safety personnel.

7.1.3 Radiation Hazards

In any ER Program work involving areas of known or potential radioactive contamination, the OUPL and the SSO must prepare a work request specific to the site and submit it to the Laboratory's Health Physics Operations Group (HS-1) for review. If work is approved, HS-1 will issue a special work permit for radioactive work. The OUPL must obtain this permit before initiating work on site.

The primary methods for protecting field team members from radiation hazards are time, distance, and shielding. Both radiation survey monitors and personal dosimeters will be used to track exposures of site workers over time. According to Section 8.0, Annex III of the IWP (LANL 1991, 0553), administrative limits will be used to ensure that site workers do not exceed the quarterly or annual limits specified in DOE Order 5480.11, Attachment 1 (DOE 1988, 0076). Restrictions will be placed on employees whose exposures have exceeded the allowable limits. Radiation levels will be maintained ALARA.

The action level for radiation is 1 mR/h (EPA 1988, 0609). If this level is exceeded, field team members must evacuate the area to a distance at which radiation is at background level. The assistance of a radiation health physicist will be obtained before the site is re-entered.

Methods for shielding field team members from radiation are not feasible for the OU 1079 investigations. The most effective means of protecting individuals from contamination are preventing contact with contaminated materials and controlling contaminated dust. Thorough monitoring and decontamination procedures are key components in reducing radiation hazards.

7.1.4 Chemical Hazards

Chemical hazards are to be monitored during the performance of duties in contaminated zones. If concentrations of toxic materials exceed the action limit (which is one-half the PEL or TLV), personnel will be removed from the area until natural or mechanical ventilation reduces the levels to background values.

Airborne dust or particulates pose two problems: nuisance dust, for which standards have been established at 10 mg/m^3, and the adsorption of hazardous substances on soil particles. During drilling or other activities that may generate dust, water can be sprayed in the area to suppress the dust. The effectiveness of dust-control measures will depend on the size of the area to be sprayed and the rate of evaporation of the water. Frequent applications may be required to achieve optimal results.

7.1.5 Corrosive Hazards

The most effective means of controlling exposure to corrosive hazards is to avoid contact with these materials. Although neutralization is an ideal remedy for reducing the hazard, the choice of a neutralizing agent will depend on the corrosive substance. Because corrosive materials in OU 1079 are likely to be unknown, engineering controls for corrosive materials are very limited.

7.1.6 Biological Hazards

7.1.6.1 Animals/Insects

Site workers may be exposed to a variety of snakes, insects, and rodents. For example, rattlesnakes may be encountered in some of the high grasses in areas near the mesas, outfalls, and sewage-treatment plants. Site workers should avoid high grasses as much as possible. If field team members need access to these areas, they will wear snake leggings or cut the grass.

Insect repellents can be used to avoid bites from some insects; however, field team members should also be aware that repellents may affect sample analyses. Field team members will check for the presence of ticks after working in grass and wooded areas.

Controls for exposure to rodents are limited. Workers should be aware of potential habitats for rats and mice. If an individual is bitten by a rodent, the animal should be captured, if possible, and both the victim and the rodent should be transported to a medical facility.

7.1.6.2 Poisonous Plants

Field team members should be able to identify poisonous plants, such as poison ivy (Toxicodendron radicans), death camas (Zigadenus spp.) water hemlock (Cicuta douglasii), and poison hemlock (Conium maculatum). Contact with these plants will be avoided and no wild plant will be eaten. If these plants are present at the sampling location, they will be cleared in the appropriate fashion.

7.1.6.2.1 Poison Ivy (Toxicodendron radicans)

Poison ivy contains a toxic oil (urushiol) that causes painful swelling and eruptions on the skin with only external contact. Sensitivity varies between people. Cases of severe contact and reaction should be treated by a physician.

Poison ivy is usually found in moist habitats such as canyon bottoms. It is recognized by its deep green, shiny trifoliate leaves that have distinct, irregularly sized teeth along the margins. The leaf shape may resemble box elder, a common tree in the canyons near Los Alamos. The plant bears white or yellowish-white berries.

7.1.6.2.2 Death Camas (Zigadenus spp.)

Death camas contains a toxic substance, zygadenin, that can cause serious illness or death when ingested. If poisoning is suspected, medical help should be sought immediately.

Death camas is found in mountainous areas, including the mountains of northern New Mexico, in pinon-juniper woodlands, or pine forests. It is a small plant, typically less than 2 ft in height, and resembles a wild onion in that the long, grass-like leaves originate from an underground bulb. When in bloom, its small, lily-like flowers are greenish white and typically arranged in branching clusters along a central stalk. The most common cause of poisoning is mistaken identification with wild onions. The bulbs of the death camas do not have an onion-like odor.

7.1.6.2.3 Water Hemlock (Cicuta douglasii)

Water hemlock contains a toxic substance, cicutoxin, that affects the central nervous system of mammals when ingested. Symptoms of poisoning include vomiting, colicky pains, staggering, unconsciousness, and convulsions. Severe cases can be fatal, and no antidote is known. Immediate medical attention should be sought if this plant is ingested.

Water hemlocks are found in wet ground and along streams. The plants are tall, growing to 6 ft, with longitudinal ribs on the stem. The leaves are one- to three-times pinnately divided. The leaflets are coarsely toothed, with the lateral veins ending between the teeth. The small white flowers are arranged in umbels at the top of the plant (similar to the flower arrangements of carrots, parsley, and dill).

7.1.6.2.4 Poison Hemlock (Conium maculatum)

Poison hemlock is highly toxic when ingested. As with water hemlock, suspected poisoning cases should receive immediate medical attention. Ingestion of water hemlock or poison hemlock is often the result of misidentification with the many edible members of the same plant family including celery, carrots, parsley, dill, cilantro, anise, cumin, and fennel.

Poison hemlock is found in damp ground, near streams, and occasionally on moist slopes. The plants may be as tall as ten ft with stout, sometimes branching stems. The stems are longitudinally ribbed and have purple spots or streaks near the base. The leaves have multiple pinnate divisions, appearing somewhat similar to celery leaves. The small white flowers are arranged in umbels at the top of the plant and the ends of the branches.

7.1.6.3 Infectious Agents

If the sampling area is littered with debris such as sharp objects, broken glass, and items with jagged edges, field team members will clear it before proceeding with work. Cuts, abrasions, and puncture wounds will be treated immediately by an individual certified in first aid. Medical personnel will be consulted in the case of severe wounds, and will determine the necessity for tetanus inoculation.

7.1.6.4 Hygienic Practices

Contact with potentially biologically contaminated materials is possible. To avoid contact, good hygienic practices will be observed on site at all times. Eating, drinking, smoking, and chewing gum or tobacco will be prohibited on site. Field team members must wash their hands and faces upon leaving a contaminated area as well as before drinking, eating, or smoking. These practices are consistent with Section 9.4, Annex III of the IWP (LANL 1991, 0553).

7.1.7 Physical Hazards

This section outlines the controls necessary to reduce the severity of the physical hazards listed in Section 5.1.7 of this HSPjP.

7.1.7.1 General Physical Exposures

Failure of field project management staff and site workers to recognize, evaluate, and control site hazards can result in exposure to contaminants by means of skin contact or inhalation, burns, blowouts, slips, trips, and falls, and other hazards. A goal of zero on-site personnel exposures to physical hazards is targeted.

Pinch points are associated with activities using equipment with turning or moving parts such as drill rigs, backhoes, and some hand tools. Machinery and equipment, along with their operating procedures, should be reviewed in advance so that pinch points can be identified. The potential for pinch points or entanglement is reduced by installing guards to shield moving parts. Field team members must ensure that the guards are in place before operation. If guards have been broken, worn, or removed, the tool or equipment should be tagged and remain out of service until the guard has been replaced. The SSO will be responsible for maintaining a check list for inspection purposes. OSHA requires most equipment to be inspected annually. This inspection is typically conducted by the manufacturer, representative, or dealer. Documentation of inspections must accompany the equipment at all times.

Potential employee physical exposures shall be identified and evaluated for consistency with Laboratory and OSHA requirements. Physical exposures shall be reduced to an acceptable level through the use of engineering and work practice controls to the extent feasible. Additionally, personnel shall be properly protected in a manner consistent with Laboratory and OSHA requirements concerning PPE. PPE shall be provided to effectively eliminate potential for skin contact and to reduce potential inhalation to less than the PEL.

The minimum protection for any person who may come on the job site is as follows:

- a hard hat;
- safety glasses with side shields or goggles;
- appropriate work clothing including shirt with sleeves and durable pants such as jeans;
- gloves whenever materials are being handled: chemical-resistant gloves whenever there is a potential for contact with site contaminants (i.e., residue) and cotton gloves when performing manual tasks such as loading/unloading supplies, or handling or moving equipment and materials; and
- steel-toed safety shoes, made of leather or a chemical-resistant material.

Field team members shall work together to establish and maintain site control. Field management should prohibit entry to the work area to personnel who lack the minimum acceptable training and medical and safety equipment.

Chemical and physical hazards associated with this project will be eliminated as much as possible by engineering controls before work activities begin. These controls may include, as appropriate, barricading, guarding, posting signs, and verbally warning site personnel. None of the planned operations is inherently dangerous when performed by trained and experienced personnel working under safe conditions. The work crews will endeavor to maintain good working conditions through organization and through recognition of hazards before they result in injury and loss. Laboratory SOPs provide guidance to employees executing specific operations. Where possible, all field team members shall recognize, evaluate, and control physical hazards.

7.1.7.2 Noise

Hearing protection shall be worn in areas where noise levels are suspected or shown to exceed 85 dB. Field management will be responsible for identifying areas with high noise levels (continuous or intermittent) and on-site personnel will wear hearing protection devices in these areas as required. Warning signs will be posted.

7.1.7.3 Working in Confined Spaces

All confined spaces to be entered will be locked out/tagged out and electrically and/or mechanically de-energized. Lines entering and leaving will be broken/blanked off, and appropriate signs and personnel (safety watch) will be posted before any entry is made.

All workers entering confined spaces will have received prior training in confined-space procedures (Laboratory AR 8-1). The space will be evaluated and cleared by a designated "qualified person." The qualified person will have had training in confined-space procedures, supervised field training in the evaluation of confined spaces, and experience in conducting confined-space evaluations.

An initial hazard assessment will be conducted that includes atmospheric testing for oxygen deficiency, flammable gas concentration, toxic contaminants, and physical hazards. No entry will be made unless the oxygen concentration is between 20 and 22%, the flammable gas concentration is less than 10% of the LEL, the toxic contaminants concentrations are less than half of the PEL, and the physical hazards are controlled by engineering or administrative methods or by PPE.

Communication procedures will be established and reviewed between persons entering the space and the outside standby crew member before entry is made. A tailgate safety meeting with all crew members will be conducted before entry. Chemical, physical, and confined-space hazards that require PPE and emergency response procedures will be addressed.

7.1.7.4 Working around Potentially Energized Electrical Equipment

All electrical tools and equipment used shall be Underwriters Laboratory (UL) approved for the potential hazards existing where the equipment will be used. Electric tools and equipment will be double insulated. All electrical connections will be made through a ground fault circuit interrupter (GFCI). Fire extinguishers will be kept in sufficient number and locations to allow on-site personnel to extinguish all fires.

Each electrical connection or electric wire will be treated as live. Electric equipment and wires will not be touched with wet hands by a person standing on a wet surface. Electric cords will be disconnected from the outlet by grasping the plug, not by pulling or jerking the cord. Electric wires, extension cords, light cords, conduits, etc., will be located so that they cannot be tripped over, walked on, or otherwise damaged by pedestrian or other traffic. Extension cords will be protected from damage by routing them overhead and away from traffic areas. Electric tools and equipment will be kept from fuel sources, especially flammable liquids.

Drilling, trenching, and sampling activities may involve the potential for electrical shocks. The source of this hazard may be from overhead and underground utilities, use of portable equipment, and digging or hand-auguring into underground utilities. In addition, the following practices will also decrease the potential for shock:

- only qualified and licensed personnel will be permitted to operate potentially energized electrical equipment;

- heavy equipment and energized tools will be inspected by a competent person before use and will meet all applicable local, state, and federal standards;

- while in use, drill rigs will maintain a 35 ft minimum distance from overhead power lines; while in transit, the boom will be lowered, and the closest approach to a power line will be 16 ft;

- all areas to be drilled will be cleared through the Laboratory utilities manager before drilling begins;

- any cord with the grounding stem removed will be taken out of service and repaired or discarded; and

- GFCIs will be used on all portable electrical equipment.

7.1.7.5 Working around Heavy Equipment and Machinery

All heavy equipment will have a functioning back-up alarm. This alarm must be capable of producing sound at a frequency and intensity sufficient to overcome background noise and to be clearly audible to employees wearing hearing protection. Heavy equipment in stationary operation should be barricaded at a distance from ground personnel sufficient to avoid swinging cabs, counter weights, and booms.

The number of passengers in a vehicle will not exceed the number of functional seat belts available. Seat belts will be used at all times, and personnel will not ride on/in vehicles or equipment in a manner not designated for the conveyance of people. All equipment will be used in the manner for which it was intended. Drivers will operate the equipment in accordance with the manufacturer's instructions and in adherence to federal, state, and local regulations.

Weights for all items lifted will be calculated before lifting. The boom angle, cable, and auxiliary lines will be determined to have a rated-load margin of at least 20% greater than the weight of any lift. All rigging material used for a particular lift will represent a 50% margin of lift capability greater than the weight of the particular load.

Signaling the operator of a crane will be accomplished by means of hand signals rather than radio. All heavy equipment will carry at least a 5 lb multipurpose dry-chemical fire extinguisher.

A hazard associated with drilling is the potential failure of the wire rope. If the rope breaks under tension, it may cause severe injuries. The wire rope and its related parts will also be included in the inspection program.

7.1.7.6 Housekeeping

Work areas will be kept sufficiently clean and orderly so that work activities can proceed in an efficient and safe manner that will produce and maintain safety and quality. They will be adequately lighted, ventilated, protected, and accessible as appropriate for the work being performed. Machinery and equipment will be arranged and stored to permit safe, efficient work activities and to provide ease in cleaning. Tools and accessories shall be safely stored out of traffic areas.

Sufficient waste containers and receptacles shall be provided in appropriate locations and emptied frequently and regularly. Work areas and floors will be maintained free of debris, obstructions, foreign materials, and slippery substances such as oil, water, and grease.

Aisles, traffic areas, and exits will be maintained free of materials and debris. Combustible materials will be stored in approved containers and disposed of properly. Waste rags will be stored in metal containers. All flammable liquids will be stored in safety cans. Dangerous materials will be stored outside of the work area.

Site workers are held accountable for keeping their work areas free of housekeeping hazards.

7.1.7.7 Using Mechanical and Flame Cutting Equipment

Cutting, welding, or similar operations that produce heat, sparks, or open flames shall be sufficiently isolated from any potential combustible source. The area surrounding the activity will be inspected to ensure that no combustible materials are close by, or if they are and they are impractical to remove, that they are shielded or otherwise protected.

Oil- and grease-free clothing shall cover the body. Flame-retardant/resistant aprons, vests, leggings, capes, and gauntlet gloves will be worn as appropriate. Collars and cuffs of shirts and jackets will be buttoned, and pants cuffs will be turned up inside. Pockets should be eliminated or have button flaps. Welding helmets will have the proper shade of welding lens. Safety goggles or spectacles with tinted lenses will be worn under the welding helmet.

Sufficient ventilation will be provided in the welding or cutting area. Shields will be placed to protect others from welding-arc rays. A fire extinguisher will be assigned to the welding area.

7.1.7.8 Materials Handling

Gloves should be worn whenever material is lifted. Two or more workers may be required to lift a heavy or bulky item. A firm grip on material being moved and secure footing when lifting or handling a load is required. Fingers and toes should be in the clear before the item is set down. Material must be transported and stored in a stable manner to prevent falls, rolls, or slips. Material should be lifted with the legs and not the back. The movement of a long object must be controlled when it is carried through congested areas, on stairways, in passageways, or around blind corners. Pinch points should be avoided.

Whenever practical, a heavy item should be handled by mechanical or powered equipment. Workers should stay clear of material-handling equipment and the load being transported.

7.1.7.9 Temperature Extremes

High temperatures require personnel to be closely monitored for signs of heat exhaustion or heat stroke. Shaded areas and cool water will be provided.

In the winter, personnel must be protected from the effects of cold temperatures and wind, as well as from becoming wet during field operations.

The field management staff will evaluate personnel and operations throughout each day for impact of exposure to the elements. Special care should be taken during the first days of operation to allow site workers to become acclimated.

The following control measures can be used to help control heat-related disorders including:

- Providing adequate liquids to replace lost bodily fluids. Employees must replace water and salt lost from sweating and employees must be encouraged to drink more than the amount required to satisfy thirst. Thirst satisfaction is not an accurate indicator of adequate salt and fluid replacement. Replacement fluids can be a 0.1% salt water solution. Commercial fluid- and nutrient-replacement beverages are also effective.

- Establishing a work regimen that will provide adequate rest periods for cooling down. This may require additional shifts for workers.

- Using cooling devices, such as Vortex tubes or cooling vests, to be worn beneath protective garments.

- Informing all employees of the importance of adequate rest, acclimation, and proper diet in the prevention of heat stress. All breaks are to be taken in a cool rest area with a temperature of approximately 77°F.

Procedures for recognizing and avoiding cold stress must be implemented when the ambient temperature is less than 40°F.

If cold-stress symptoms are observed, move the individual to a warm, dry place and replace any wet clothing. If the patient is conscious and alert, gradually give the patient warm liquids, but no caffeine. Warm the patient's affected extremities with moist, lukewarm compresses; gradually increase the patient's temperature until normal circulation and temperature return. Seek medical attention for all but minor cold-stress cases.

7.1.7.10 Excavations

All excavations should be performed from a stable-ground position. A person trained in excavation safety will make daily inspections of the excavation. The inspector will determine the likelihood of cave-in, and remedial action, such as sloping or shoring, will be taken if the walls appear unstable.

All soil should be at least 2 ft from the edge of the excavation to prevent it from falling back into the excavation. The excavation should be guarded on all sides by barricades or caution tape at least 2 ft from the edges.

All field team members will participate in the daily tailgate safety meetings and will be instructed regarding the following requirements:

- Before excavating, the existence and location of underground pipes, electrical equipment, and gas lines will be determined. This will be done, if possible, by contacting the appropriate utility company and/or client representative to mark the location of the lines. If the client's knowledge of the area is incomplete, an appropriate device, such as a cable-avoiding tool, will be used to locate the service line.

- Combustible gas readings of the general work area will be made regularly.

- No ignition sources will be permitted if the ambient airborne concentration of flammable vapors exceeds 10% of the LEL during the excavation. A CGI will be used to make this determination.

- Operations must be suspended and the area vented if the airborne flammable concentration reaches 10% of the LEL in the area of an ignition source (i.e., internal combustion engine exhaust pipe).

- If excavating equipment is located near overhead power lines, a distance of 15 ft must be maintained between the lines and any point on the equipment. If the lines have appreciable sag or if windy conditions exist, this distance shall be 20 ft.

Trenches within the OU 1079 SWMUs must be excavated to a depth of less than 5 ft whenever possible; trenches with depths greater than 5 ft may require protective systems such as sloping, benching, or shoring. In addition, trenches at depths of 4 ft or more must have a means of egress available every 25 ft. Air monitoring must also be conducted within the trench. Soil piles, tools, and other debris must be stored at least 2 ft from the edge of the excavation. All excavations must be marked to restrict access when the area is not occupied. Field team members must be aware of the conditions inside the trench as well as any activities taking place outside the excavation.

7.1.7.11 Underground Hazards

The FTL must take any steps necessary to ensure that all underground utilities (i.e., electrical power sources, gas lines) have been located, and to ensure that all utilities to the site area have been neutralized. Drilling and digging where there may be buried utilities involves unacceptable risks.

Every effort will be made to notify utility companies and to obtain their assistance, along with that of Laboratory personnel, in identifying subterranean hazards. Additionally, drilling and digging operations will progress only if field management has reasonable assurance that objects, utilities, product lines, and other obstacles in the dig area have been identified and located. A magnetometer or similar device will be employed to assist in identifying subterranean hazards that are not adequately identified by other sources. Drillers will use a hand (manual) posthole digger to dig down the first 3 ft before inserting the drill auger. These measures should minimize the potential of encountering buried physical hazards.

If unmapped or unneutralized utilities are discovered or encountered during drilling and digging, work will stop immediately and will not be resumed until the hazard has been eliminated.

The various manholes, ventilation pipes, and entrances to below-ground areas represent hazards to personnel and vehicles traveling across the site. All of these hazards will be marked with stakes and warning tape as necessary to prevent personnel and equipment from standing on or driving over manholes, or running into vertical vent pipes. Open manholes or similar openings will be effectively roped off or barricaded.

Permits will be correctly completed and posted before any excavation or drilling operation begins.

7.1.7.12 Traffic

Traffic control will be maintained in and around the job site at all times to avoid personnel injuries and prevent equipment damage. Work areas regularly occupied by pedestrians will be delineated so that vehicle equipment operators will not encounter them. Delineation will be accomplished using barricades, warning signs, warning lights, traffic cones, and so forth.

If work takes place in or near heavy traffic areas, these areas will be appropriately marked with the aforementioned devices as necessary to protect personnel. Personnel will wear fluorescent orange and/or reflective clothing, vests, etc., when working in and around traffic areas.

Sufficient parking will be provided. Vehicles not being actively used will be parked so that they do not interfere with traffic. When a vehicle is being maneuvered in a confined area with limited visibility, personnel positioned outside the vehicle will assist the operator.

Pedestrians and civilian traffic have the right-of-way on site. Personnel on foot will be careful when around heavy equipment and when walking near roads. Ground personnel should always make eye contact and wait for a signal to proceed before passing close to or in front of operating equipment or moving vehicles.

All drivers and operators will adhere to speed limits, signs, and road markings. Equipment operators and ground personnel will be especially careful when air line respirators are in use because of the potential for injury if an air line were to become tangled in the track or wheel of a vehicle or equipment. Under no circumstances will systems supplying air to the respirators of ground employees be attached to vehicles or equipment.

7.1.7.13 Compressed Gases and Systems

Compressed gases will be used according to the supplier's instructions, Compressed Gas Association guideline documents, and the requirements of this HSPjP. Additionally, these gases will be used in a manner that prevents the development of a hazardous exposure potential to on-site personnel or bystanders.

Compressor hose segments will be secured using chains and/or locking pins. In addition to securing the segments, the pressurized hose will be connected to the compressor through a pressure-sensing device that will discharge the pressure if the hose pressure system fails (i.e., if the hose is cut).

Personnel are required to wear safety glasses and gloves when handling/hooking up compressed-gas cylinders or systems.

7.1.7.14 Breaking Concrete

Continuous real-time air monitoring must be provided throughout the operation. Controls will be used as necessary to establish and maintain an acceptable level of exposure. If monitoring is inconclusive, PPE will be provided to exposed employees.

The operation will be kept wet to reduce dust. Eye/face and respiratory protection must be used as necessary. Eye and face protection includes goggles, safety glasses with side shields, and/or a face shield that extends past the throat and attaches to a hard hat.

Hearing protection will be worn as required. If earplugs do not offer enough protection, earmuff-type hearing protectors and plugs will be used.

To combat the damaging effects of jackhammer vibration, rubber hand grips and padded gloves will be used to absorb the vibration. Lower-back protection, such as a belt designed for this purpose, will be required.

Pressure hoses supplying jackhammers will have a conductive pressure hose to limit the potential for electrical shock injuries to personnel in the event a previously unknown active electrical source is encountered.

7.1.7.15 Topography

To reduce hazards associated with topography, the SSO will inspect each site for potential hazards. Some of these hazards can be alleviated, such as removing any obstacles in immediate work areas, clearing icy surfaces, and placing tools in an accessible but protected area. Boundaries surrounding excavations, trenches, and boreholes will be marked. Field team members conducting site activities near the edge of a mesa will not be permitted to work closer to the edge than 5 ft.

Barrier tape will be used to designate this restricted area. One exception to this requirement is the sampling of outfall. In this instance, the worker will be tied off before descending over the edge. All field team members will be informed of the potentially hazardous locations as well as of the controls. Field team members will also be expected to observe good housekeeping practices for the duration of the work in each area.

7.1.7.16 Lightning

Lightning strikes the tallest object in an area and takes the fastest route into the ground through the best conductor; therefore buildings or vehicles provide better protection that being in the open. A large building with a metal structure is the safest because electric current will run along the outside metal frame and into the ground. An automobile with a metal roof serves the same purpose; however, convertibles or fabric- topped cars are not safe because lightning can burn through the fabric.

Wood or brick buildings that are not protected by lightning rods have high potential for a conducted strike, which travels down natural conductors such as wiring or pipes. Any contact with an ungrounded conductor can be dangerous. Telephones, faucets, electrical equipment, and metal fences are examples of ungrounded conductors.

A person in the open during a lightning storm should crouch to avoid being the tallest object. A tingling sensation or hair standing on end signals that lightning is about to strike and a crouching position must be assumed immediately. The safest crouching position is to place the hands on the knees and keep the knees and feet together while remaining as low as possible. Stretching out flat on damp soil could cause the body to attract current running into the ground from a nearby tree. Keeping feet and knees spread or placing the hands on the ground could complete a circuit and cause high-voltage current to run throughout the body.

A grove of trees affords more protection than remaining in the open or taking shelter under a single tree. Lower ground is also safer; however, taking cover in ditches and ravines presents the danger of being carried away by flood waters.

Side strikes injure more people than direct strikes. Side strikes are caused when electric current jumps from its present conductor to a more effective conductor. The human body is a better conductor than a tree trunk, so a person should stay 6 ft from a tree to avoid a side strike. A group of people taking shelter under a grove of trees should stand 6 ft apart to avoid side strikes from one person to another.

The force of electrical current temporarily disrupts the nervous system; therefore, even if breathing and heartbeat have stopped, a lightning victim may not be dead. Many victims can be revived by artificial respiration and CPR. Current is no longer running through the body once the lightning flash is over, and it is safe to touch a lightning victim. Even a victim who seems only slightly stunned should receive immediate medical attention because internal organs may be damaged.

7.2 Personnel Protective Equipment (PPE)

If engineering controls and work practices do not provide complete protection against hazards in OU 1079 SWMUs, field team members will be required to use PPE. PPE shields or isolates individuals from chemical, physical, biological, and some radiological hazards that may be encountered on site. Protection from these hazards is afforded to the respiratory system, skin, eyes, face, hands, feet, head, body, and ears. Two important criteria for selecting this equipment are the potential hazards on the site and the type of work to be performed. These choices are also balanced with the hazards that are associated with the equipment itself such as reduced mobility, dexterity, vision, and communication, as well as heat stress. Field team members must also be able to communicate when wearing hearing protection.

The EPA has established four levels of protection for workers involved with potentially hazardous materials on the basis of the degree of dermal and respiratory protection appropriate to the hazards at the site. Level A consists of maximum dermal and respiratory protection through the use of a fully encapsulating suit and air-supplying respirator. Level B maintains the maximum respiratory protection with a downgrade in dermal protection. The distinguishing feature for Level C is modified respiratory protection through an air-purifying respirator (APR). Level D is a basic work uniform.

Further information on the components of Levels A, B, C, and D and the selection criteria and limitations of each are presented in the following text. OU 1079 investigations will also be conducted according to Laboratory AR 12-1, "Personal Protective Equipment"; Laboratory TB 1201, "Eye and Face Protection"; TB 1202, "Protective Clothing"; and TB 1203, "Respiratory Protective Equipment." In addition, the site-specific special work permit for radioactive work will specify the appropriate protective clothing and equipment to be used on sites with known or suspected radioactive contamination.

7.2.1 Selection of PPE

This section details PPE to protect field team members from the various hazards discussed within this HSPjP. PPE required at individual OU 1079 SWMUs depends on the types of work to be conducted and the known, suspected, or unknown contaminants present. Table III-1 lists the levels of protection required for each SWMU.

PPE must be selected that will protect employees from the specific hazards they are likely to encounter during work on site. Selection of the appropriate PPE is a complex process that takes into consideration a variety of factors. Key factors involved in this process are identification of the hazards or suspected hazards and their routes of transmission to employees (inhalation, skin absorption, ingestion, and injection), and the performance of the PPE materials (and seams) in providing a barrier. The amount of protection provided by PPE is material-hazard specific; i.e., protective equipment materials will protect well against some hazardous substances and poorly, or not at all, against others. In many instances, protective equipment materials that will provide continuous protection from a particular hazardous substance cannot be found. In these cases, the breakthrough time of the protective material should exceed the work durations.

In some cases, layers of PPE may be necessary to provide sufficient protection or to protect expensive PPE inner garments, suits, or equipment. As more information about hazards and conditions on site becomes available, the SSO can make decisions to upgrade or downgrade the level of PPE to match the tasks at hand.

The following are guidelines that the SSO can use to determine the selection of the appropriate PPE. As noted previously, the site information may suggest the use of combinations of PPE selected from the different protection levels. The following does not fully address the performance of the specific PPE material in relation to the specific hazards at the job site. PPE selection, evaluation, and reselection is an ongoing process until sufficient information about the hazards and PPE performance is obtained.

7.2.1.1 Level A Protection

Level A protection is worn when a hazardous substance has been identified that requires the highest level of protection for the skin, eyes, and respiratory system on the basis of

- a measured or potential high concentration of atmospheric vapors, gases, or particulates;
- site operations and work functions that involve a high potential for splash, immersion, or exposure to unexpected vapors, gases, particulates, or materials that are harmful to the skin or capable of being absorbed through the skin;
- the known or suspected presence of substances with a high degree of hazard to the skin where skin contact is possible; or
- operations being conducted in confined, poorly ventilated areas.

Note: Level A protection will not be worn during the OU 1079 field investigation; therefore, no description of Level A PPE is given.

7.2.1.2 Level B Protection

Level B protection will be specified for situations requiring self-contained breathing apparatus (SCBA), and for situations in which the identity and quantity of contaminants is unknown. SCBAs will be used when

- oxygen levels are less than or equal to 19.5%;
- chemical concentrations exceed the PEL;
- the chemicals of concern do not have adequate warning properties;
- cartridges/canisters are not available for the chemicals and/or concentrations of concern; or
- the identity of the contaminant is unknown.

Level B protection consists of the following:

- a full-face, positive-pressure SCBA [Mine Safety and Health Administration (MSHA)/NIOSH-approved];
- contaminant-resistant clothing, such as Saranex or polyvinyl chloride (PVC), for dust and splash protection against chemicals of concern;
- inner gloves of latex surgical material;
- outer gloves of rubber, PVC, or nitrile, depending on suspected contaminants;
- rubber steel-toed safety boots with disposable boot covers;
- hard hat for protection from overhead hazards, with a hood for splash protection, and splash shields which are optional depending on activity and conditions; and
- hearing protection when the noise level exceeds 85 dB.

The SSO is responsible for workers adhering to the recommended level of PPE and may upgrade or downgrade the level of protection as additional information about site hazards becomes available.

7.2.1.3 Level C Protection

Level C protection will be considered in instances where a known chemical contaminant(s) has exceeded the specific PEL. An APR will be selected if the following criteria are met:

- oxygen levels are greater than 19.5%;
- chemical concentrations do not exceed the Immediately Dangerous to Life and Health (IDLH) levels;
- the chemical has adequate warning properties; and
- cartridges/canisters are designed for the chemicals and concentrations of interest.

Level C protection will include the following:

- full-face APR (OSHA/NIOSH-approved) with combination organic vapor/particulate cartridges or canisters capable of filtering out the chemicals of concern;
- contaminant-resistant clothing, such as Saranex or PVC, for dust and splash protection against chemicals of concern;
- inner gloves of latex surgical material;
- outer gloves of rubber, PVC, or nitrile, depending on suspected contaminants;
- rubber steel-toed safety boots with disposable boot covers in wet conditions;
- leather safety boots with disposable boot covers in dry conditions;
- hard hat for overhead hazard protection, with optional splash shields depending on activity and conditions;
- hearing protection where the noise level exceeds 85 dB; and
- escape mask for respiratory protection in the event of a release or of respirator failure.

7.2.1.4 Level D Protection

Level D protection can be used when the air contains no known hazard and work will not result in unexpected inhalation of or contact with hazardous levels of any chemicals. Level D protection will consist of the following:

- cotton or Tyvek coveralls;
- rubber, PVC, or nitrile outer gloves for chemical/particulate protection;
- leather gloves for abrasion protection;

- steel-toed safety boots for puncture/crush protection;
- optional boot covers for dusty or muddy conditions;
- hard hat with optional splash shield for protection from overhead splash hazards;
- safety glasses for splash and particulate protection;
- hearing protection (earplugs or earmuffs) if the noise level exceeds 85 dB; and
- escape mask for respiratory protection in case of an unsuspected release from which escape is necessary.

7.2.2 PPE for Task-Specific Hazards

The previously mentioned guidelines will apply to all work performed in OU 1079. Specific health and safety considerations for the activities conducted under the sampling and analysis plans in Chapters 5 through 8 of this work plan are discussed in the following text. Levels of protection for activities at each SWMU are outlined in Table III-1. Specific PPE levels were selected based on available site information as presented in Chapter 3 of this work plan.

7.2.2.1 Field Surveys

The field surveys for the SWMUs within OU 1079 may be performed in Levels B, C, or D protective clothing, depending on the potential hazard. Topographic, radiological, geomorphologic, and geophysical surveys may be performed in Level D.

Level C or D protection will be worn for most soil/gas survey work unless air monitoring indicates the presence of contamination. In that case, Level B will be worn until the situation meets the criteria for Level C protection. Level C respiratory protection will include both organic vapor and particulate cartridges. Leather gloves may be used to protect skin from friction during slam-bar action. The sampling effort may involve drilling through asphalt or concrete. Under these circumstances, site workers will wear hard hats, safety glasses, protective shields, dust masks, and hearing protection where necessary.

7.2.2.2 Surface Sampling

Surface sampling will involve collecting soil or sediment samples from the first 30 cm of soil. Site workers may wear Level B, C, or D protection, depending on the specific site conditions. Safety harnesses will be used by any member working at the edge of a mesa. Under extremely dusty conditions, site workers will take measures to suppress the dust. The appropriate air monitoring must also be performed.

7.2.2.3 Subsurface Sampling

The subsurface sampling program comprises a variety of activities that will involve drilling and excavation. Field team members will wear Level B protection during these activities until the situation meets the criteria for Level C protection. Regardless of the level of protection in use, field team members will wear gloves, safety boots, hard hats, and eye and ear protection, as required, during drilling operations.

Air monitoring for oxygen and flammable or toxic gases will be performed before drilling and excavating begin, especially in low-lying areas. Continuous monitoring for flammable or toxic gases will be conducted at the borehole during drilling or coring. Excavation or trenching operations will be monitored where soil is being disturbed. Completed excavations and trenches will be monitored periodically for oxygen and flammable or toxic gases.

The SSO is responsible for selecting the appropriate level of protection on the basis of the air-monitoring information. The initial levels of protection for these activities are discussed in the following paragraphs.

The level of protection for the installation of suction lysimeters and monitoring wells will depend on the type of SWMU being sampled. Level B protection will be used for the initial coring in the surface impoundments and trenches and for the suction lysimeter installation and coring. This level is required because of the potential for release of known and unknown hazardous materials. An electrochemical monitor will be worn by the sampling team to detect the presence of hydrogen cyanide. Once the installations are complete, the levels of protection may be downgraded if conditions permit.

Sampling beneath former drain lines and industrial waste (acid-waste) lines in former septic tank and sump locations can be performed in Level C protection unless air-monitoring results indicate otherwise. There may be cases when Level B protection and additional splash gear may be used.

7.3 Hazard Communication

In accordance with right-to-know legislation under 29 CFR Part 1910.120, site workers must be informed of potential hazards associated with a site before commencing work activities. The following sections describe the provisions for hazard communication to be observed during work in OU 1079.

7.3.1 Safety Meetings

Pre-entry briefings will be held before initiating any site activity. Safety meetings and safety inspections will also be conducted to ensure that the HSPjP is being followed.

7.3.2 Employee Information

The SSO shall ensure that the following DOE and Laboratory forms are posted where FTLs and field team members can easily read them (DOE 1982, 0056):

- DOE Order 5480.2, Form F "Occupational Safety and Health Protection" (DOE 1984, 0059);
- DOE Order 5480.4, Form F "Occupational Safety and Health Complaint Form" (DOE 1984, 0059);
- Laboratory Special Work Permit; and
- OSHA Job Safety and Health Protection Form.

The Laboratory health and safety standard concerning employees' right to know shall be posted at the work site.

7.3.3 Material Safety Data Sheets

Material Safety Data Sheets (MSDSs) describe the chemical/physical properties, exposure information, toxicological effects, and appropriate protection for chemicals used in the course of site work. The SSO will be responsible for obtaining the necessary MSDSs, and attaching them to this HSPjP.

8.0 SITE CONTROL

The objectives of site control are to protect employees and the general public from exposure to hazardous substances and conditions, and to prevent the spread of contamination. Site control entails the establishment of boundaries on the basis of the nature and extent of contamination at the site as well as on safe accessibility. Three general areas will be defined in this HSPjP: the exclusion zone, the Contamination-Reduction Zone (CRZ), and the support zone. Site access issues are also addressed in Section 7.0, Annex III of the IWP (LANL 1991, 0553).

The FTL and/or the SSO will walk the intended job site before the start of work. During the site walk, the following tasks will be accomplished:

- Determine how best to implement the HSPjP (e.g., set up zones, establish site control, place decontamination area(s), etc.) and whether variances must be made to the plan. If variances are necessary, the requirements in Section 2.4 of this HSPjP will be followed.

- Define the job site, work to be done, and potential health and safety impacts. Information gathered during the initial site entry and from the guidelines of this HSPjP will be used to determine if changes in personnel protective protocols (e.g., levels of protection) need to be made.

- Assess the work area and vicinity, especially noting areas, equipment, material, and conditions that can result in health and safety hazards. Special priority will be given to identifying all suspected conditions that may pose inhalation or skin-absorption hazards that are IDLH, and other conditions that may cause death or serious harm. Examples of such hazards include confined spaces, potentially explosive or flammable situations, visible vapor clouds, or the presence of biological indicators such as dead animals or vegetation. During this assessment, the SSO or a qualified designee will carry appropriate real-time air-monitoring equipment (i.e., hnu® PID, Draeger tubes, LEL/oxygen meter, etc.) capable of detecting airborne concentrations of potential site contaminants at their respective PEL as well as other hazardous (i.e., flammable/oxygen-deficient) atmospheres.

- Assimilate information for the first day's tailgate safety meeting (pre-entry briefing).

The FTL and the SSO will use the information that will be furnished by air monitoring with direct reading instruments and observation/testing of soils and sediments collected from boreholes and excavations to ensure continuing site control.

8.1 Exclusion Zone

The exclusion zone is the area in which contamination does or could occur. Due to the types of areas in which OU 1079 SWMUs are located, the implementation of boundaries for the exclusion zones will vary. The designation of the exclusion zone for each SWMU depends on the following factors:

- number and distribution of sampling locations;

- types and amounts of contaminants expected (including HE);

- air-monitoring results;

- use of mechanical equipment/heavy equipment (including drill rigs and backhoes);

- proximity to overhead and underground utility lines; and
- topography.

Access to the exclusion zone will be restricted to field team members who have direct responsibilities for sampling in this area and are wearing the appropriate PPE. Different zones with different levels of protection requirements can be established within the exclusion zone if necessary.

The hotline is the outer boundary of the exclusion zone. Depending on the location of the SWMU (i.e., isolated areas versus residential or commercial), the hotline will be marked in the most appropriate fashion. Barriers such as fences, barrier tape, or signs can be used depending on the circumstances.

8.2 Contamination Reduction Zone (CRZ)

The CRZ is the transition area between the contaminated area and the clean area. This zone serves as a buffer and prevents further spread of contamination from the site by providing a specified area for decontamination activities.

The CRZ will be upwind of the exclusion zone, if possible. The outer boundary of the zone is the contamination-control line, which will be indicated accordingly. Because of the potential presence of contamination in this area, support workers at the contamination-control line will wear the appropriate level of protection.

8.3 Support Zone

The support zone is the location of administrative and other support functions. This zone will also be upwind of the exclusion zone, if possible. Personnel are not required to wear PPE in this area.

8.4 Site-Control Procedures

To promote adequate site security, personnel safety, and smooth operation of the site activities, the following measures will be instituted as necessary:

- All information regarding work to be performed, emergency procedures, and health and safety hazards will be reviewed at a daily tailgate safety meeting. This meeting will occur before work begins.
- A copy of this plan will be available at the job work site.
- Only authorized personnel will be permitted in the work area. These individuals must have successfully passed a medical examination and have been properly trained in specific H&S and the use of respiratory protective equipment. All visitors must report to the FTL.

- All personnel entering the site will be thoroughly briefed on hazards, equipment requirements, safety practices, emergency procedures, and communication methods.

- Protective clothing and respiratory protective equipment will be used for various stages of the operation as needed. The levels of protection are described in Section 7.2 of this HSPjP and will depend on the degree of hazard.

- Food, beverages, and tobacco products will not be allowed in contaminated areas or potentially contaminated areas. Taking medication, smoking, and applying cosmetics are also prohibited. These activities are allowed only in the established clean room and clean areas.

- Before eating, drinking, or smoking, employees will remove outer protective garments and wash their hands.

- Before leaving the site at the end of each work shift, personnel who worked in contaminated zones will thoroughly shower or wash themselves to remove any contaminants.

- Containers will be moved only with the proper equipment and will be secured to prevent dropping or loss of control during transport.

- Emergency equipment will be located in readily accessible uncontaminated locations. A complete first-aid kit will be readily available on site. A fire extinguisher will be at the work site and will be readily available for the team's use in case of an emergency. It will be located not more than 25 ft from the work activity. An eyewash capable of washing both eyes at once and delivering at least 0.4 gal. of water per minute for at least 15 min will be readily available. At least one eyewash will be maintained in the CRZ.

- Employee entrance and exit routes will be planned and emergency escape routes will be designated. A map showing emergency escape routes will be posted at the site.

- Work areas will be illuminated to a minimum of 20 footcandles. Supplementary lighting may be necessary at night, inside buildings and tanks, or in poorly lit areas.

- All operators of equipment used on site will be familiar with the requirements for inspection and operation of such equipment. Unfamiliar operations will be discussed with affected employees before work begins. The FTL will be responsible for checking the proficiency of the operator. Perimeter barricades will be placed around the equipment used in a fixed location. Audio and/or visual back-up alarms will be used on all heavy equipment on site.

- Personnel will be transported only by means prescribed for movement of personnel. When trucks or other heavy equipment enter or leave the site, an individual shall direct the driver.

- Electrical equipment will not be permitted in areas where a flammable atmosphere may exist. All static ignition sources will be identified and eliminated through use of bonding and grounding techniques.

MSDSs will be obtained for every chemical product used on site. This information will be stored in a central location and made readily available to all employees upon request. MSDSs, or applicable information, will be available with regard to materials used in soil-collection and drilling activities. All containers of any chemical products will be properly labeled to comply with the OSHA Hazard Communication Standard (29 CFR Part 1910.120).

On-site personnel will use the buddy system. Buddies will maintain visual contact with one another. Personnel must observe each other for signs of heat stress or toxic exposure such as

- changes in complexion and skin discoloration;
- changes in coordination or demeanor;
- excessive salivation and pupillary response; or
- changes in speech pattern.

Personnel will inform the supervisor of nonvisual effects of toxic exposure such as

- headaches, dizziness, or blurred vision;
- nausea or cramps; or
- irritation of eyes, skin, or respiratory tract.

Walking and working surfaces may become wet and slippery while employees are performing tasks, requiring extra caution. Visible barriers will be erected around any open excavations. Employees will keep the work and support areas neat and orderly and free of trash and debris.

A designated break area will be upwind from the excavation area and outside the CRZ. The area must be clearly marked and no contaminated personnel or equipment will be permitted.

If the facility does not have a water supply available, potable water will be carried to the site for use in decontamination and employee cleanup activities. All refuse will be deposited in designated containers while on site. The FTL and the SSO have the responsibility to ensure that the area is kept clean.

9.0 DECONTAMINATION PROCEDURES

This section outlines the procedures for an effective decontamination plan. Decontamination is the process of removing or neutralizing contaminants that have accumulated on equipment and personnel in a sequential fashion. The objectives of the decontamination process are to protect workers from exposure to the contaminants and to minimize the transfer of contaminants into clean areas.

The degree of expected contamination depends on the tasks to be conducted under the sampling and analysis plans in Chapters 5 through 8 of this work plan. Contact with hazardous substances is possible; therefore, it will be assumed that all personnel and equipment engaged in field activities will be potentially contaminated and that the appropriate level of decontamination is required. The types of material to be addressed by decontamination procedures for OU 1079 include the following:

- contaminated soil in the form of dust or mud;
- contaminated sediment and sludge; and
- contaminated liquid or aerosol resulting from splashing or spraying.

General guidelines for decontamination are cited in Sections 7.0 and 10.0, Annex III of the IWP (LANL 1991, 0553). A decontamination plan will be developed and implemented before any personnel may enter areas where the potential for contamination exists. Personnel performing decontamination for the ER Program must certify that they have read and understood this procedure as well the procedures in the IWP (LANL 1991, 0553).

9.1 Contamination Prevention

Minimizing contamination at the outset promotes effective decontamination. The following preventive measures should be taken:

- avoid contact with hazardous substances as much as possible;
- use remote sampling, handling, and container-opening techniques;
- encase instruments and equipment with bags or coatings;
- bag or coat the exterior of sample containers; and
- use disposable garments and equipment where appropriate.

9.2 General Equipment Decontamination

The supplies necessary for equipment decontamination include solutions for decontamination, the appropriate cleaning supplies, and protective gear for personnel conducting decontamination. The level of protection required for decontamination support personnel will be adjusted according to the degree of contamination that is expected or determined.

All equipment used during the field procedures will be subject to decontamination procedures, except for disposable items. The types of equipment to be employed during sampling include monitoring equipment, sampling tools, heavy equipment, and vehicles. In addition, contamination must be removed from the exterior of sample containers to prevent exposure to field team members and laboratory personnel. Plastic bags must be sealed with a rubber band at the neck of the container to minimize the potential for gross contamination on site. The contents of the bags can be transferred to clean bags at the hotline and any residual contamination can be removed. The decontamination process must be designed to avoid contaminating the sample.

Reusable protective equipment must be decontaminated using a soap-and-water wash and two successive rinses. All heavy equipment and vehicles that are suspected of contamination must be steam-cleaned using high-pressure washers. All decontamination rinsate must be collected in approved containers.

9.3 Personnel Decontamination

The supplies and equipment necessary for decontamination of personnel correspond to the level(s) of protection in use on site. Personnel decontamination equipment consists of solutions and cleaning supplies, air tanks/respirator cartridges, a rest area, and a shower facility.

Personnel decontamination should be performed for all levels of protection. Decontamination stations will be located in the CRZ. The degree of decontamination required will depend on the nature and magnitude of contamination.

9.4 Decontamination Support

If the sampling crews need assistance with decontamination, field team members will serve as support. Support team responsibilities will include setting up the decontamination line, maintaining supplies, briefing the sampling crews in the decontamination line, and implementing emergency decontamination plans.

During the briefing sessions for the decontamination process, the support team will apprise the sampling team of the proper steps and activities at each station. In cases in which a relatively involved decontamination line exists, the sampling teams will proceed through a dry run before the decontamination line goes into operation.

Emergency decontamination may be necessary for persons who must evacuate the site under emergency conditions or because of injury. These procedures are detailed in Section 10.0, Annex III of the IWP (LANL 1991, 0553). It is imperative that the support team be prepared to perform these procedures.

The level of protection used by the support team will depend on the degree of contamination that is anticipated. In general, the support team will use Level C protection when field team members are dressed in Level B or C clothing. A decontamination support team will not be necessary where Level D protection is used.

9.5 Disposal Procedures

Disposable clothing and equipment will not need to be decontaminated, but will be considered hazardous waste. In addition, all decontamination solutions and rinse water will be contained, collected, and handled of as suspected hazardous waste. Arrangements will be made with the Laboratory for acquisition and disposal of drums containing soapy water, rinse water, methanol, and trash.

9.6 Decontamination Verification

The decontamination of any equipment or protective gear to be removed from a contaminated area to a controlled or uncontrolled area must be done with HS-1 approval and oversight. Protective clothing and equipment will be visually inspected for the effectiveness of decontamination.

10.0 EMERGENCY-RESPONSE PROCEDURES

This section presents the emergency-response plan, describes contingency plans for specific types of emergencies, describes the actions required by the Laboratory in the event of a release of radioactive/toxic materials, and outlines pertinent requirements for notification and documentation of emergencies. Additional references for this section include Sections 6.0 and 13.2, Annex III of the IWP (LANL 1991, 0553); Laboratory AR 1-1, "Accident/Incident Reporting"; AR 1-2, "Emergency Preparedness"; AR 1-8, "Working Alone"; and Laboratory TB 101, "Emergency Preparedness."

The SSO, with assistance from the FTL, will have responsibility and authority for coordinating all emergency-response activities until the proper authorities arrive and assume control. A copy of the emergency-response plan will be available at the site at all times and all personnel working at the site will be familiar with the plan.

10.1 Emergency-Response Plan

This section describes the elements of the emergency-response plan for OU 1079. This plan will be adjusted for conditions specific to each SWMU.

10.1.1 Emergency Contacts

The names of persons and services to contact in case of emergency are provided in Attachment III-3. This emergency-contact form will be copied and posted in prominent locations at the site. Two-way radio communication will be maintained at remote sites when possible.

10.1.2 Site Mapping

A copy of the site map will be modified to indicate the following areas of importance in the emergency- response plan:

- hazardous areas (especially potential IDLH atmospheres);
- site terrain (topography, buildings, barriers);
- site accessibility by road and air (with a current indication of detours);
- work zones/work crew locations;
- surrounding population/environment;
- shelters and safe areas; and
- evacuation routes.

10.1.3 Site Security and Control

In an emergency, the FTL (or a designee) is responsible for controlling the entry of personnel into hazardous areas and accounting for all individuals on site. Depending on the nature and size of the SWMU, a checkpoint will be established in advance for control. The buddy system will remain in effect at all times for personnel working on site. If a security problem occurs, one short blast will be sounded from an air horn and field team members will remain in place to await instructions from security.

10.1.4 Communications

Internal communication involves communication between field team members. The objectives of internal communication are to alert workers to danger, convey safety information, and maintain site control. Routine communications for OU 1079 will depend on the area represented by the work zones and the tasks associated with that area. Where there is substantial distance between the workers providing support and the workers conducting sampling activities, two-way radio communication will be employed. A set of predetermined hand signals will be used if radio communication fails. This contingency is especially important for workers wearing Levels B and C protective equipment.

Emergency communication will also be established for the site. An air horn will be used to notify field team members of the following conditions:

- major fire -- two long blasts;
- major release of hazardous substances -- two short blasts;
- minor fire or release -- one long blast; and
- security problem -- one short blast.

A description of all signals will be posted in a prominent location at the site.

External communication will be necessary to request assistance or to notify the appropriate authorities about hazardous conditions that may affect public or environmental safety. The names and phone numbers of appropriate contacts will be posted in a prominent location. If a telephone is not available on site, the nearest public telephone will be located in advance. All site personnel must be informed of this location.

Communication protocols will be explained at the daily tailgate safety meetings and reviewed at least once a week for the duration of site operations.

10.1.5 Evacuation Routes/Procedures

If a fire, explosion, or release of potentially hazardous materials occurs, field team members may need to retreat to a safe area or evacuate the site. Field team members should assemble at a predesignated, safe site if an evacuation is necessary. Procedures for evacuation will depend on the nature and size of the SWMU under investigation.

If the area is relatively small and/or unconstrained, field team members will be able to exit the exclusion zone at the most convenient point, preferably in the upwind direction. Areas that are expected to be safe will be indicated on the site map.

At sites in which a relatively large exclusion zone exists or in areas that are constrained in some way (e.g., surrounded by a fence, located within a trench, bordered by steep cliffs), evacuation routes will be established in advance and illustrated on the site map.

In either case, all field team members will report to a designated checkpoint to be accounted for by the FTL. All field team members will be informed of the evacuation procedures specific to each SWMU.

10.1.6 Emergency Equipment and Supplies

The SSO (or a designee) will be responsible for maintaining emergency equipment and restocking supplies. The type and amount of emergency equipment will be selected on the basis of the potential hazards.

10.2 Specific Emergencies

10.2.1 Fire/Explosion

Fire extinguishers may be effective for small, contained fires. One long blast of an air horn will signal a minor fire or release. Field team members will meet and be counted at a designated checkpoint. For a major fire or explosion, evacuation will be signaled by two long blasts. Field team members will report to a specified location (such as evacuation vehicles) and proceed away from the fire. A designated individual will locate the nearest phone at a safe distance and call the Los Alamos County Fire Department at 911. If an explosion occurs, all personnel will be evacuated and no one will re-enter the work area until it has been cleared by Laboratory explosives safety personnel.

10.2.2 Radiation/Chemical Exposures

A minor release of potentially hazardous materials will be indicated by one long blast of an air horn. All personnel will assemble at the designated checkpoint and be counted by the FTL (or a designee). The SSO will issue further instructions.

Two short blasts of an air horn will alert field team members to a major release involving hazardous or radioactive materials. Field team members will meet at a checkpoint predetermined on the basis of wind direction. A portable wind sock or streamer will be positioned at each site. When the horn is sounded, all field team members will move in an upwind direction, avoiding the plume. If the source of the release is directly upwind, field team members will move to the exit and away from the plume. Once the team achieves a safe distance, the FTL and the SSO will account for all site personnel. The SSO will determine a further course of action.

Exposure to radiation and/or chemicals should be reported to the Laboratory's Occupational Medicine Group, HS-2. The Los Alamos County Medical Center should be notified of life-threatening or serious exposures. If a field team member is exposed to hydrofluoric acid, a special paste must be obtained from HS-2 and applied to the patient's affected area(s), and the hospital must be notified immediately.

10.2.3 Injuries

Trained personnel may treat minor injuries on site. Seriously injured victims should be transported to a medical facility as soon as possible. The Los Alamos County Fire Department provides emergency transport services.

If an injured person has been contaminated with chemicals, decontamination will be performed only if it will not aggravate the injury. Emergency decontamination is discussed in Section 10.0, Annex III of the IWP (LANL 1991, 0553).

10.2.4 Vehicle Accidents/Property Damage

In addition to the required police report, DOE has established reporting requirements for a vehicle accident. These requirements are described in Section 10.4 of this HSPjP. Injuries incurred in an accident will be treated in the manner described in Section 10.2.3 of this HSPjP.

10.3 Provisions for Public Health and Safety

Emergency planning is presented in the Laboratory's ES&H Manual (LANL 1990, 0335). The Laboratory identifies four situations in which hazardous materials may be released into the environment. These categories are founded, in part, on Emergency Response Planning Guideline (ERPG) concentrations. These concentrations were developed by the American Industrial Hygiene Association (AIHA) and on the basis of the maximum concentration of toxic material that can be tolerated for up to one hour.

The four types of emergencies are defined as follows:

- UNUSUAL EVENT: An event that has occurred or is in progress that normally would not be considered an emergency, but that could reduce the safety of the facility. No potential exists for significant releases of radioactive or toxic materials off site.
- SITE ALERT: An event that has occurred or is in progress that would substantially reduce the safety level of the facility. Off-site releases of toxic materials are not expected to exceed the concentrations defined in ERPG-1.

- SITE EMERGENCY: An event that has occurred or is in progress and that involves actual or likely major failures of facility functions necessary for the protection of human health and the environment. Off-site releases of toxic materials may exceed the concentrations described in ERPG-2.

- GENERAL EMERGENCY: An event that has occurred or is in progress that substantially interferes with the functioning of facility safety systems. Off-site releases of radioactive materials may exceed protective response recommendations and toxic materials may exceed ERPG-3.

The ERPG concentrations, as well as the appropriate emergency response actions, are summarized in Section 6.0, Annex III of the IWP (LANL 1991, 0553).

10.4 Notification Requirements

Field team members will notify the SSO of emergency situations. The SSO is responsible for notifying the appropriate emergency assistance personnel (e.g., fire, police, and ambulance), the OUPL, and the Laboratory HS Division Office according to DOE Order 5500.2B (DOE 1991, 0736), DOE/AL Order 5000.3 and 5500.2B (DOE 1991, 0736). The Laboratory HS Division Office is responsible for implementing notification and reporting requirements according to DOE Order 5484.1 (DOE 1990, 0733).

10.5 Documentation

An unusual occurrence is any deviation from the planned or expected behavior or course of events in connection with any DOE or DOE-controlled operation if the deviation has environmental protection, safety, or health protection significance. Examples of unusual occurrences include any substantial degradation of a barrier designed to contain radioactive or toxic materials, or any substantial release of radioactive or toxic materials. Proper reporting procedures are detailed in Section 13.2, Annex III of the IWP (LANL 1991, 0553).

The Laboratory principal investigator will submit a completed DOE Order Form 5484.X for any of the following accidents/incidents, according to Laboratory AR 1-1:

- Occupational injury is any injury such as a cut, fracture, sprain, or amputation that results from a work accident or from an exposure involving a single incident in the work environment. Note: Conditions resulting from animal bites, such as insect or snake bites, or from one-time exposure to chemicals are considered injuries.

- Occupational illness of an employee is any abnormal condition or disorder, other than one resulting from an occupational injury, caused by exposure to environmental factors associated with employment. It includes acute and chronic illnesses or diseases that may be caused by inhalation, absorption, ingestion, or direct contact with a toxic material.

- Property damage losses of $1,000 or more are accidents that cause damage to DOE property, regardless of fault, or accidents wherein DOE may be liable for damage to a second party, are reportable where damage is $1,000 or more. They include damage to facilities, inventories, equipment, and properly parked motor vehicles. Excluded is damage resulting from a DOE-reported vehicle accident.

- Government motor-vehicle accidents resulting in damages of $150 or more or involving an injury, unless the government vehicle is not at fault, damage of less than $150 is sustained by the government vehicle, and no injury is inflicted on the government-vehicle occupants. Accidents are also reportable to DOE if

    - damage to a government vehicle not properly parked is greater than or equal to $250;

    - damage to DOE property is greater than or equal to $500 and the driver of a government vehicle is at fault;

    - damage to any private property or vehicle is greater than or equal to $250 and the driver of a government vehicle is at fault; or

    - any person is injured and the driver of a government vehicle is at fault.

The ER Program Health and Safety Project Leader will work with the OUPL and the FTL to ensure that health and safety records are maintained with the appropriate Laboratory group, as required by DOE orders. The reports are as follows:

- DOE/AL Order 5000.3, "Unusual Occurrence Reporting System" (DOE 1991, 0737);

- DOE Form F 5484.3, Attachment 1, "Supplementary Record of Occupational Injuries and Illnesses," DOE Order 5484.1 (DOE 1990, 0733);

- DOE Form F 5484.4, Attachment 2, "Tabulation of Property Damage Experience," DOE Order 5484.1 (DOE 1990, 0733);

- DOE Form F 5484.4, Attachment 4, "Report of Property Damage or Loss," DOE Order 5484.1 (DOE 1990, 0733);

- DOE Form F 5484.7, Attachment 14, "Annual Summary of Exposures Resulting in Internal Body Depositions of Radioactive Materials," DOE Order 0484.1 (DOE 1990, 0733);

- DOE Form F 5484.8, Attachment 10, "Termination Occupational Exposure Report," DOE Order 5484.1 (DOE 1990, 0733);
- DOE OSHA-200, Attachment 7, "Log of Occupational Injuries and Illnesses," DOE Order 5484.1 (DOE 1990, 0733);
- DOE Form EV-102A, Attachment 8, "Summary of Department of Energy and Department of Energy Contractor Occupational Injuries and Illnesses," DOE Order 5484.1 (DOE 1990, 0733);
- DOE Form F 5821.1, Attachment 12, "Radioactive Effluent/Onsite Discharges/Unplanned Releases," DOE Order 5484.1 (DOE 1990, 0733).

Copies of these reports will be stored with the appropriate Laboratory group. Specific reporting responsibilities are given in Section 1, General Administrative Requirements, of the Laboratory ES&H Manual (LANL 1990, 0335).

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ACGIH (American Conference of Governmental Industrial Hygienists) 1990. 1990-1991 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices, ACGIH, Cincinnati, Ohio. **(AECIH 1990, 0726)**

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DOE (U.S. Department of Energy), December 13, 1982. "Hazardous and Radioactive Mixed Waste Management," DOE Order 5480.2, Washington, DC. **(DOE 1982, 0056)**

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Response Support Division, Environmental Response Team, Washington, DC. **(EPA 1988, 0609)**

LANL (Los Alamos National Laboratory), June 1, 1990. "Environment, Safety and Health Manual," AR 10-3, Chemical, Hazardous and Mixed Waste, Los Alamos, New Mexico. **(LANL 1990, 0335)**

LANL (Los Alamos National Laboratory), May 1991. "Generic Quality Assurance Project Plan," Rev. 0, Environmental Restoration Program, Los Alamos, New Mexico. **(LANL 1991, 0412)**

LANL (Los Alamos National Laboratory), November 1991. "Installation Work Plan for Environmental Restoration," Revision 1, Los Alamos National Laboratory Report LA-UR-91-3310, Los Alamos, New Mexico. **(LANL 1991, 0553)**

NIOSH (National Institute for Occupational Safety and Health), OSHA (Occupational Safety and Health Administration), USCG (U.S. Coast Guard), and EPA (U.S. Environmental Protection Agency), October 1985. "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities," Washington, DC. **(NIOSH et al. 1985, 0414)**

OSHA (Occupational Safety and Health Administration), July 1, 1991, Title 29. Code of Federal Regulations (CFR) Part 1910.120, "Hazardous Waste Operations and Emergency Response," Washington, DC. **(OSHA 1991, 0610)**

Seitz, D. and G.W. Bequette, September 1991. "Los Alamos National Laboratory Emergency Response Plan," Los Alamos National Laboratory, Los Alamos, New Mexico. **(Seitz and Bequette 1991, 0753)**

Attachment III-1

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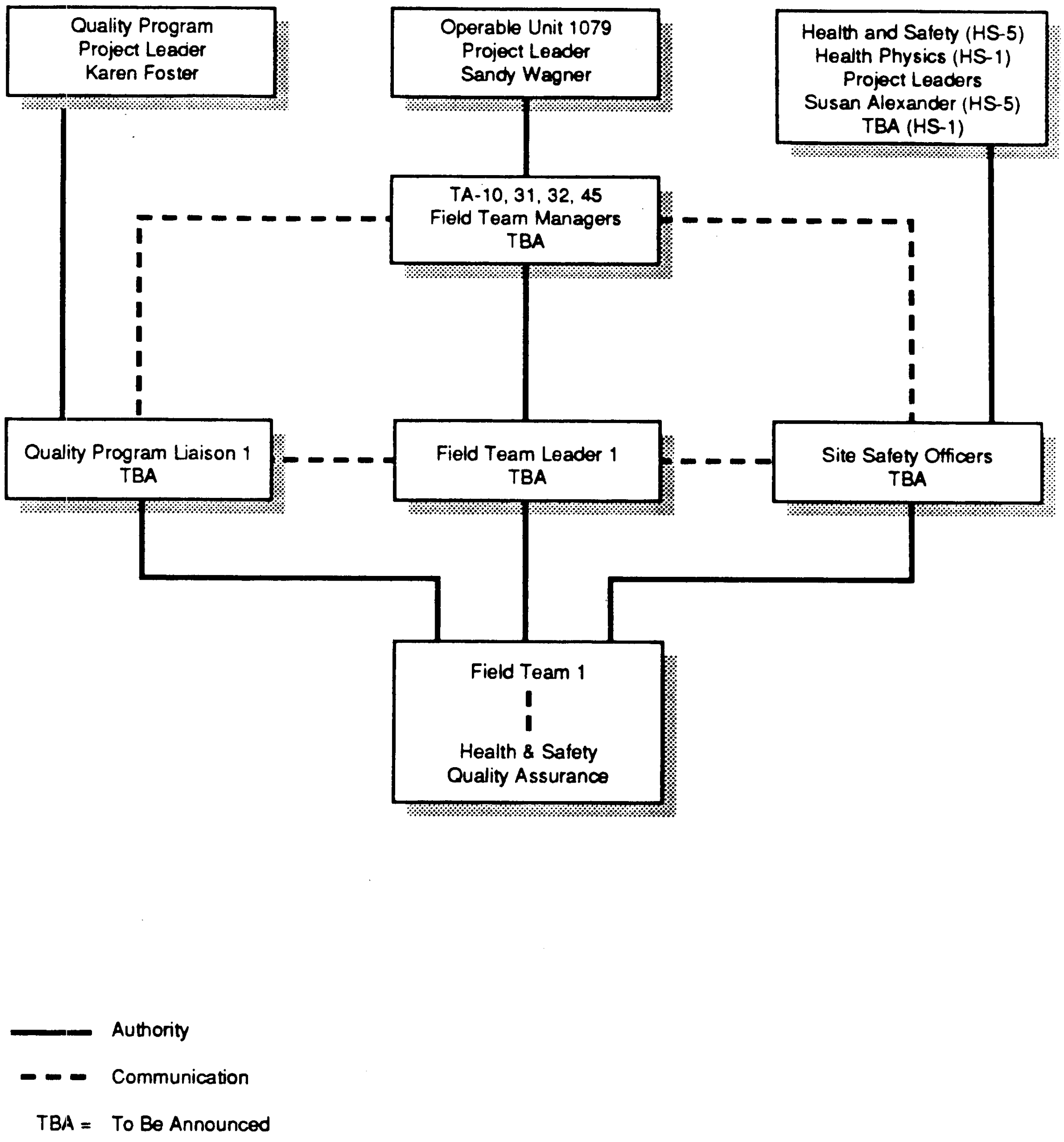


OU1079 Field Work Organization Chart Showing Health and Safety and Quality Assurance Responsibility.

ATTACHMENT III-2

HEALTH AND SAFETY CHECK LIST
HSPjP
OPERABLE UNIT 1079

Date:________Time:_________FIELD TEAM LEADER Signature________________________________

SITE SAFETY OFFICER Signature:_________________________________

Activities being conducted, equipment being used, general condition and effectiveness of decontamination, PPE being worn:

____

____

____

____

____

____

A key indicator of a well-maintained and safely operated site is the appearance of the work area on a daily basis. Work area appearance and safety are the responsibility of all personnel. Work areas shall be straightened on a daily basis before work stops. Time should be set aside at the end of each work period to remove trash, tools, spare parts, extra materials, rags, plastic, and so forth. Work should be stopped and a general cleanup should be conducted whenever trash, dirt, or other materials are being spread beyond the immediate work area. The Site Safety Officer will complete this check list during a daily health and safety inspection tour of the work area.

This check list is designed so that any "no" responses are indicators of a safety or health deficiency. If any question does not apply, an "NA" will be placed on the line. Not all questions will be applicable to all sites. All "no" responses should be followed up with a written explanation, the corrective action taken, and the date.

HEALTH AND SAFETY CHECK LIST
Page 1 of 6

TRAINING	YES	NO
Is a daily tailgate safety meeting held and documented?		
Are all visitors to the site properly signed in and given site-specific orientation and safety training?		
Are all persons entering the site informed of the contents of the H&S Plan and required to sign a statement indicating such?		
Have all persons entering the site received the appropriate hazardous waste training and is this training documented?		
Have all persons entering the site received a respirator fit test and training?		
Have all persons entering the site received training (hazard communication) on all hazards that may be encountered?		
Have all persons entering the site received the required physical examination?		
Is the H&S Plan available for on-site inspection and review by employees, etc.?		
Are emergency reporting and evacuation procedures known by each person on site and documented on the Emergency Contact sheet?		
Are all persons who enter confined spaces properly trained?		
Is the site-specific organizational structure chart posted at the job site?		
Are personnel who work on or near drill rigs instructed in the location and use of the rig's "kill" switch?		
Do heavy equipment and crane operators possess appropriate and up-to-date required licenses/certifications/permits?		
Are copies of all training records kept on site?		

INSPECTIONS	YES	NO
Are regulated areas established and defined for each work area in which contaminated materials may be present?		
Is hearing protection worn in areas where sound levels are suspected or shown to exceed 85 dB?		

HEALTH AND SAFETY CHECK LIST

Page 2 of 6

INSPECTIONS (Continued)	YES	NO
Are all persons on site using the minimum protective equipment (hard hat, safety glasses with side shields or goggles, steel-toed safety shoes) and appropriate clothing for the anticipated hazards?		
Is there a multipurpose dry-chemical fire extinguisher on each piece of heavy equipment?		
Are all fire extinguishers inspected monthly?		
Is the "no smoking" policy enforced?		
Are approved safety containers used to store fuels?		
Do all contaminated scrap, waste, debris, and clothing containers have labels?		
Is the food and beverage consumption prohibition enforced in the regulated area?		
Is there a method available for employees to wash their faces and hands with soap and water before eating and drinking?		
Are contaminated materials stored in tightly closed containers in well-ventilated areas?		
Does all heavy equipment have a functioning back-up alarm?		
Is the buddy system in use throughout the site?		
Is access to the regulated areas controlled so that only authorized personnel are permitted to enter?		
Is a daily log maintained of persons entering the regulated area?		
If benzene is present, are warning signs and benzene hazard signs posted?		
Are MSDSs for the hazardous materials posted at the site?		
Are contact lenses <u>not</u> worn with respiratory protection?		
Are all persons required to wear respirators clean-shaven before each day's shift?		

HEALTH AND SAFETY CHECK LIST

Page 3 of 6

INSPECTIONS (Continued)	YES	NO
Are adequate potable liquids provided at the job site?		
Is periodic air monitoring conducted?		
Are air-monitoring instruments calibrated daily before use?		
Are emergency services and equipment available at the site and is equipment in appropriate condition?		
Are provisions made for adequate flushing of the skin or eyes in the event of contaminated exposure?		
Are dry-chemical ABC fire extinguishers provided at each site?		
Do all work activities begin after sunrise and end before sunset?		
Are potable water containers clearly marked as to their contents and not used for any other purpose?		
Are outlets for nonpotable water clearly marked?		
If permanent toilet facilities are unavailable, are chemical toilets provided?		
Do employees shower at the end of their work shift and when leaving the hazardous waste site?		
Are appropriate warning signs placed around open excavations?		
Are excavations sloped (1 ft to 1 ft), or shored if more than 4 ft deep?		
Is a standby person available when entry into an excavation is required?		
Are appropriate access methods, such as ladders, used to enter the excavation?		
Are equipment and materials stored and handled at all times so as not to endanger personnel?		
Is a check-in/check-out roster maintained at the site?		
Are crane operators controlling the lift area maintaining a safe perimeter to prevent any site personnel from coming under or within an unsafe distance of a live load?		

HEALTH AND SAFETY CHECK LIST

INSPECTIONS (Continued)	YES	NO
If personnel are required to work in or near high-traffic areas, are they wearing fluorescent orange and/or reflective clothing or vests?		
Are vehicles not actively used in operations parked so that they do not interfere with work or traffic?		
Are cutting and welding operations not allowed within 300 ft of a potential liquid-fuel source or a building?		
Are supplied air respirators required for employees performing hot work on painted, galvanized, coated, or previously contaminated metal?		
Are two 10-lb or more ABC multipurpose fire extinguishers available in the immediate vicinity of hot work?		
Are seat belts used by persons riding in/on vehicles and equipment?		
Are personnel riding in/on vehicles or equipment in a manner designated for the conveyance of people?		
Is noncrane heavy equipment used to pull (lift) material properly equipped and designed to do so?		
Is a drilling-equipment safety-inspection report completed by the drilling operator before beginning any site work?		
Is all equipment used to handle or transfer flammable liquids bonded and grounded, spark proof, and explosion proof, as appropriate?		
Are all fuels stored in approved safety containers?		
Are fuel storage locations marked with the warning signs, "Flammable Liquids" and "No Smoking"?		
Are spark-proof hand tools used when working with flammable/combustible materials or when breaking lines?		
Are safety glasses and gloves worn when handling or hooking up compressed-gas cylinders?		
Are compressor hose segments secured using chains and/or locking pins?		
Are all electric connections made through a GFCI?		

HEALTH AND SAFETY CHECK LIST

Page 5 of 6

INSPECTIONS (Continued)	YES	NO
Are extension cords routed and stored to prevent damage and tripping hazards?		
Does a second person secure or steady a ladder while an employee is ascending and descending?		
Is stockpiled soil piled at an angle less than 45 degrees and at least 2 ft from the edge of an excavation?		
Is the regulated area isolated from the rest of the work site in a manner that minimizes the number of employees exposed to site containers?		
If heat stress is a concern, has a work/rest regimen been established and implemented, including physiological monitoring?		
If contaminants at the site are unknown, is Level B protection worn?		
Are suitable quantities of absorbent, appropriate drums and labels complying with DOT, OSHA, and EPA regulations on hand where leaks, spills, or ruptures may occur?		
Have procedures for all phases of decontamination been developed and implemented?		
Is the direction of emergency egress away from high-hazard areas?		
Are means of emergency egress maintained free of obstructions and available for full and instant use?		
Are work areas kept clean and in good repair with no unnecessary holes or openings?		
Are wastes (noncontaminated) kept in a closed, nonleaking sanitary container and removed as often as necessary and appropriate in a manner that would avoid creating a health or safety problem?		
Are appropriate labels provided on all chemical containers?		
Are storage areas free of accumulation of materials that could constitute a hazard from tripping, fire, explosion, or pest harborage?		
Is vegetation within the site controlled?		

HEALTH AND SAFETY CHECK LIST

Page 6 of 6

INSPECTIONS (Continued)	YES	NO
Is electrical equipment free of recognizable hazards that could cause injury?		
Are all machines maintained to prevent someone from being in the danger zone during the operating cycle?		
Are electrical equipment, cords, plugs, and cord sets inspected each day for external defects, deformed, broken, or missing pins, insulation damage, and indications of internal damage?		
Are extension cords protected from damage?		
Are flexible cords used only in continuous lengths without splices or tape?		
If compressed air is used, is it reduced to 30 lbs/in^2 or less with a chip guard?		

ATTACHMENT III-3

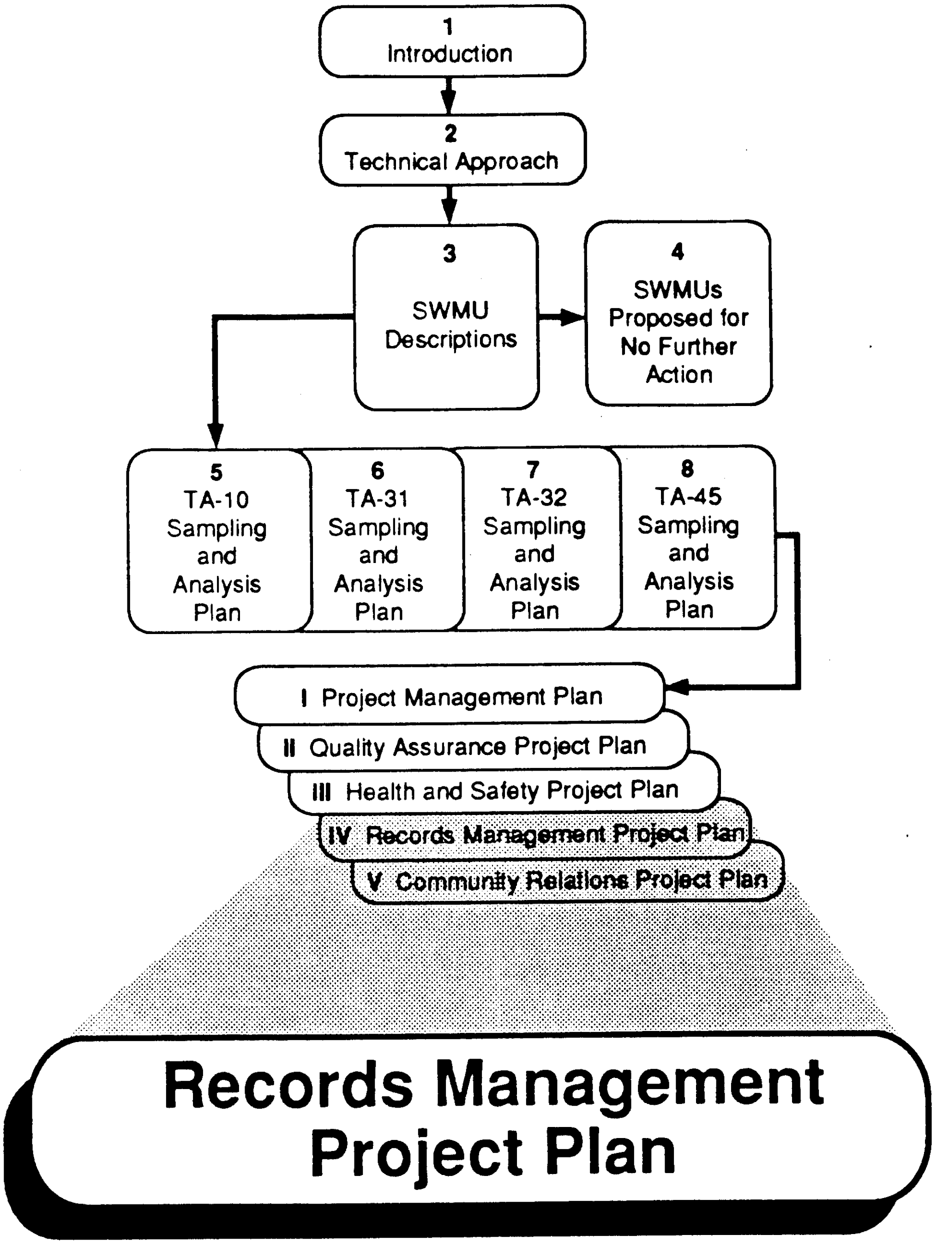
EMERGENCY CONTACTS

Site Safety Officer
Name: ______________________________ Call:

Environmental Restoration Health and Safety Project Leader
Name: ______________________________ Call:

24-Hour LANL Health/Safety Coordinator
Call: ______________________________

ANNEX IV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Records Management Project Plan

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1.0 INTRODUCTION

The Records Management Program Plan for the Environmental Restoration (ER) Program at Los Alamos National Laboratory (the Laboratory) is described in Annex IV of the Installation Work Plan (IWP) (LANL 1991, 0553). This Records Management Project Plan (RMPjP) for Operable Unit (OU) 1079 Work Plan has been tiered to the program plan in the IWP to meet the requirements for protecting and managing records (including technical data), to provide an ongoing tool to support the technical efforts of the ER Program, and to function as a support system for management decisions throughout the existence of the ER Program.

The ER Program uses the following statutory definition of a record (44 USC 3301):

> Records are defined as "...books, papers, maps, photographs, machine-readable materials, or other documentary materials, regardless of physical form or characteristics,...appropriate for preservation...because of the informational value of the data in them."

The RMPjP will be implemented consistently to meet the requirements of the program plan and the Quality Assurance Project Plan (QAPjP) (Annex II of this work plan) and to provide an auditable and legally defensible system for records management. Another important function of the RMPjP is to maintain the publicly accessible documentation comprising the Administrative Record required by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA).

2.0 IMPLEMENTATION OF THE RECORDS MANAGEMENT PROJECT PLAN

Records management activities at OU 1079 will follow the guidelines summarized in Chapter 2 of the IWP. As the RMPjP develops to support OU needs, additional detail will be provided in the OU 1079 annual reports.

The RMPjP incorporates a threefold approach based on records control and commitment to quality guidelines: a structured work flow for records, the use of approved procedures, and the compilation of a referable information base. ER Program records are those specifically identified in quality procedures (QPs), administrative procedures (APs), standard operating procedures (SOPs), ER program and project plans; management guidance documents, and records identified by ER Program participants as being essential to the program. Records are processed in a structured work flow. The records management procedure (LANL-ER-AP-02.1) governs records management activities, which include records identification, submittal, review, indexing, retention, protection, access, retrieval, and correction (if necessary). Other procedures, such as LANL-ER-AP-01.3, "Review and Approval of Environmental Restoration Program Plans and Reports," LANL-ER-AP-01.4, "Distribution of Controlled Documents Prepared for the Environmental Restoration Program," and LANL-ER-AP-01.5, "Revision or Interim

Change of Environmental Restoration Program Controlled Documents," are also followed.

Records (including data) will be protected in and accessed through the referable information base. The referable information base includes all the information systems maintained at the Records Processing Facility (RPF) and the Facility for Information Management, Analysis, and Display (FIMAD). RPF personnel receive ER Program records, assign an ER identification number, and process records for delivery to the FIMAD. The RPF will complement FIMAD in certain aspects of data capture, such as scanning. The RPF also functions as an ER Program reference library for information that is inappropriate either in form (e.g. old records) or in content (e.g., Federal Register) for storage at the FIMAD. FIMAD provides the hardware and software necessary for data capture, display, and analysis. The information will be readily accessible through a network of work stations. Configuration management accounts for, controls, and documents the planned and actual design components of FIMAD.

3.0 USE OF ER PROGRAM RECORDS MANAGEMENT FACILITIES

The ER Program's RPF and FIMAD facilities will be utilized for management of records resulting from the conduct of work on OU 1079. Interaction with these facilities is detailed in LANL-ER-AP-2.01, Annex IV of the IWP, and other program procedures and management guidance documents, as appropriate.

4.0 COORDINATION WITH THE QUALITY PROGRAM

Records will be protected throughout the process, as described in Annex IV of the IWP and in LANL-ER-AP-02.1. The originator is responsible for protecting records until they are submitted to the RPF. The level of protection afforded by the originator will be commensurate with the value of the information contained in the record. Upon receipt of a record, the RPF will temporarily store the original of the record in one-hour, fire-rated equipment and will provide a copy of the record to the FIMAD. The RPF will then send the original record to a dual storage area for long-term storage in a protected environment.

5.0 COORDINATION WITH THE HEALTH AND SAFETY PROGRAM

The Laboratory's Occupational Medicine Group (HS-2) will maintain medical records because of their confidential nature. Training records will be maintained by appropriate custodians in coordination with Laboratory/DOE policy and will take into account the specific needs of the ER Program. FIMAD will only contain information about the completion of training, dates of required refresher training, as well as the specific location of training records for program participants.

6.0 COORDINATION WITH THE ER PROGRAM'S MANAGEMENT INFORMATION SYSTEM

Specific reporting requirements are ER Program deliverables and, as such, are monitored through the ER Program's management information system. Records resulting from the conduct of work as OUs contribute to the development of these deliverables.

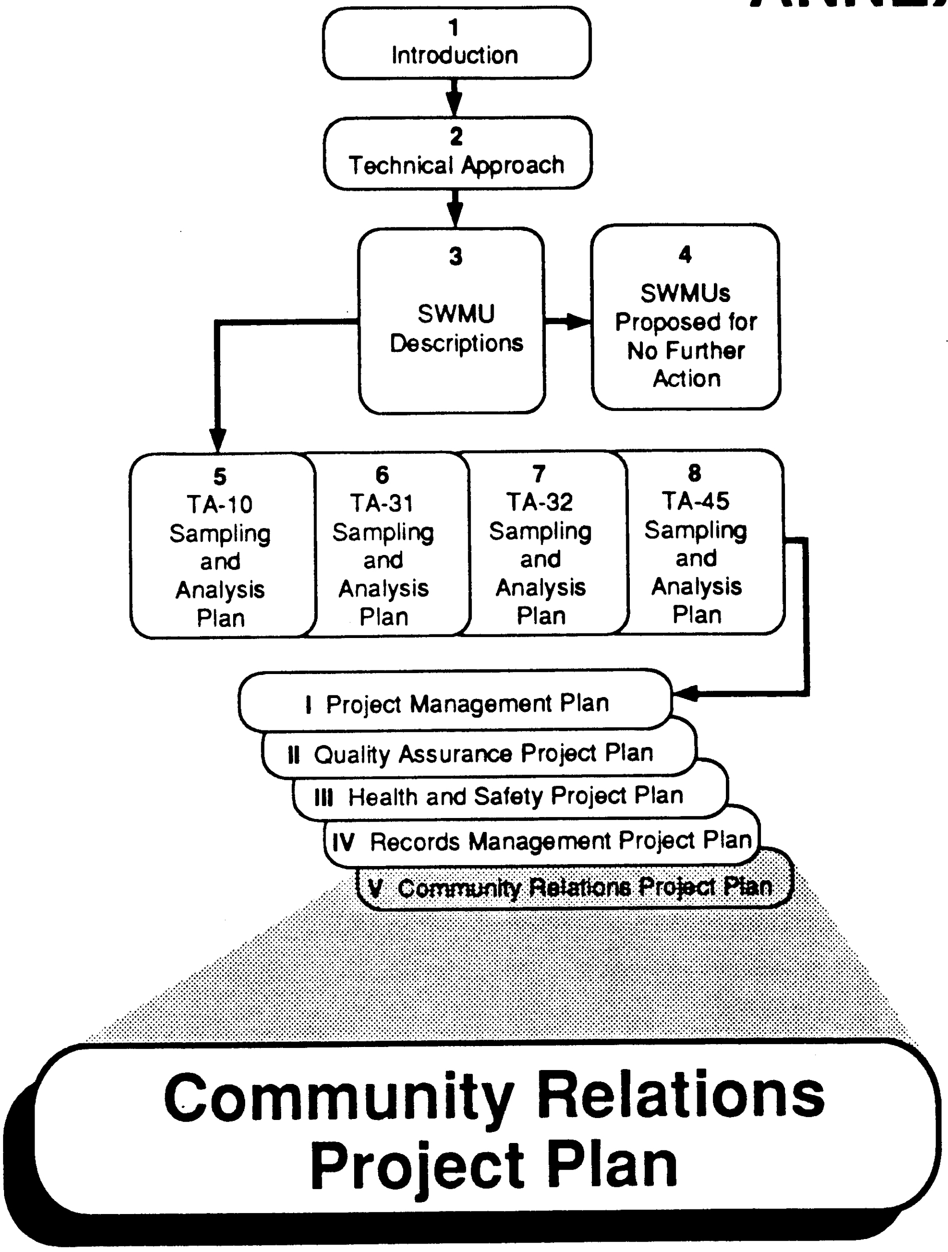
7.0 COORDINATION WITH THE COMMUNITY RELATIONS PROGRAM

RCRA and CERCLA require that records be made available to the public. Two complementary approaches are being implemented: hard copy and electronic access. The community reading room, located at 2101 Trinity Drive in Los Alamos, allows public access to paper copies of key documents. A work station and necessary data links are being prepared to allow public access to electronic information stored in the FIMAD system.

REFERENCES

Los Alamos National Laboratory, November 1991. "Installation Work Plan for Environmental Restoration," Revision 1, Los Alamos National Laboratory Report LA-UR-91-3310, Los Alamos, New Mexico. **(LANL 1991, 0553)**

ANNEX V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1.0 OVERVIEW OF COMMUNITY RELATIONS PROJECT PLAN

The Community Relations Project Plan (CRPjP) specific to Operable Unit (OU) 1079 follows the directives, goals, and regulatory requirements set forth in the Community Relations Program Plan in Annex V, Volume I of the Installation Work Plan (IWP) for the Environmental Restoration (ER) Program (LANL 1991, 0553). This annex describes the community relations activities for OU 1079 during the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI). The activities are based on current knowledge of public information needs and resources available to the Los Alamos National Laboratory (Laboratory) ER Program Staff.

As shown in Figure V-1, public participation is required by regulation during the corrective measures study (CMS); however, the Laboratory will also provide opportunities for public participation during the five-year RFI process as described in this project plan and illustrated in Figure V-2. The Hazardous and Solid Waste Amendments (HSWA) module of the Laboratory's RCRA Facility Permit (EPA 1990, 0306) requires that the following specific items be addressed in the Community Relations Plan:

- Establishing a mailing list of interested parties;
- Providing to the public news releases, fact sheets, approved RFI Work Plans, RFI final reports, Special Permit Conditions Reports, phase reports, and available quarterly progress reports that explain the progress and conclusions of the RFI;
- Creating a public information repository and reading room at which up-to-date information is provided;
- Conducting informal meetings for the public and local officials, including briefings and workshops, as appropriate;
- Conducting public tours and briefings to address individual concerns and questions;
- Quarterly technical progress reports during the RFI process for the Administrative Authority; and
- Establishing procedures for immediate notification of the San Ildefonso Pueblo or other affected neighboring parties in the event of a newly-discovered off-site release.

These items are addressed in Sections 2.1 through 2.6 of this plan.

All information concerning ER Program activities at OU 1079 will originate with or be provided to the public through the Community Relations Project Leader as follows:

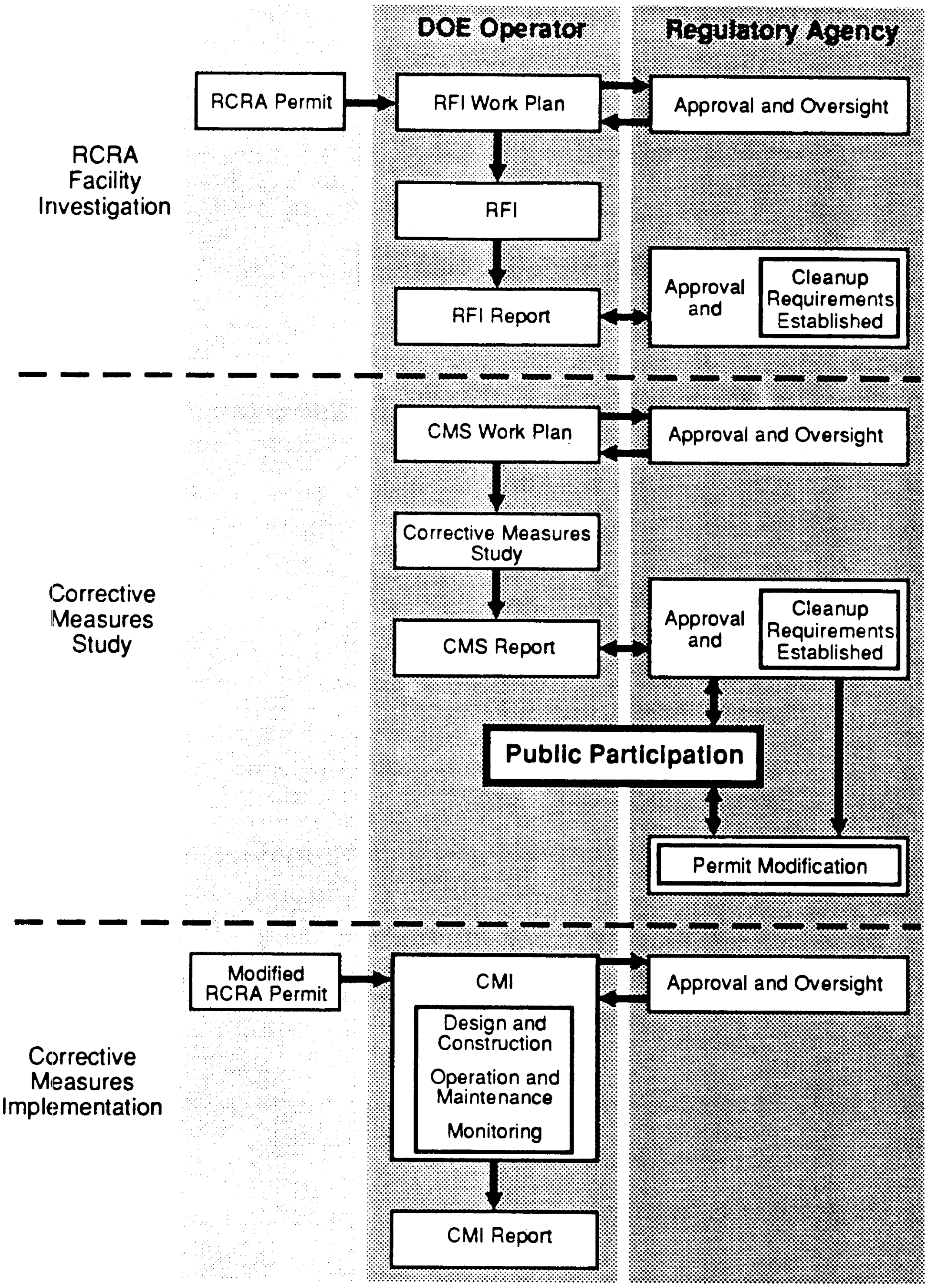


Figure V-1. Opportunities mandated by regulations for public participation during the RCRA corrective action process.

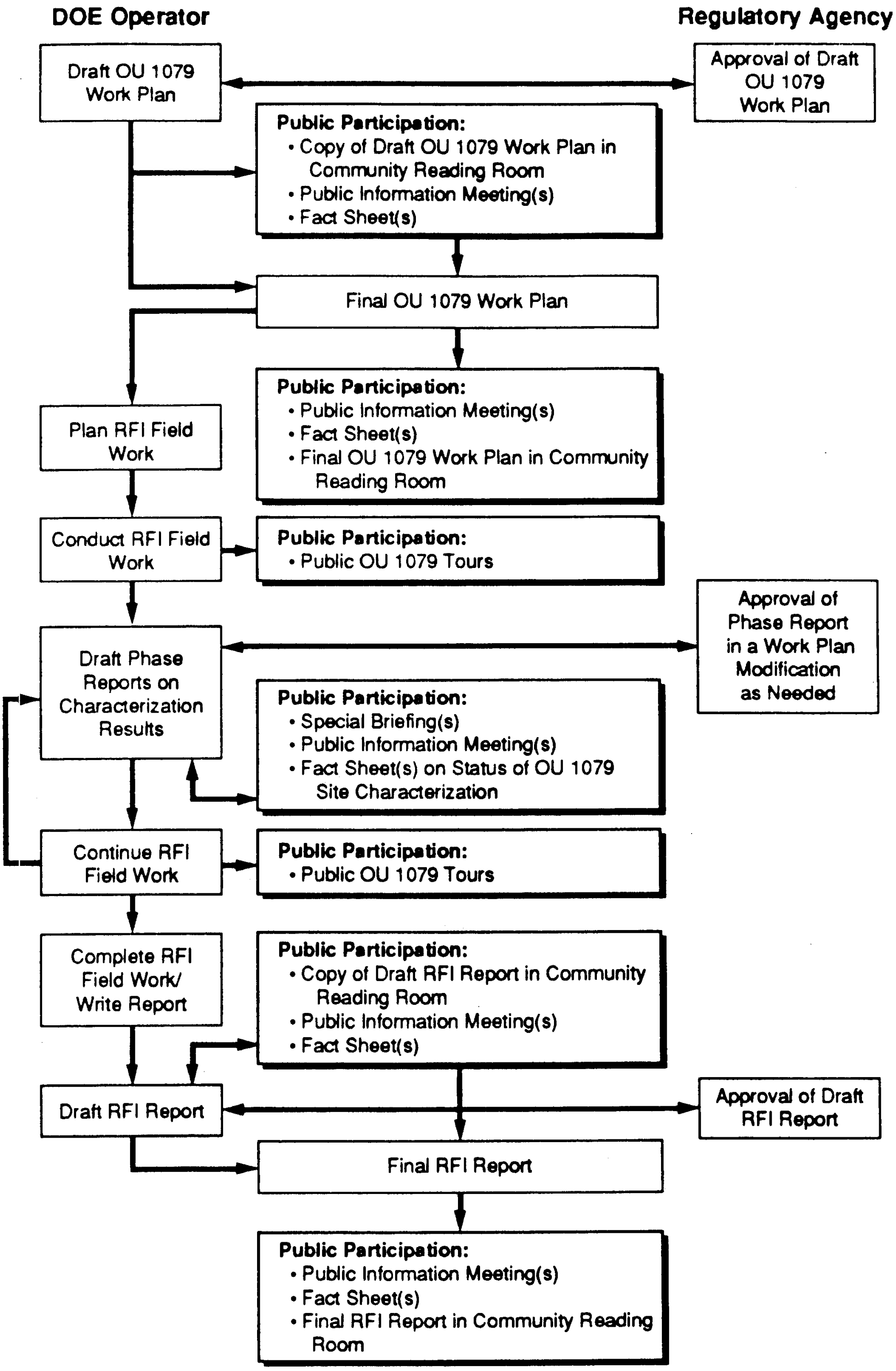


Figure V-2. Opportunities for public participation during the OU 1079 RFI.

Christina Armijo (temporary)
Community Relations Project Leader
Environmental Restoration Program
Los Alamos National Laboratory
2101 Trinity Drive, Suite 20
Los Alamos, New Mexico 87545
(505) 665-2127

2.0 COMMUNITY RELATIONS ACTIVITIES

The following subsections provide a brief description of community relations activities to be conducted at OU 1079 during RFI activities. The scope of each activity may be tailored to respond to public information needs.

2.1 Mailing List

The Community Relations office will add to the ER Program mailing list any residents and business owners near former Technical Areas (TA)-10, TA-31, TA-32, and TA-45, as well as current and former workers at OU 1079, to keep them informed of meetings, activities, and schedules pertaining to the OU.

2.2 Fact Sheets

The Community Relations Office has developed a fact sheet with a single map inset that shows the OU and the location of its SWMUs, summarizes site history and use, known contaminants of concern, and planned activities (Attachment 1). The fact sheet was mailed to all affected property owners in August 1991. Updated fact sheets will be developed as public information needs change and progress is made during the RFI process.

2.3 ER Program Reading Room

As they are developed, documents and data associated with OU 1079, such as the RFI Work Plan, quarterly technical progress reports, and the RFI report will be made available to the public at the ER Program Reading Room at 2101 Trinity Drive, Suite 20, in downtown Los Alamos, from 9 am to 4 pm on Laboratory business days. A copy of the OU 1079 RFI Draft Work Plan will be available at the reading room in June 1992.

2.4 Public Information Meetings, Briefings, Tours and Responses to Inquiries

Public information meetings have been held in Los Alamos to introduce the community to the ER program and to present a brief overview of OUs in the townsite. Quarterly public information meetings will be held to discuss specific OU 1079 activities and significant milestones during the RFI process. Tours will be conducted for interested parties as requested.

If an issue of concern with limited interest is raised at a public information meeting, a special briefing or a one-to-one meeting may be necessary. The Community Relations Project Leader and the OU 1079 Project Leader will coordinate responses to such inquiries.

2.5 Quarterly Technical Progress Reports

As the RFI for OU 1079 is implemented, the Laboratory will summarize technical progress in quarterly technical progress reports, as required by the HSWA module of the Laboratory's RCRA Facility Permit (Task V, C, page 46). These reports will be available at the ER Program Reading Room.

2.6 Procedures for Public Notification

The ER Program is developing an administrative procedure to notify property owners regarding the presence of a Solid Waste Management Unit (SWMU) on or near their property. In addition, the ER Program is developing an administrative procedure pertaining to requesting and obtaining property access agreements for RFI Work Plan sampling activities on properties not owned by the Department of Energy.

2.7 Informal Public Review and Comment on the Draft OU 1079 RFI Work Plan

The Laboratory will encourage public input regarding the field sampling proposed in the draft RFI Work Plan for OU 1079 following its submittal to EPA in May 1992. Public comment regarding numbers of samples, types of samples, and quality assurance samples (e.g., duplicate samples) will be incorporated, as appropriate, into the final RFI Work Plan for OU 1079.

REFERENCES

EPA (U.S. Environmental Protection Agency), April 10, 1990. RCRA Permit No. NM0890010515, EPA Region VI, issued to Los Alamos National Laboratory, Los Alamos, New Mexico. **(EPA 1990, 0306)**

LANL (Los Alamos National Laboratory), November 1991. "Installation Work Plan for Environmental Restoration," Revision 1, Los Alamos National Laboratory Report LA-UR-91-3310, Los Alamos, New Mexico. **(LANL 1991, 0553)**

ATTACHMENT 1

LOS ALAMOS NATIONAL LABORATORY
ENVIRONMENTAL RESTORATION PROGRAM

FACT SHEET FOR OPERABLE UNIT 1079 (TECHNICAL AREAS 10, 31, 32, 45)

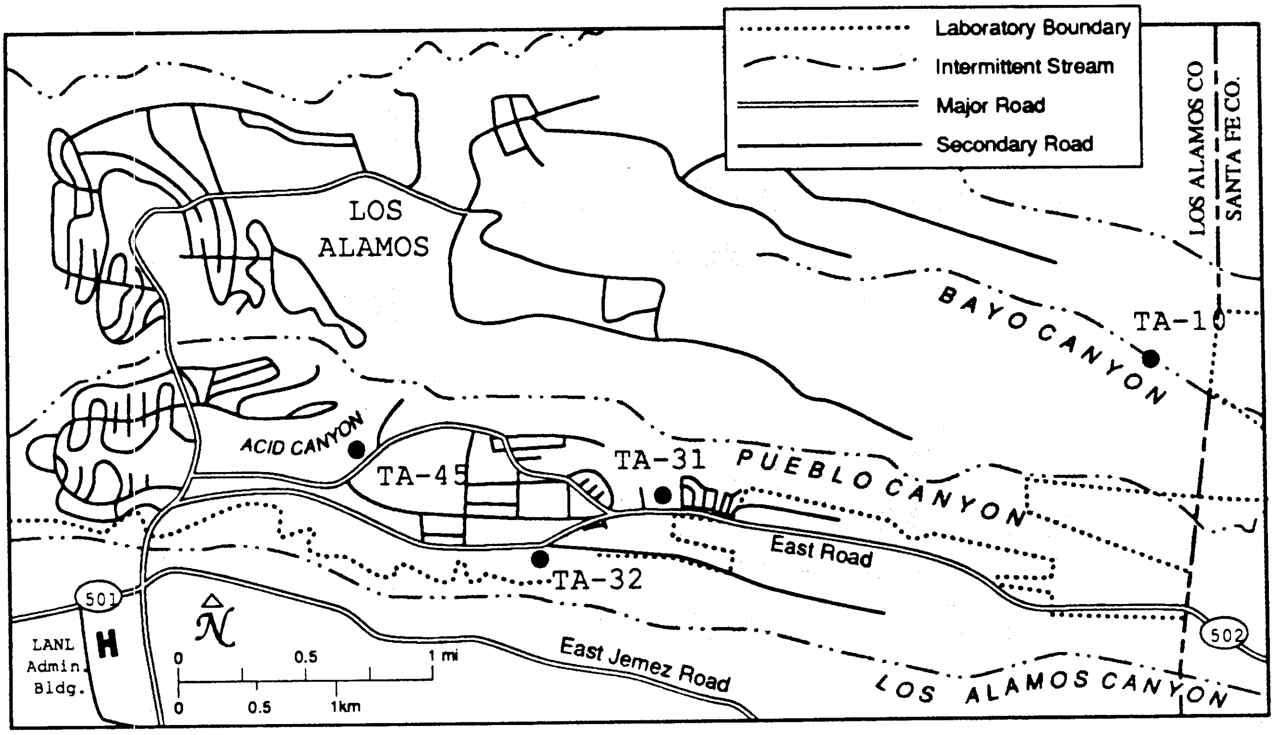
- An Operable Unit is a logical grouping of potential contaminated release sites called Solid Waste Management Units (SWMUs). Operable Unit 1079 consists of SWMUs identified in formerly utilized Technical Areas (TAs) 10, 31, 32, and 45. The properties that comprise the former TAs are currently under the control of Los Alamos County and are the sites of private residences, businesses and public recreation areas such as Bayo Canyon.

- TA-10, used from 1943-1961, was a firing site to conduct experiments utilizing high explosives in conjunction with research on nuclear weapons development. TA-31, also known as East Receiving Yard, was used from 1945-1954 for materials storage. Medical research studies were conducted at TA-32 (Medical Research Facility) from 1944-1954. Treated effluent was discharged during the years 1951-1964 following the construction of the TA-45 Radioactive Wastewater Treatment and Vehicle Decontamination Facilities. Prior to 1951, untreated radioactive wastewater was discharged into Acid Canyon, near its confluence with Pueblo Canyon.

- Hazardous, explosive, and radioactive waste residues from past Laboratory activities may be present in Operable Unit 1079. The primary areas of concern are isolated small areas of Bayo and Acid Canyons.

- The Hazardous and Solid Waste Amendment (HSWA) Module of the Laboratory's Resource Conservation and Recover Act (RCRA) operating permit specifies the corrective action

Operable Unit 1079 Locator Map



process by which contaminated areas are identified, characterized, and remediated. Within this process, the Laboratory will further assess each of the TAs in Operable Unit 1079 to determine the extent of residual contamination and select the appropriate corrective action from a broad spectrum of possible remedial alternatives. The alternatives range from long-term monitoring and institutional controls to excavation and disposal of contaminated soils and restoration.

- The Laboratory will develop a RCRA Facility Investigation (RFI) work plan by May 1992 that will outline procedures to verify past cleanups or determine the presence of residual contamination in Operable Unit 1079. This site investigation will define the type and extent of any contamination and identify any potential receptors.
- For many years, the Laboratory has conducted a comprehensive environmental monitoring and surveillance program in Los Alamos County and throughout Northern New Mexico. The program is designed to identify releases from Laboratory operations which could pose a health risk to individuals living in the communities surrounding the Laboratory. No contamination is known to exist on private property which threatens the health and safety of local residents. This finding is based on assessment of technical data gathered from this program. If an imminent health threat is found, immediate action will be taken by the Department of Energy (DOE) and the Laboratory.
- Contamination of the drinking water supply is unlikely as the main aquifer is at least 700 feet below site surfaces.

BACKGROUND OF OPERABLE UNIT 1079

TA-10, located in Bayo Canyon, was used from 1943-1961 as a firing site to conduct experiments utilizing high explosives. The site consisted of several firing pads, control buildings, battery buildings, a radiochemistry laboratory, and other associated structures. Bayo Canyon is currently undeveloped and is open to the public for recreational use.

TA-31, known as the East Receiving Yard, was used from 1945-1954 for deliveries from Navajo Van Line. The site consisted of warehouses, a receiving dock, a drum storage area, and a septic tank system. No documented spills occurred at the site. The former TA-3l site is now occupied by the Los Alamos Dog Obedience Club, tennis courts, East Park, and some private residences.

TA-32 was used from 1944-1954 as the first Laboratory medical research facilities. The site consisted of laboratories, an office building, several warehouses, an incinerator and several septic tank systems. No documented spills occurred at the site. The former TA-31 site is south of Trinity Drive and is used by the Los Alamos County Roads Division for storage and maintenance of equipment and materials.

TA-45, used from 1951-1964, was the site of the first radioactive wastewater treatment plant at the Laboratory. Radioactive acid waste from TA-l operations was discharged into Acid Canyon untreated from 1943-1951, until the treatment plant was built. The site consisted of the treatment plant and associated waste lines and outfalls, a vehicle decontamination facility, a sanitary sewer system, and a transformer station. The area formerly occupied by TA-45 is north of the intersection of Canyon Road and Central Avenue, and northeast of the Larry Walkup Aquatic Center. The site is currently utilized by Los Alamos County for equipment storage.

PREVIOUS CLEANUP IN OPERABLE UNIT 1079

TA-10, the firing site in Bayo Canyon, was decontaminated and decommissioned (removed) from 1960-1963. All structures were burned or demolished and removed. Surface debris was removed from around the firing sites along with the asphalt from the firing pads. The soil beneath the firing pads and the waste disposal pits were excavated. All contaminated material was taken to Laboratory disposal sites. Periodic surface surveys and searches were conducted between 1966 and 1976 to remove any additional materials. An extensive survey of the area was undertaken in 1977 as part of the Formerly Utilized Sites Remedial Action Plan (FUSRAP) sponsored by DOE. This survey detected above background concentrations of radioactivity in isolated small areas of Bayo Canyon. Concrete monuments and other institutional controls have been installed in some areas of the canyon to delineate a "restricted area" where excavation of the soil may pose a health hazard. No further cleanup action has been initiated at the site.

TA-31, the East Receiving Yard, was decontaminated and decommissioned in 1954. All structures were removed from the site except the septic tank, which was removed in 1988. No further cleanup activities have taken place at the site.

TA-32, a medical research facility, was abandoned in 1954. All the structures at the site were razed, but the exact date is unknown. Any contaminated structures were taken to Laboratory disposal sites. It is possible that one septic tank remains in place at the site. No further cleanup activities have taken place.

TA-45, the radioactive wastewater treatment facility, was decommissioned from 1965-1966. All structures at the site were demolished with the exception of the sewage lift station, which was transferred to Los Alamos County. Associated waste lines, manholes and contaminated soil were excavated. Additional decontamination of the TA-45 site took place in the late 1970s/early 1980s under FUSRAP. The FUSRAP investigation indicated areas of residual surface and subsurface contamination. In 1982, additional soil and rock were removed from the mesa top and Acid Canyon. However, some residual radioactivity remains in Acid Canyon at or below FUSRAP guidelines.

FUTURE ACTION AND PROPOSED TIME FRAME

The RCRA Facility Investigation (RFI) Work Plan that describes the characterization activities and verification sampling will be completed for Operable Unit 1079 by May 1992. RFI characterization activities are scheduled to be initiated by 1992 and be completed by 1998. The Corrective Measures Study (CMS), which develops the set of remediation alternatives, is scheduled to begin in 1999 and be completed in 2001.

Ensuring the safe management of past, present, and future waste requires cooperation of government, industry, and the public. The Laboratory's commitment is to provide information to the public, such as this fact sheet, concerning actions taken during investigations and throughout the entire cleanup process. If you have additional questions about Operable Unit 1079 or about the Laboratory's Environmental Restoration Program, please do not hesitate to visit, call, or write:

Patricia Trujillo-Oviedo
Environmental Restoration Program
Los Alamos National Laboratory
Box 1663, MS M314
2101 Trinity Drive, Suite 20
Los Alamos, NM 87545
505-665-2127

APPENDIX A

Photographs of OU 1079 SWMUs

FIGURE NO.	LANL NEGATIVE NO.	DESCRIPTION
A-10-1	77-12644	Aerial view of TA-10's two detonation control complexes during operation. SWMUs 10-001(a and b), Firing Sites 1 and 2, with control building TA-10-13, are in right foreground. SWMUs 10-001(c and d), Firing Sites 3 and 4, with control building TA-10-15, are in the left center. The vicinity of SWMU 10-005, a Subsurface Debris Disposal Pit, is indicated near SWMUs 10-001(c and d).
A-10-2	5630-53	View from Kwage Mesa of SWMUs 10-001(a-d), Firing Sites, during early part of 1961-63 D&D activities. Complex in upper left is SWMUs 10-001(c and d), Firing Sites 3 and 4, and control building TA-10-15. Partially demolished structure in center is control building TA-10-13 near SWMUs 10-001 (a and b), Firing Sites 1 and 2.
A-10-3	77-12651	Demolition in area of SWMUs 10-001(a and b), Firing Sites 1 and 2, during 1963 D&D activities.
A-10-4	633609	Northeast view of debris clean-up crew at SWMU 10-001(c), Firing Site 3, during 1963 D&D activities.
A-10-5	77-12649	Restored terrain at SWMUs 10-001(a and b), Firing Sites 1 and 2, after 1963 D&D activities.
A-10-6	RN87-109020	Aerial view of SWMUs 10-001(a-d), Firing Sites, and 10-005, Subsurface Debris Disposal Pit, in 1987.

FIGURE NO.	LANL NEGATIVE NO.	DESCRIPTION
A-10-7	77-12655	South elevation of the TA-10 Radiochemistry Laboratory, structure TA-10-1, during operation. SWMUs 10-003(a-o), the Liquid Disposal Complex, served the Radiochemistry Laboratory and included subsurface disposal tanks, piping, pits, and a leach field. SWMU 10-002(b), a Subsurface Solid Waste Disposal Pit, was located near the laboratory.
A-10-8	77-12639	SWMUs 10-003(a-o), the Liquid Waste Disposal Complex, during demolition in 1963. Pictured are SWMUs 10-003(f and g), 10-003(i-l), and 10-003(n). These included a disposal pit, tanks, manholes, a leach field, and associated industrial waste (acid waste) lines.
A-10-9	77-12641	Excavation of the Liquid Waste Disposal Complex in the vicinity of SWMUs 10-003(a-f), Liquid Waste Disposal Pits, during 1963 D&D activities.
A-10-10	77-12643	SWMUs 10-003(a-o), the Liquid Waste Disposal Complex, during demolition in 1963. Pictured are SWMUs 10-003(f and g), 10-003(i-1), and 10-003(n). These included a disposal pit, tanks, manholes, a leach field, and associated industrial waste (acid waste) lines.
A-10-11	77-12652	Excavation of SWMUs 10-003(a-f), Liquid Waste Disposal Pits, during 1963 D&D activities. Building in right background is TA-10-1, the Radiochemistry Laboratory.
A-10-12	77-12645	Restored terrain after 1963 D&D activities in the vicinity of SWMUs 10-003(a-o), the Liquid Waste Disposal Complex.

FIGURE NO.	LANL NEGATIVE NO.	DESCRIPTION
A-10-13	77-12676	North elevation of the personnel building, structure TA-10-21, during operation. SWMU 10-004(a) was the septic tank system that served the personnel building. SWMU 10-004(a) was located behind TA-10-21.
A-31-1	None*	South aerial view of TA-31, the East Receiving Yard, during operation in 1948. SWMU 31-001, a Sanitary Septic System, consisted of a sewer line running from structure TA-31-7 to a septic tank that discharged into Pueblo Canyon. The entire site is listed as Area of Concern C-31-001, based on the potential for soil contamination beneath former structures and the paved parking area.
A-31-2	RN91-232071	East aerial view of former TA-31, the East Receiving Yard, in 1991. SWMU 31-001, a Sanitary Septic System, consisted of a sewer line running from structure TA-31-7 to a septic tank that discharged into Pueblo Canyon. The entire site is listed as Area of Concern C-31-001, based on the potential for soil contamination beneath former structures and the paved parking area.
A-32-1	15928	Northwest aerial view of TA-32, the Medical Research Facility , in 1950. SWMU 32-001 is the incinerator that served the facility. SWMUs 32-002(a and b) are two septic tank systems that served the facility and that discharged into Los Alamos Canyon. The entire site is listed as Area of Concern C-32-001, based on the potential for soil contamination beneath former structures.

FIGURE NO.	LANL NEGATIVE NO.	DESCRIPTION
A-32-2	RN87-111014	Northwest aerial view of former TA-32, the Medical Research Facility, in 1987. SWMU 32-001 is the incinerator that served the facility. SWMUs 32-002(a and b) are two septic tank systems that served the facility and that discharged into Los Alamos Canyon. The entire site is listed as Area of Concern C-32-001, based on the potential for soil contamination beneath former structures.
A-45-1	79-7326	View of SWMU 45-001, the Radioactive Waste Treatment Facility, during operation. The parking lot in the foreground is AOC C-45-001.
A-45-2	79-7325	Excavation and removal of SWMU 45-001, the Radioactive Waste Treatment Facility, during initial D&D activities in 1966-1967. The sewage lift station is the only TA-45 structure that remains on the site today.
A-45-3	79-7324	Workers chipping away cliff face below the treated effluent outfall of SWMU 45-001, the Radioactive Treatment Facility, during initial D&D activities in 1966.
A-45-4	77-12667	The TA-45 site after D&D in 1966-1967. SWMU locations indicated are 45-001, 45-002, and 45-003. The tank farm in the upper right was not part of TA-45.
A-45-5	77-12666	View of SWMU 45-002, the Vehicle Decontamination Facility, during operation.
A-45-6	77-12663	View of broken concrete floor of SWMU 45-002, the Vehicle Decontamination Facility, during 1966-1967 D&D activities.
A-45-7	77-12671	View of SWMU 45-003, Industrial Waste (Acid Waste) Lines, during 1966-1967 D&D activities. This was the untreated influent line to the Treatment Plant.

FIGURE NO.	LANL NEGATIVE NO.	DESCRIPTION
A-01-1	79-7321	View of SWMU 1-002, the Untreated Industrial Waste (Acid Waste) Outfall, at the discharge point, prior to D&D activities.
A-01-3	CN77-8175	View of upper portion of cliff face beneath SWMU 1-002, the Untreated Industrial Waste (Acid Waste) Outfall, in the 1970s.

*Photograph from LA County Historical Society. No unique identification number.

Figure A-01-1 View of SWMU 1-002, the Untreated Industrial Waste (Acid Waste) Outfall, at the discharge point, prior to D&D activities.

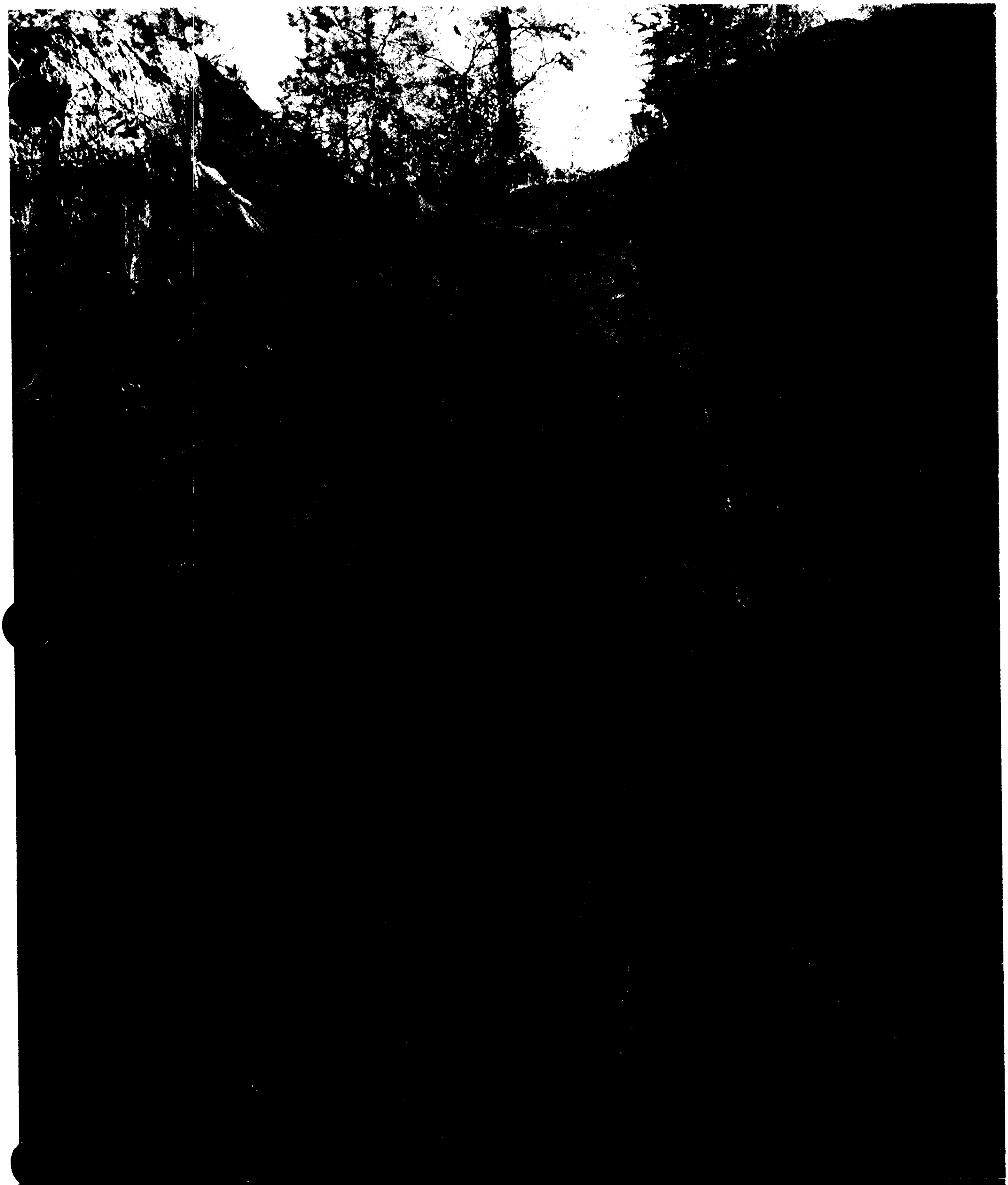


Figure A-01-3 View of upper portion of cliff face beneath SWMU 1-002, the Untreated Industrial Waste (Acid Waste) Outfall, in the 1970s.

Figure A-10-1 Aerial view of TA-10's two detonation control complexes during operation. SWMUs 10-001(a and b), Firing Sites 1 and 2, with control building TA-10-13, are in right foreground. SWMUs 10-001(c and d), Firing Sites 3 and 4, with control building TA-10-15, are in the left center. The vicinity of SWMU 10-005, a Subsurface Debris Disposal Pit, is indicated near SWMUs 10-001(c and d).

Figure A-10-2 View from Kwage Mesa of SWMUs 10-001(a–d), Firing Sites, during early part of 1961–63 D&D activities. Complex in upper left is SWMUs 10-001(c and d), Firing Sites 3 and 4, and control building TA-10-15. Partially demolished structure in center is control building TA-10-13 near SWMUs 10-001(a and b), Firing Sites 1 and 2.

Figure A-10-3 Demolition in area of SWMUs 10-001(a and b), Firing Sites 1 and 2, during 1963 D&D activities.

Figure A-10-4 Northeast view of debris clean-up crew at SWMU 10-001(c), Firing Site 3, during 1963 D&D activities.

Figure A-10-5 Restored terrain at SWMUs 10-001(a and b), Firing Sites 1 and 2, after 1963 D&D activities.

Figure A-10-6 Aerial view of SWMUs 10-001(a–d), Firing Sites, and 10-005, Subsurface Debris Disposal Pit, in 1987.

Figure A-10-8 SWMUs 10-003(a–o), the Liquid Waste Disposal Complex, during demolition in 1963. Pictured are SWMUs 10-003(f and g), 10-003(i–l), and 10-003(n). These included a disposal pit, tanks, manholes, a leach field, and associated industrial waste (acid waste) lines.

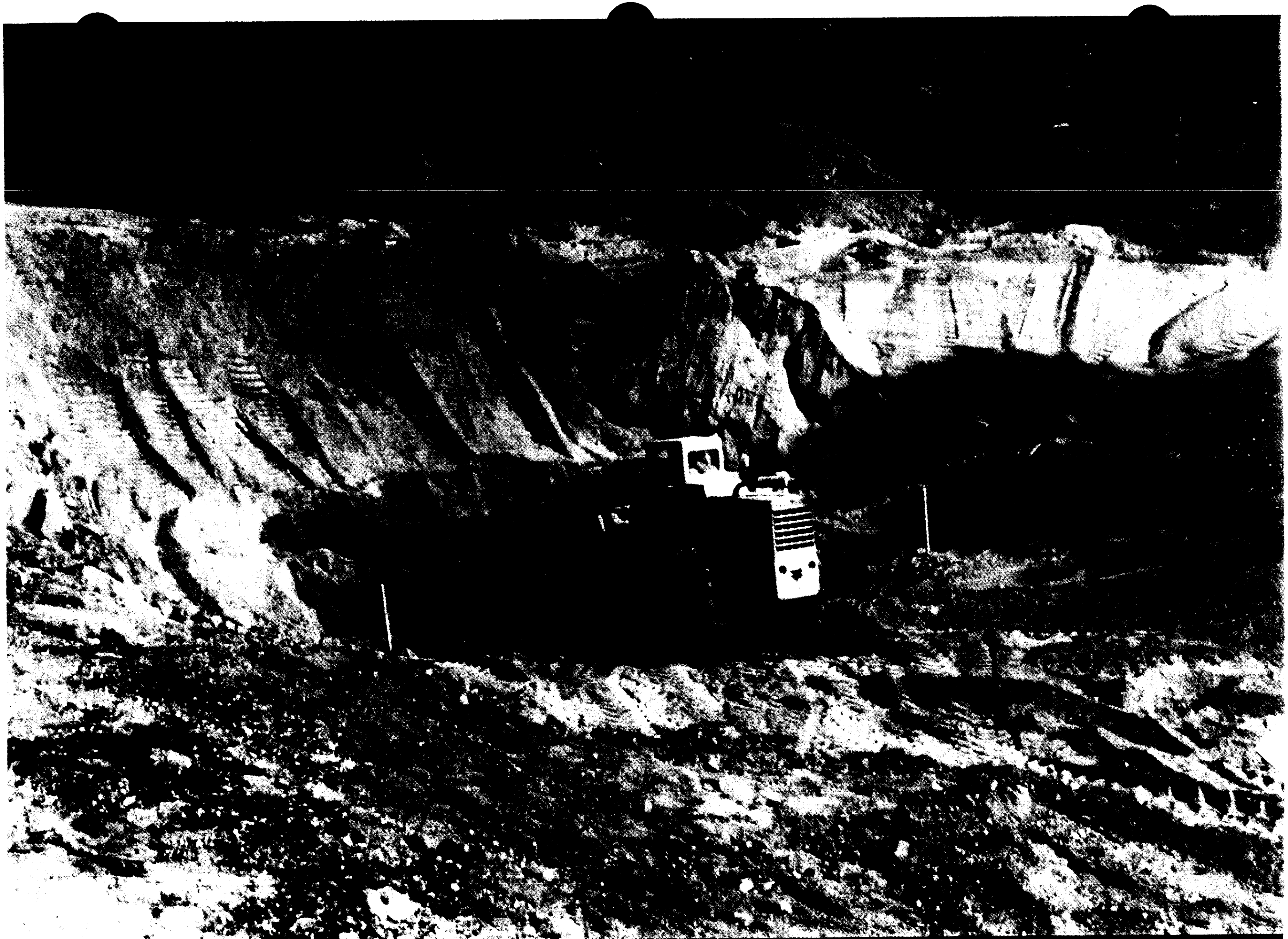


Figure A-10-9 Excavation of the Liquid Waste Disposal Complex in the vicinity of SWMUs 10-003(a–f), Liquid Waste Disposal Pits, during 1963 D&D activities.

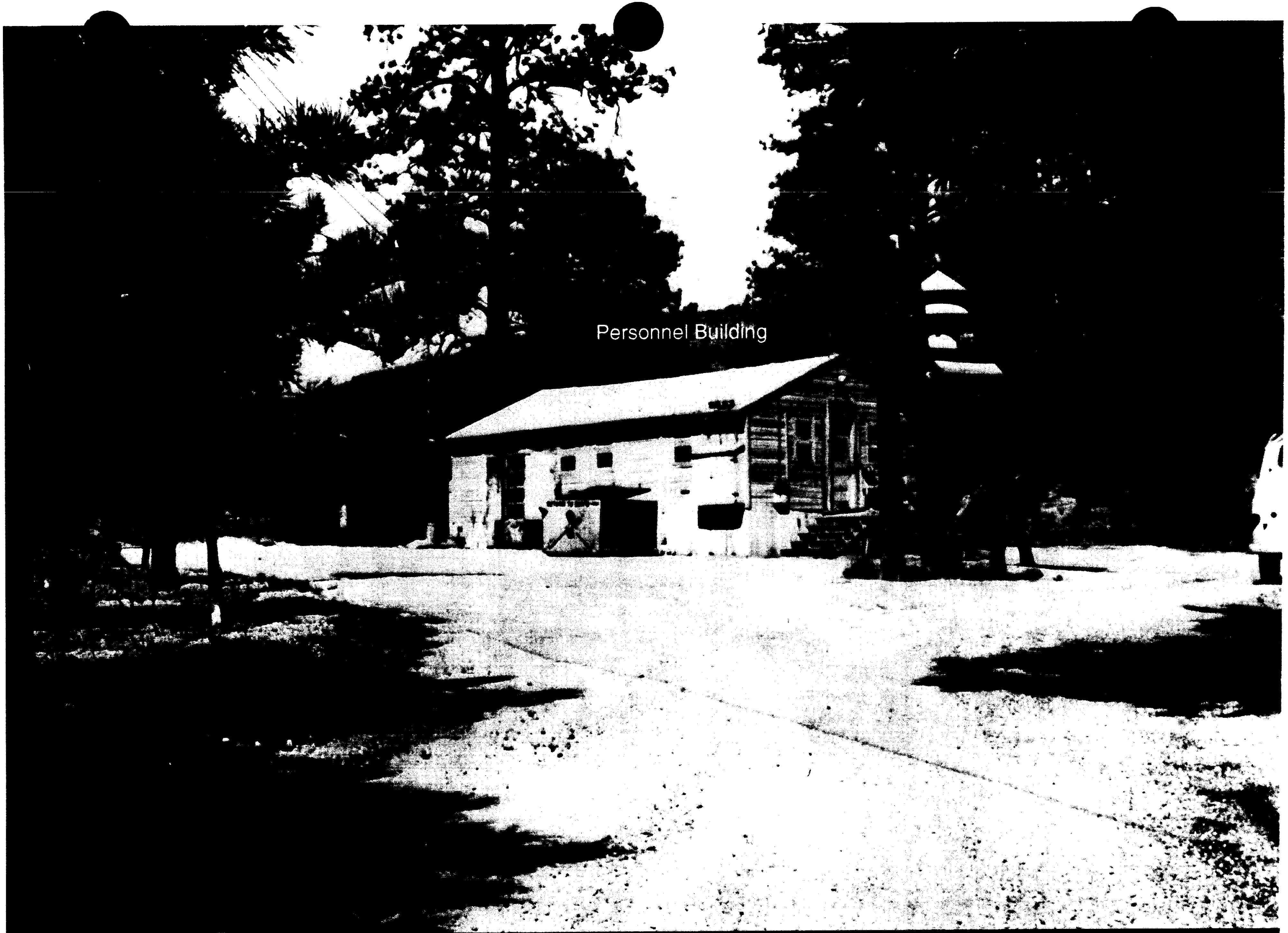


Figure A-10-13 North elevation of the personnel building, structure TA-10-21, during operation. SWMU 10-004(a) was the septic tank system that served the personnel building. SWMU 10-004(a) was located behind TA-10-21.

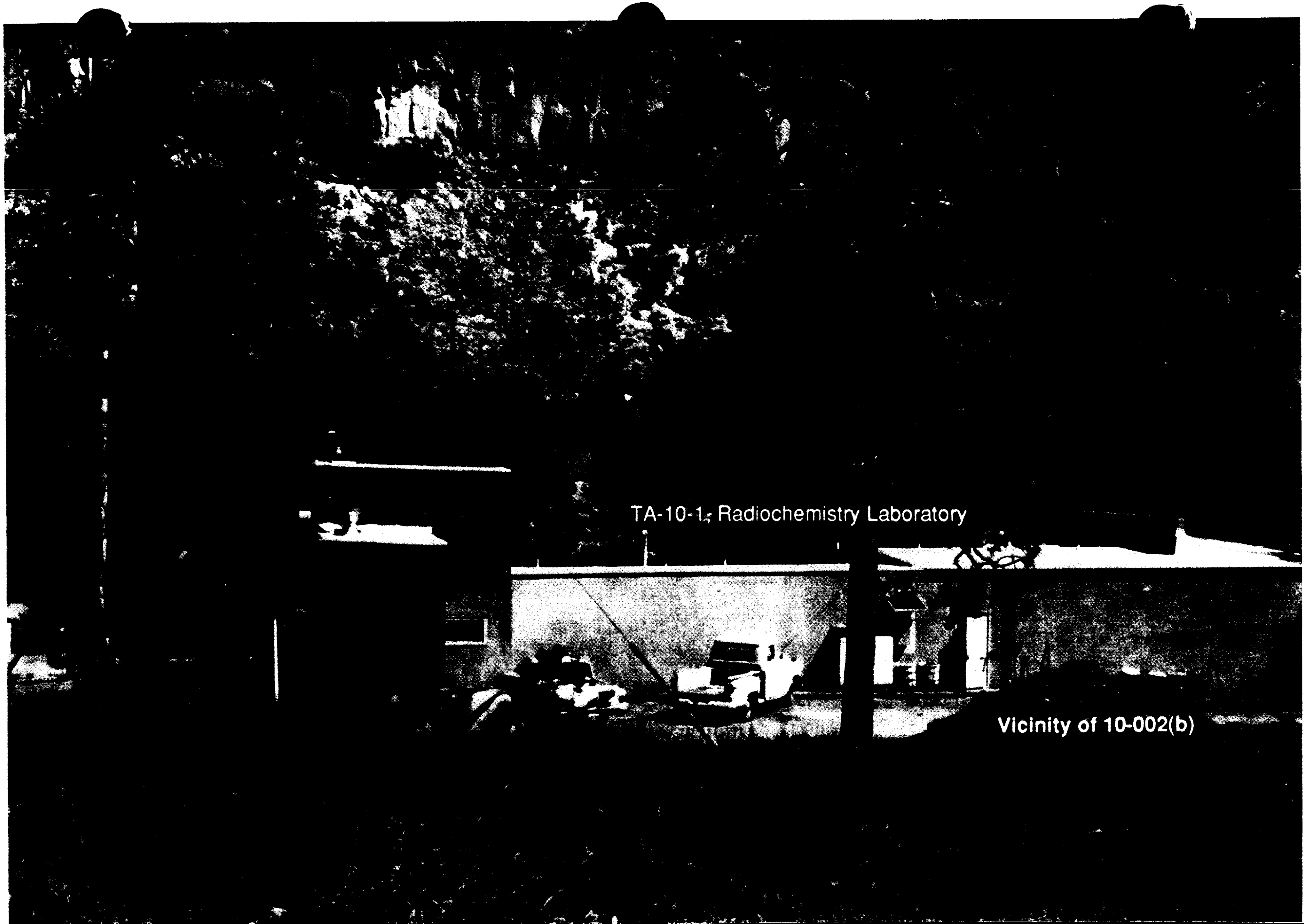


Figure A-10-7 South elevation of the TA-10 Radiochemistry Laboratory, structure TA-10-1, during operation. SWMUs 10-003(a-o), the Liquid Disposal Complex, served the Radiochemistry Laboratory and included subsurface disposal tanks, piping, pits, and a leach field. SWMU 10-002(b), a Subsurface Solid Waste Disposal Pit, was located near the laboratory.

Figure A-10-12 Restored terrain after 1963 D&D activities in the vicinity of SWMUs 10-003(a–o), the Liquid Waste Disposal Complex.

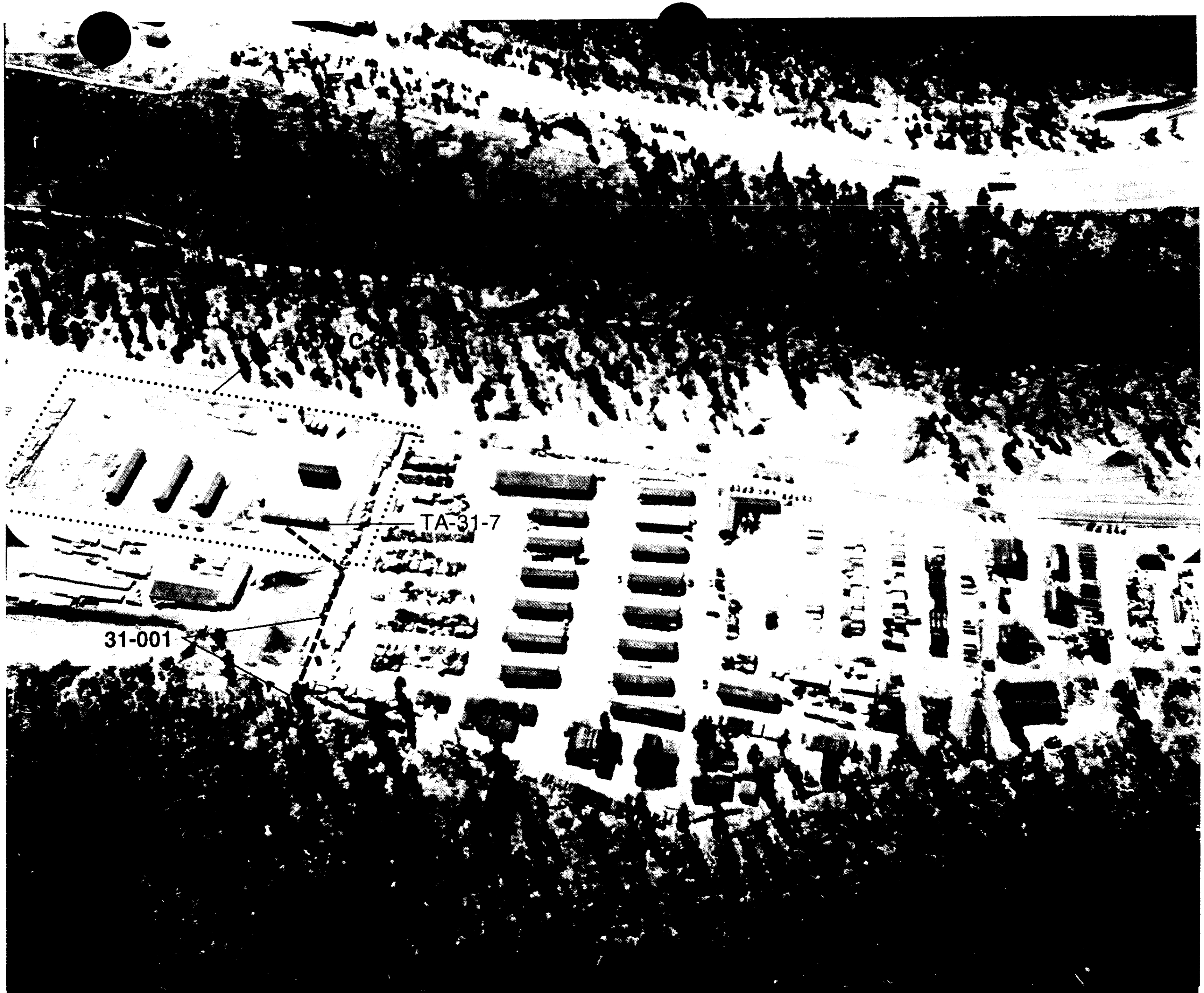
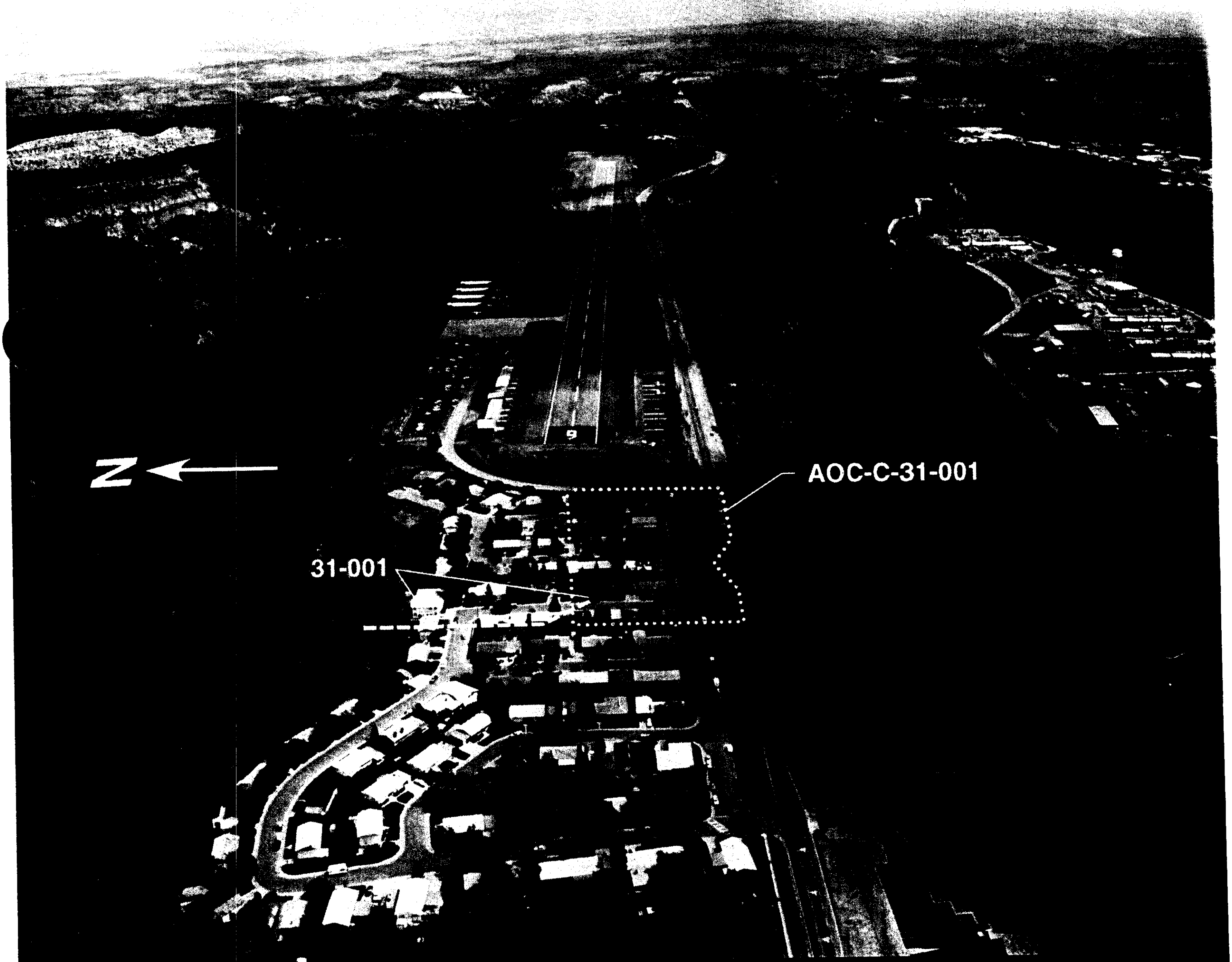


Figure A-31-1 South aerial view of TA-31, the the East Receiving Yard, during operation in 1948. SWMU 31-001, a Sanitary Septic System, consisted of a sewer line running from structure TA-31-7 to a septic tank that discharged into Pueblo Canyon. The entire site is listed as Area of Concern C-31-001, based on the potential for soil contamination beneath former structures and the paved parking area.



re A-31-2 East aerial view of former TA-31, the East Receiving Yard, in 1991. SWMU 31-001, a Sanitary Septic System, consisted of a sewer line running from structure TA-31-7 to a septic tank that discharged into Pueblo Canyon. The entire site is listed as Area of Concern C-31-001, based on the potential for soil contamination beneath former structures and the paved parking area.

Figure A-32-1 Northwest aerial view of TA-32, the Medical Research Facility, in 1950. SWMU 32-001 is the incinerator that served the facility. SWMUs 32-002(a and b) are two septic tank systems that served the facility and that discharged into Los Alamos Canyon. The entire site is listed as Area of Concern C-32-001, based on the potential for soil contamination beneath former structures.

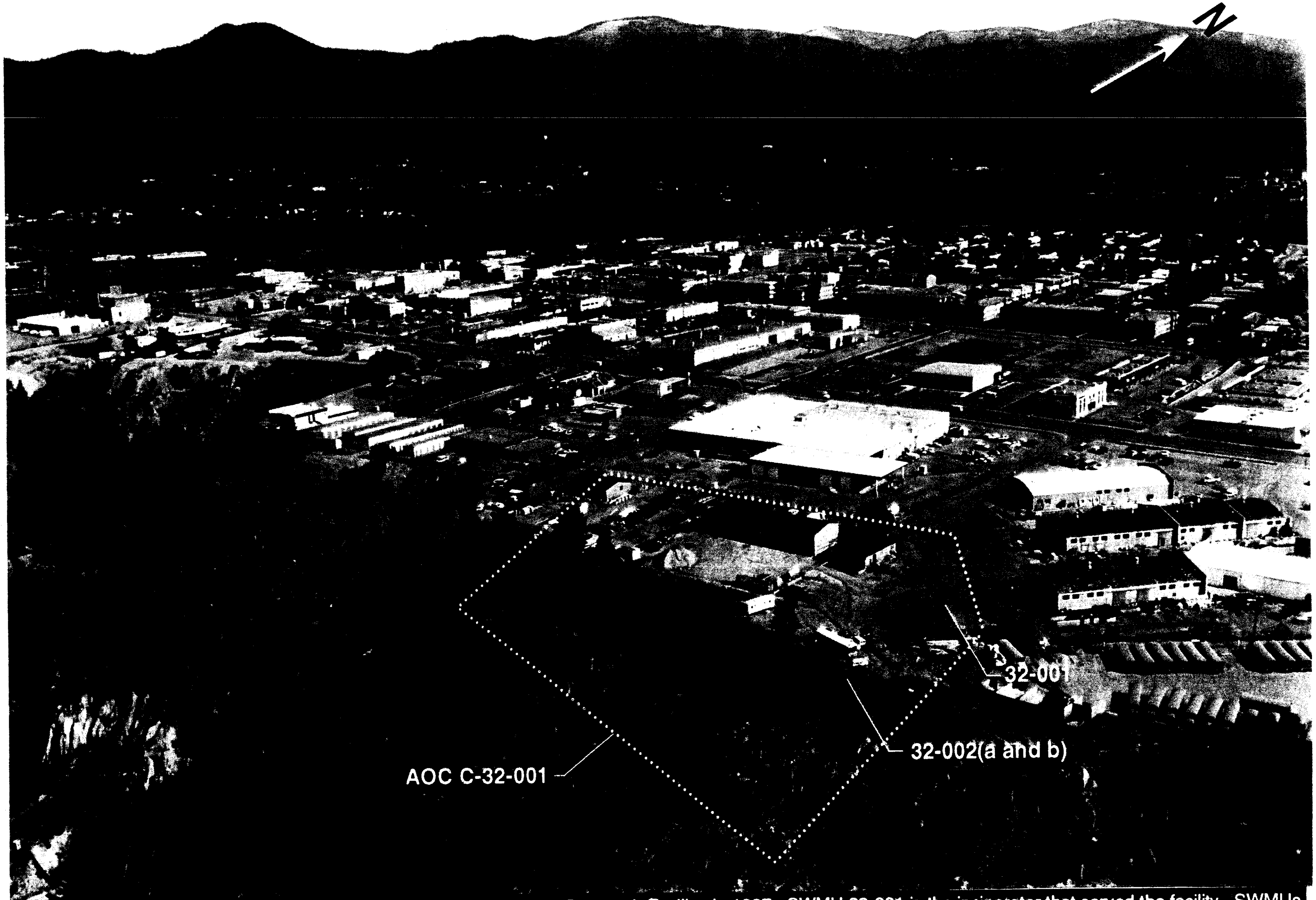


Figure A-32-2 Northwest aerial view of former TA-32, the Medical Research Facility, in 1987. SWMU 32-001 is the incinerator that served the facility. SWMUs 32-002(a and b) are two septic tank systems that served the facility and that discharged into Los Alamos Canyon. The entire site is listed as Area of Concern C-32-001, based on the potential for soil contamination beneath former structures.

Figure A-45-1 View of SWMU 45-001, the Radioactive Waste Treatment Facility, during operation. The parking lot in the foreground is AOC C-45-001.

Figure A-45-2 Excavation and removal of SWMU 45-001, the Radioactive Waste Treatment Facility, during initial D&D activities in 1966–1967. The sewage lift station is the only TA-45 structure that remains on the site today.

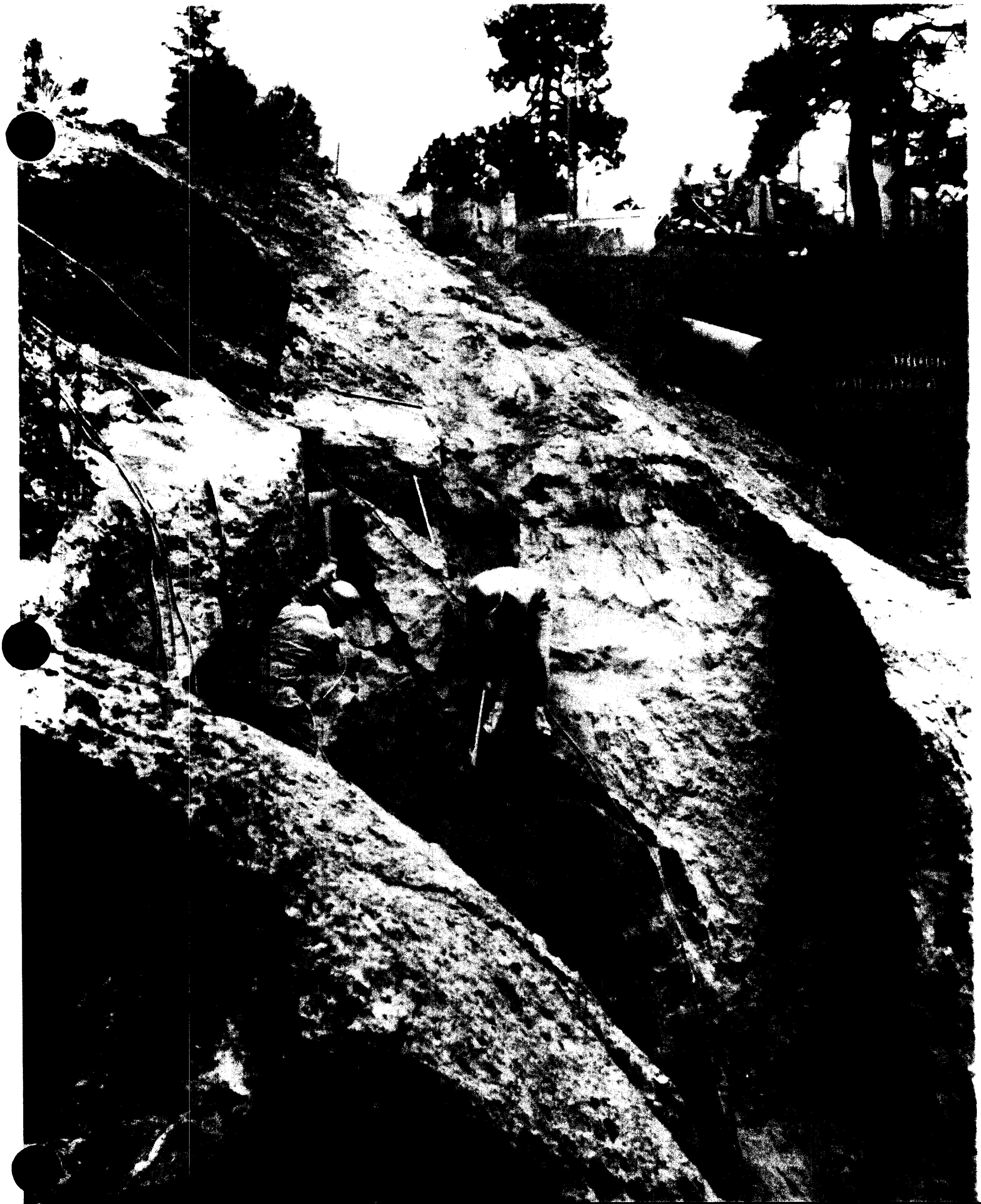


Figure A-45-3 Workers chipping away cliff face below the treated effluent outfall of SWMU 45-001, the Radioactive Treatment Facility, during initial D&D activities in 1966.

Figure A-45-4 The TA-45 site after D&D in 1966–1967. SWMU locations indicated are 45-001, the Radioactive Treatment Facility, during initial D&D activities in 1966.

Figure A-45-5 View of SWMU 45-002, the Vehicle Decontamination Facility, during operation.

Figure A-45-6 View of broken concrete floor of SWMU 45-002, the Vehicle Decontamination Facility, during 1966–1967 D&D activities.

Figure A-45-7 View of SWMU 45-003, Industrial Waste (Acid Waste) Lines, during 1966–1967 D&D activities. This was the untreated influent line to the Treatment Plant.

APPENDIX B

- TA-10 Data and Analysis
- TA-45 Data

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1.0 TA-10 FIRING SITES SAMPLING PLAN DESIGN

1.1 The Problem

One question that should be answered based on a soil sample from a site is:

> What is the concentration of a given contaminant in a block of some prespecified size within the area of concern?

The block size of interest may be determined based on an exposure scenario (e.g., quarter-acre lots for a future residential site), remedial constraints (e.g., it is most practical to remove the topsoil from areas of a given minimum size), or some other criterion. The accuracy needed to estimate the block will depend on the risks and costs associated with misclassification of the block for the specified purpose.

Formulating the problem in this way suggests that a sampling plan which is uniform across the site is desirable, for the question applies uniformly to all blocks within the site.

1.2 The Approach

This section provides an investigation of the relationship between the spacing of samples on a rectangular grid and the estimation error for a block of a given size. The block size for this problem will be 70x70 ft, in a site of about $17x10^6$ ft^2. The range of grid spacings is upward from a 20 ft grid. At this smallest value, 16 points could fit within the 70x70 ft block, and a reasonable estimate of the block mean would be the average of these 16 points. However, it would require more than 42,000 samples to cover the entire site at this spacing. A 70 ft grid, which would guarantee one point in each 70x70 ft block, requires more than 3,000 samples. In general, however, taking the value of the single included observation as the estimate of block mean produces a larger error than using a prediction approach that incorporates information from observations outside the block, as discussed below. A 150 ft grid requires about 755 samples, and a 500 ft grid requires less than 70 samples. At these spacings, there will be 70x70 ft blocks with no samples for which prediction-based estimates are essential.

Thus, for a reasonable sample size, estimators that are based on a model for the spatial distribution of the contaminant should be considered. Such a model could include trends or "fixed effects" with respect to geographical coordinates, geologically defined strata, or field screening measurements, as well as residual terms or "random effects" characterized by their spatial correlation properties. Below, the simplest case is described, assuming a constant trend (to be estimated) and a spatially stationary correlation model for the deviations in contaminant level about the overall mean. This simple model might be appropriate for a site which has been remediated once. In this case the trends that might have originally existed, due to the mode of release (e.g., an explosion at a firing site, a leak from a point or line source) or the subsequent distribution mechanisms (prevailing winds, concentration by runoff from storms), can be assumed to have been removed.

While nothing need be known about the level of the spatial mean in order to estimate the block prediction error under this model, it is necessary to have information about the spatial correlation of the residual. As with the estimation of a simple mean from a random sample, for which the population variance together with the sample size suffices to determine the precision of the estimate, the precision of a block estimate can be determined in advance, given these second-order properties of the spatial distribution and the spatial configuration of the prospective samples.

In the absence of any information about the contaminant(s) of interest, it is possible to assume that the spatial distribution of an as yet unmeasured contaminant is similar to that of one for which some information already exists, at least with respect to the important second order properties (i.e., coefficient of variation, correlation range). The alternative to this assumption would be to conduct reconnaissance sampling designed explicitly to evaluate these parameters (and perhaps also to test the hypothesis that no trend exists.).

In Bayo Canyon, post-cleanup measurements on ^{90}Sr and total uranium (as well as gross-alpha and gross-beta activity) are available for 44 samples across the site (Attachment 1). These measurements are shown in Figures B-1a and B-1b, where the symbol size is proportional to the observation. Figures B-1a and B-1b show irregular patterns without gross trends.

The observations on the two radioactive elements appear to be close to normal log distribution (Figures B-2a and B-2b). The slopes of the fitted line in these figures estimates the standard deviation of the natural logarithms, which approximates the coefficient of variation of the original observations. If two contaminants are linearly well correlated, they should have similar coefficients of variation. However, uranium and strontium are only moderately correlated ($r \approx 0.4$), and their coefficients of variation differ by a factor of two.

Significant differences between the spatial distributions of the two elements are also apparent in variagram estimates. The variagram function is a convenient summary of the second-moment properties of a spatially distributed quantity such as the concentration of a contaminant in soil. It is defined as a function of the separation between the following observations:

$$\gamma_Z(h) = \gamma_Z(x+h,x) = \frac{1}{2}E[Z(x+h) - Z(x)]^2,$$

i.e., one-half of the average squared difference between observations of Z separated by a distance h. Typically, one observes a discontinuity at the origin. By definition, $\gamma_z(0)$ is zero, but values bounded away from zero are often observed even for very small separations h, which could be due to analytical error, local

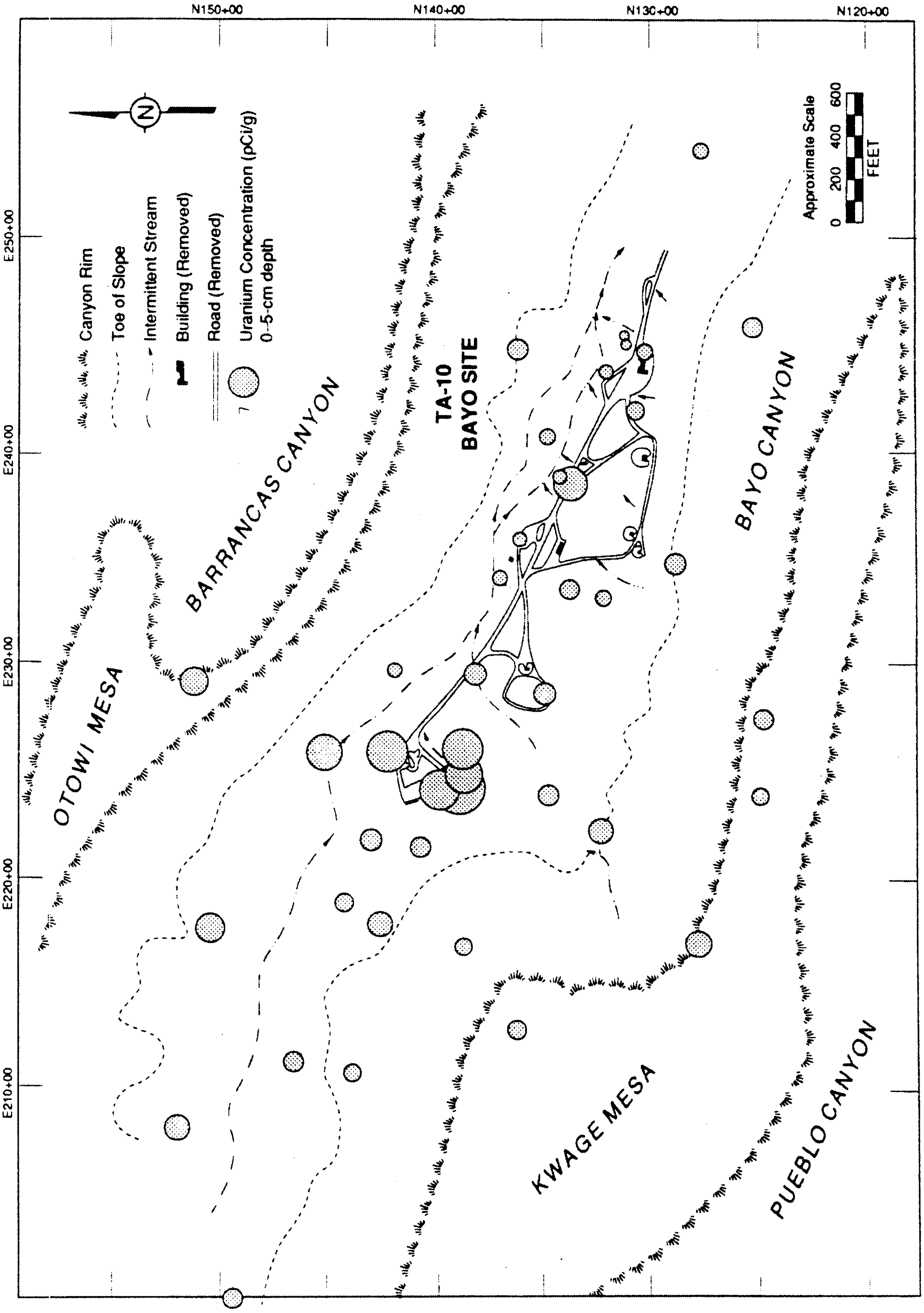

Figure B-1a. Uranium concentration at TA-10 for 0–5 cm depth interval (modified from Mayfield et al. 1979, 06-0041).

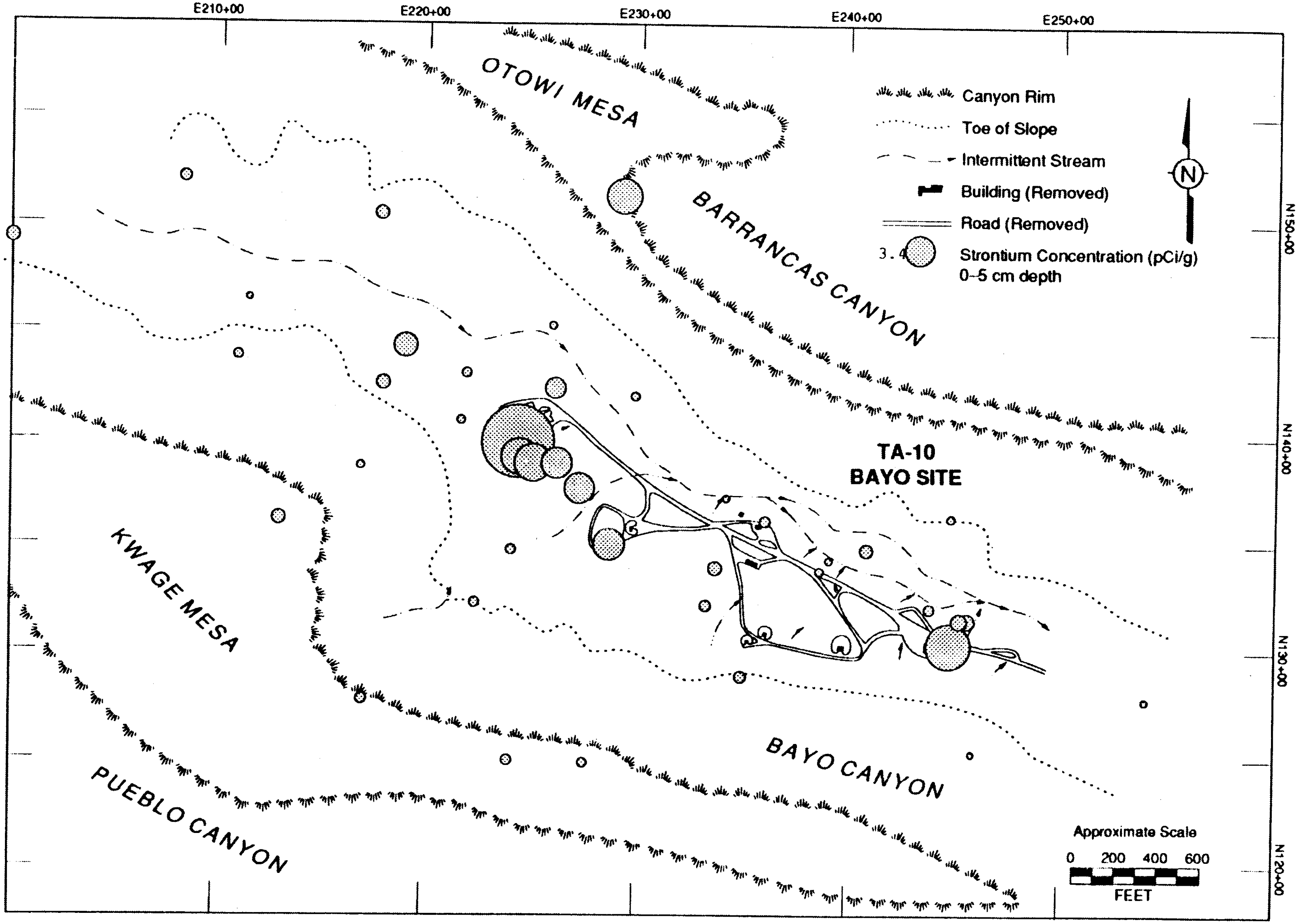

Figure B-1b. Strontium concentration at TA-10 for 0-5 cm depth interval (modified from Mayfield et al. 1979, 06-0041).

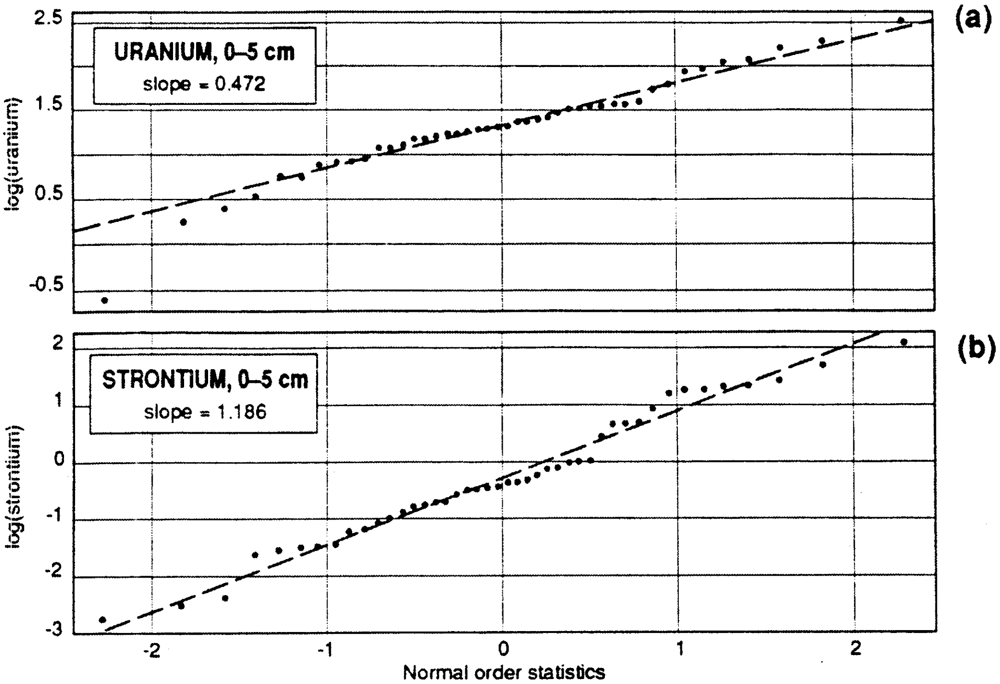

Figure B-2. Log-normal plots for uranium and strontium (0–5 cm).

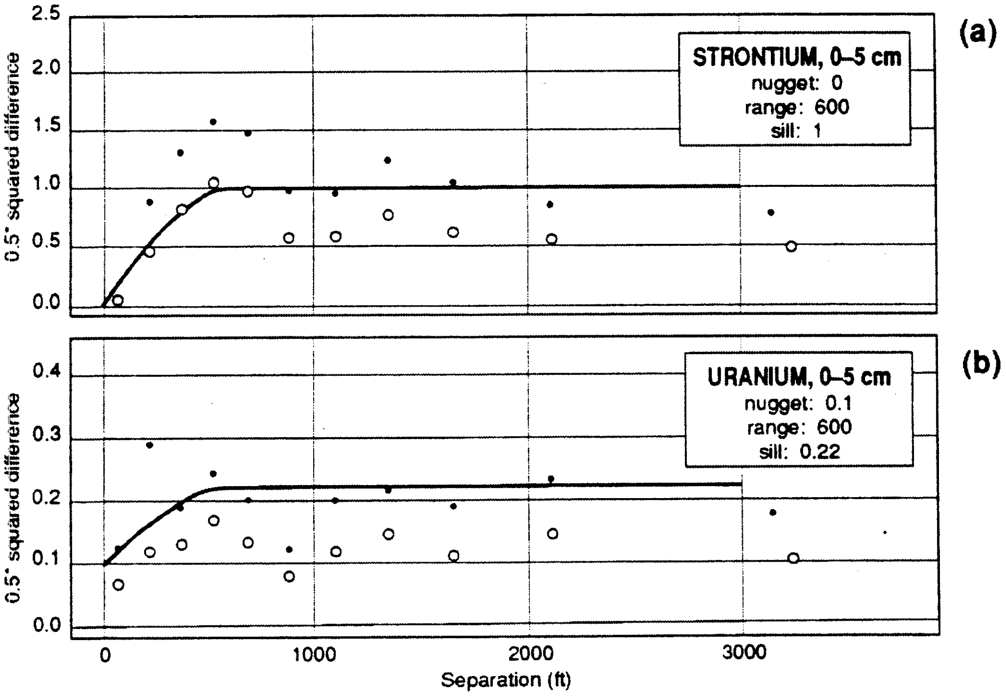

Figure B-3. Variagrams for strontium and uranium (0–5 cm).

heterogeneity, or both. Geostatisticians refer to this as the "nugget" effect. Also, there is typically a distance beyond which the variagram function levels off, and there is no correlation among observations separated by larger distances. This is called the "range" or correlation distance, and the constant value of γ_Z beyond this point is called the "sill" of the variagram.

For the Bayo Canyon data, the spatial distribution of log(^{90}Sr) appears to be quite smooth, and can be modeled without a nugget, although the overall variance or sill (the square of the coefficient of variation of the unlogged data) is large (approximately 1) (Figure B-3a). The local variability of log(total uranium), on the other hand, appears to be a substantial fraction (at least 35%) of the smaller overall variance (about 0.22) (Figure B-3b). Both sets of measurements exhibit a correlation distance of about 600 ft. It is difficult to determine the reason for these differences without more information,and if one of these variables is to be used as a proxy for unknown contaminants in the design phase of a sampling plan, it may be important to understand these differences better. It appears from the raw data that ^{90}Sr is measured with greater accuracy than total uranium, and it may also be that the natural level of uranium is substantial, unlike the background for ^{90}Sr. Both of these factors could contribute to the much larger coefficient of variation for ^{90}Sr. It will be relatively conservative, however, to assume that other elements may be as variable as ^{90}Sr is observed to be.

1.3 Block Prediction

The block that is most difficult to predict (i.e., will have the largest estimation error) is the block centered at the midpoint between four grid points. The approach below will estimate the prediction variance for the centered block (always of size 70x70 ft) in grids of various spacing. The closest 16 points (a 4x4 ft subset of the grid) will be used to form the prediction. A preliminary study indicated that using a larger subgrid does not result in a greater accuracy, for the range of grid spacings under consideration here.

To estimate the average value of Z(x) over a block V

$$Z_v = \frac{1}{|V|}\int_v Z(x)dx$$

based on data collected at points x_α (the support of the samples is supposed negligible by comparison with V), the kriging equations are solved

$$\sum_\beta \lambda_\beta \gamma_Z(x_\alpha, x_\beta) + \mu = \overline{\gamma}_Z(x_\alpha, V), \alpha = 1, \ldots, n$$
$$\sum_\beta \lambda_\beta = 1$$

for coefficients λ_α and for μ. Here,

$$\bar{\gamma}_Z(x,V) = \frac{1}{|V|}\int_V \gamma_Z(x,y)dy = \frac{1}{2|V|}\int_V E[Z(x) - Z(y)]^2\ dy.$$

The estimated block average, if measurements z_α at the x_α were available, would be

$$\hat{Z}_V = \sum_\alpha \lambda_\alpha z_\alpha.$$

However, even prior to the collection of data, the variance of this estimate can be computed:

$$\sigma_Z^2 = E(\hat{Z}_V - Z_V)^2 = \sum_\alpha \lambda_\alpha \bar{\gamma}_Z(v_\alpha, V) + \mu - \bar{\gamma}_Z(V,V),$$

where

$$\bar{\gamma}_Z(V,V) = \frac{1}{|V|^2}\int_V\int_V \gamma_Z(x,y)\ dx\ dy.$$

Once the variagram $\gamma_Z(x,y)$, the block V, and the sampling grid (i.e., the sample locations $x\alpha$) are specified, we can form an estimate of the prediction error for Zv.

Figure B-4 shows how the prediction error σ_Z for a 70x70 ft block varies as a function of grid spacing. Curves are shown for six processes Z with different variagram functions: all have a sill of one, one of two ranges (300 or 600 ft) and one of three nugget-to-sill ratios (0, 0.25 or 0.50). The prediction error for the shorter range reaches its asymptotic value sooner, as expected, and this asymptotic value drops as the nugget increases. If this latter result seems counterintuitive, think of the process as a sum of two processes. One is a white noise process with constant mean, which can be predicted equally well using observations near to or distant from the block. The larger the component of variance due to this process, the more important the prediction of its mean becomes to the total prediction, and the precision of this part of the prediction is independent of the grid spacing. The other part of the prediction is based on the zero-mean, spatially correlated deviations from the mean trend, and this is better predicted from nearby observations, which provides an improvement over prediction by the simple mean when they are available, but an overall decrease in performance when they are not.

Figure B-5 is a similar illustration for the two variagrams estimated from Bayo Canyon data for ^{90}Sr and total uranium. Both the relatively small overall variation in uranium and the fact that 35 to 50% of this variation appears to be pure noise contribute to producing accurate block estimates even for large grids. For ^{90}Sr, however, prediction error increases by more than an order of magnitude as the

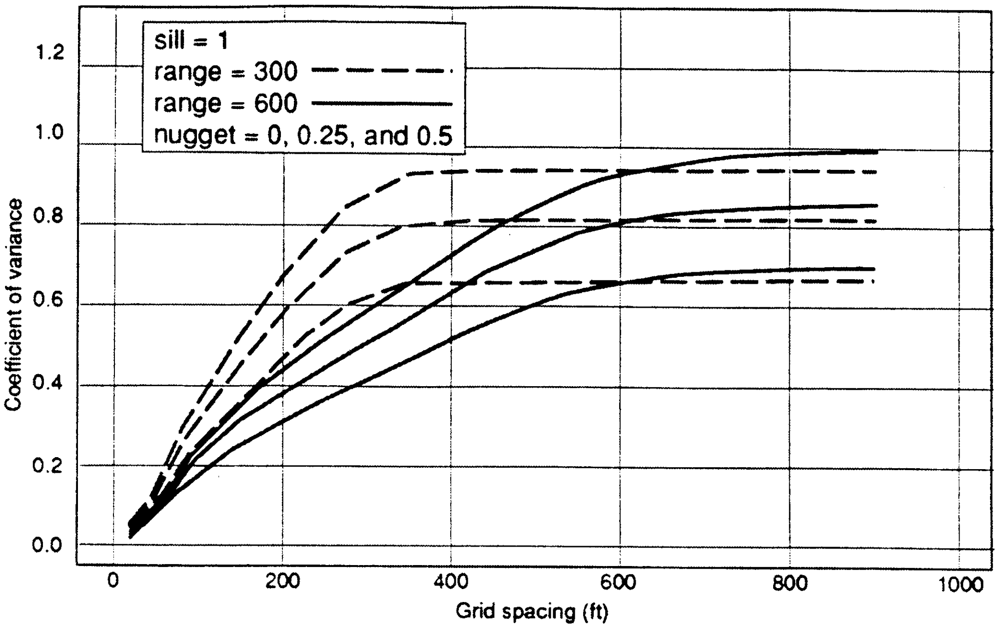

Figure B-4. Prediction of error for 70 x 70 ft block from grid.

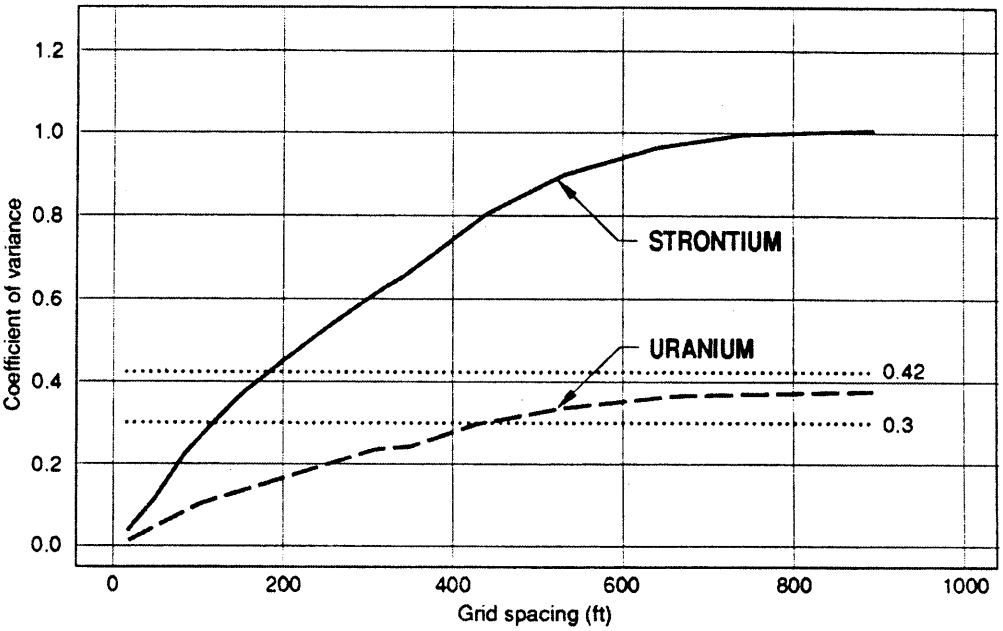

Figure B-5. Predictability of log(strontium) and log(uranium).

grid spacing increases from 50 to 500.

1.4. Using Prediction Error to Determine Grid Spacing

Let X(x) denote the concentration of the contaminant of interest at location x, and let

$$X_v = \frac{1}{|V|} \int_v X(x)dx$$

be the average concentration in the 70x70 ft block V. Let $Y(x) = \log(X(x))$, and

$$Y_v = \frac{1}{|V|} \int_v Y(x)\ dx.$$

Then

$$X_v \approx k \exp(Y_v),$$

where

$$k = 1 + \bar{\gamma}_Y (V,V)/2.$$

Suppose a decision will be based on a test of the hypothesis

$$H_0 : E[X_v] < \mu_0,\ vs.\ H_A : E[X_v] \geq \mu_0,$$

and a test of the following form will be used:

> Accept H_0 if $\hat{X}_v < c$, reject (in favor of H_A) otherwise.

Further suppose that two points on a "discomfort" curve for error are given:

> If it is true that $E[\hat{X}_v] \geq \mu^+ > \mu_0$ then the probability of accepting H_0 should be less than β, and
>
> if it is true that $E[\hat{X}_v] \leq \mu^- < \mu_0$ then the probability of accepting H_0 should be greater than $1 - \alpha$.

To compute $\hat{X}_v$ as k $\exp(\hat{Y}_v)$, where $\hat{Y}_v$ is estimated by block kriging as above, from observations of a normal process (i.e., X is assumed to have log-normal marginals). Then

$$Pr\,\{\hat{X}_v < c\} = Pr\,\{\hat{Y}_v < \log(c/k)\}.$$

Assuming $\hat{Y}_v$ is normal with mean $\log(\mu^+/k)$ gives

$$Pr\,\{\hat{Y}_v < \log(c/k)\} \leq \Phi\left(\frac{\log(c/\mu^+)}{\sigma_Y}\right) \leq \beta.$$

(Φ is the standard normal cdf), while when $X_v \leq \mu^-$,

$$Pr\,\{\hat{Y}_v < \log(c/k)\} \geq \Phi\left(\frac{\log(c/\mu^-)}{\sigma_Y}\right) \geq 1 - \alpha.$$

These two inequalities combine to form an inequality for σ_Y:

$$\sigma_Y \leq \frac{\log\,(\mu^+/\mu^-)}{z_{1-\alpha} - z_\beta},$$

where $z_{1-\alpha}$ and z_β are percentiles of the standard normal. (Notice that the value of the cutoff "c" does not appear in this last equation.)

For example, suppose that μ^+ is a factor of two greater than μ^0 and μ^- is a factor of two smaller, so that $\log(\mu^+/\mu^-) = 1.386$. Further, suppose that both α and β are 0.05. Then the bound on σ_Y is 0.42, which can be guaranteed (referring to Figure B-5) with a grid spacing of about 180 ft, corresponding to a sample size of about 280 to cover the entire site. Notice that for a spatial distribution like uranium's, this criterion can be met by any sampling grid (of at least 16 points). If α and β are decreased to .01, then the bound on σ_Y becomes 0.30, requiring a spacing of about 120 ft (625 samples).

1.5 Grid Spacing Required for TA-10 Surface Sampling

The discomfort curve for the decision errors for Be developed in Chapter 5 (Figure 5.1-2) was used to determine many values of μ^+ and μ^-, and $z_{1-\alpha}$ and z_β in the previous equation (1.4.1). It was determined that the most restrictive case was at the boundary of the shaded region where neither condition is considered in error.

This boundary region requires a Type II error ([F(-) or β] of 0.25 when the true risk is 1.25 x 10^{-6} (μ^+ = 0.25 mg/kg) and a Type I error [F(+) or (α)] of 0.30 when the true risk is 5 x 10^{-7} (μ^- = 0.1 mg/kg). Using equation 1.4.1, the bound for the prediction error of the average concentration of Be over an exposure unit is log (0.25/.1)/1.05, which equals .87 (the natural logarithm is used). The ^{90}Sr prediction error curve (Figure B-5) gives a required grid size of approximately 500 ft for this prediction error. (This large grid spacing reflects low concern about decision errors [large α and β] until the ratio between μ^+ and μ^- is quite large [1,000 to 10,000].) The grid sampling plan is, therefore, to place a 500 ft grid over the entire area (17 x 10^6 ft^2) and sample at each grid node for a total of 68 samples. Some additional samples will be collected in the surface investigation as described in Subsection 5.1.1.6 of this work plan.

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ATTACHMENT 1

TA-10 DATA SET

TABLE B-1 DATA USED FOR KRIGING ANALYSIS IN THE TA-10 CENTRAL AREA

Hole No.	LASL Grid East	North	Depth (m) From	To	Gross Alpha	Gross Beta	^{238}Pu (pCi/g)	^{239}Pu (pCi/g)	^{90}Sr (pCi/g)
m1	24454	12974	0	1.5	86	163			
m1	24454	12974	1.5	3.1	67	171			
m1	24454	12974	3.1	4.6	60	197			
m1	24454	12974	4.6	6.1	67	187			
m1	24454	12974	6.1	7.6	42	190			<.05
m1	24454	12974	7.6	9.1	59	204	0.013	0.013	<.05
m1	24454	12974	9.1	10.7	66	231			<0.5
m2	24452	13179	0	1.5	43	417			
m2	24452	13179	1.5	3.1	49	234	0.008	0.210	42.0
m2	24452	13179	3.1	4.6	67	144			1.9
m2	24452	13179	4.6	6.1	72	135			
m3	24336	13210	0	1.5	63[a]	301[a]			
m3	24336	13210	1.5	3.1	57[b]	317[b]	0.006	0.014	7.4

[a] Average of 3 analyses

[b] Average of 2 analyses

(Modified from Mayfield et al. 1979, 06-0041)

TABLE B-2 DATA USED FOR KRIGING ANALYSIS IN THE TA-10 CENTRAL AREA

	LASL Grid				
Hole No.	East	North	Depth (m)	Gross Alpha (pCi/g)	Gross Beta (pCi/g)
e-1	24447	13182	.3	2.5	35
e-1	24447	13182	.9	2.6	31
e-1	24447	13182	1.5	1.9	10.7
e-1	24447	13182	2.1	1.8	3.9
e-1	24447	13182	2.7	2.6	4.4
e-1	24447	13182	3.35	2.2	3.1
e-1	24447	13182	4.0	3.0	5.6
e-1	24447	13182	4.6	2.4	4.1
e-1	24447	13182	5.2	2.7	4.7
e-1	24447	13182	5.8	--	--
e-1	24447	13182	6.85	3.8	42
e-1	24447	13182	8.35	--	--
e-1	24447	13182	9.85	--	--
e-2	24466	13173	.3	3.1	10.3
e-2	24466	13173	.9	--	--
e-2	24466	13173	1.5	1.2	1.1
e-2	24466	13173	2.1	1.6	1.5
e-2	24466	13173	2.7	--	--
e-2	24466	13173	3.35	1.5	3.7
e-2	24466	13173	4.0	1.4	1.8
e-2	24466	13173	4.6	1.3	3.4
e-2	24466	13173	5.2	1.6	1.7
e-2	24466	13173	5.8	--	--
e-2	24466	13173	6.85	2.1	5.5
e-2	24466	13173	8.35	2.7	9.0
e-2	24466	13173	9.85	--	--
e-3	24487	13167	.3	4.1	9.2
e-3	24487	13167	.9	4.0	9.9
e-3	24487	13167	1.5	5.0	15
e-3	24487	13167	2.1	3.3	8.1
e-3	24487	13167	2.7	--	--
e-3	24487	13167	3.35	3.0	3.9
e-3	24487	13167	4.0	5.2	10.3
e-3	24487	13167	4.6	43.0	5.2
e-3	24487	13167	5.2	3.6	6.5
e-3	24487	13167	5.8	--	--
e-3	24487	13167	6.85	3.8	6.1
e-3	24487	13167	8.35	--	--
e-3	24487	13167	9.85	--	--
e-4	24448	13156	.3	2.8	11.2
e-4	24448	13156	.9	2.1	3.2
e-4	24448	13156	1.5	1.0	1.1
e-4	24448	13156	2.1	1.0	3.4
e-4	24448	13156	2.7	1.6	4.7

TABLE B-2 DATA USED FOR KRIGING ANALYSIS IN THE TA-10 CENTRAL AREA (CONTINUED)

	LASL Grid				
Hole No.	East	North	Depth (m)	Gross Alpha (pCi/g)	Gross Beta (pCi/g)
e-4	24448	13156	3.35	1.3	1.4
e-4	24448	13156	4.0	1.8	1.0
e-4	24448	13156	4.6	3.0	7.5
e-4	24448	13156	5.2	4.9	3.5
e-4	24448	13156	5.8	1.6	2.4
e-4	24448	13156	6.85	3.8	2.9
e-4	24448	13156	8.35	--	--
e-4	24448	13156	9.85	--	--
e-5	24429	13184	.3	3.4	186.0
e-5	24429	13184	.9	4.2	89.0
e-5	24429	13184	1.5	--	--
e-5	24429	13184	2.1	2.7	39.0
e-5	24429	13184	2.7	--	--
e-5	24429	13184	3.35	2.8	16.0
e-5	24429	13184	4.0	2.4	28.0
e-5	24429	13184	4.6	3.7	--
e-5	24429	13184	5.2	1.9	20.0
e-5	24429	13184	5.8	2.1	21.0
e-5	24429	13184	6.85	3.7	16.0
e-5	24429	13184	8.35	3.7	18.0
e-5	24429	13184	9.85	--	--
w-2	24361	13205	.3	1.8	6.7
w-2	24361	13205	.9	4.2	10.9
w-2	24361	13205	1.5	3.8	7.8
w-2	24361	13205	2.1	--	--
w-2	24361	13205	2.7	--	--
w-2	24361	13205	3.35	--	--
w-2	24361	13205	4.0	--	--
w-2	24361	13205	4.6	--	--
w-2	24361	13205	5.2	--	--
w-2	24361	13205	5.8	--	--
w-2	24361	13205	6.85	--	--
w-2	24361	13205	8.35	--	--
w-2	24361	13205	9.85	--	--
w-3	24377	13200	.3	3.4	47.0
w-3	24377	13200	.9	3.3	36.0
w-3	24377	13200	1.5	3.7	30.0
w-3	24377	13200	2.1	2.3	30.0
w-3	24377	13200	2.7	2.9	12.0
w-3	24377	13200	3.35	--	--
w-3	24377	13200	4.0	3.1	9.9
w-3	24377	13200	4.6	3.6	12.0
w-3	24377	13200	5.2	--	--
w-3	24377	13200	5.8	--	--

TABLE B-2 DATA USED FOR KRIGING ANALYSIS IN THE TA-10 CENTRAL AREA (CONTINUED)

	LASL Grid			Gross Alpha	Gross Beta
Hole No.	East	North	Depth (m)	(pCi/g)	(pCi/g)
w-3	24377	13200	6.85	2.1	4.6
w-3	24377	13200	8.35	4.9	6.5
w-3	24377	13200	9.85	4.8	5.6
w-4	24366	13200	.3	1.7	5.9
w-4	24366	13200	.9	2.8	16.0
w-4	24366	13200	1.5	2.4	2.1
w-4	24366	13200	2.1	1.9	1.6
w-4	24366	13200	2.7	1.0	1.0
w-4	24366	13200	3.35	1.4	2.3
w-4	24366	13200	4.0	--	--
w-4	24366	13200	4.6	2.1	5.4
w-4	24366	13200	5.2	--	--
w-4	24366	13200	5.8	--	--
w-4	24366	13200	6.85	4.4	4.1
w-4	24366	13200	8.35	4.4	3.2
w-4	24366	13200	9.85	4.6	3.6
w-5	24327	13227	.3	--	--
w-5	24327	13227	.9	--	--
w-5	24327	13227	1.5	2.1	22.0
w-5	24327	13227	2.1	--	--
w-5	24327	13227	2.7	--	--
w-5	24327	13227	3.35	--	--
w-5	24327	13227	4.0	--	--
w-5	24327	13227	4.6	--	--
w-5	24327	13227	5.2	--	--
w-5	24327	13227	5.8	--	--
w-5	24327	13227	6.85	--	--
w-5	24327	13227	8.35	--	--
w-5	24327	13227	9.85	--	--
w-6	24362	13227	.3	3.1	34.0
w-6	24362	13227	.9	--	18.0
w-6	24362	13227	1.5	3.3	21.0
w-6	24362	13227	2.1	3.9	4400.0
w-6	24362	13227	2.7	6.9	20.0
w-6	24362	13227	3.35	2.5	21.0
w-6	24362	13227	4.0	12.0	2300.0
w-6	24362	13227	4.6	59.0	24000.0
w-6	24362	13227	5.2	--	--
w-6	24362	13227	5.8	--	--
w-6	24362	13227	6.85	0.5	6400.0
w-6	24362	13227	8.35	5.7	--
w-6	24362	13227	9.85	--	1510.0

(Modified from Mayfield et al. 1979, 06-0041)

TABLE B-3 DATA USED FOR TA-10 KRIGING IN THE CENTRAL, TA-10-44, AND TA-10-48 AREAS

Point Name	LASL Grid		Depth (cm)	Gross Beta	Gross Alpha (pCi/g)	^{90}Sr (pCi/g)	^{137}Cs (pCi/g)	U-T (µg/g)	^{238}Pu (pCi/g)	^{239}Pu (pCi/g)
	East	North								
2168A-1	24137	13164	75	1	22	NA	NA	NA	NA	NA
2168A-2	24137	13164	225	2	24	NA	NA	NA	NA	NA
2168A-3	24137	13164	380	2	24	NA	NA	NA	NA	NA
2168A-4	24137	13164	530	0	22	NA	NA	NA	NA	NA
2168A-5	24137	13164	680	3	26	1.59	NA	NA	NA	NA
2168B-1	24141	13168	75	2	17	NA	NA	NA	NA	NA
2168B-2	24141	13168	225	2	24	NA	NA	NA	NA	NA
2168B-3	24141	13168	380	1	26	NA	NA	NA	NA	NA
2168B-4	24141	13168	530	2	25	NA	NA	NA	NA	NA
2168B-5	24141	13168	680	4	29	0.15	NA	NA	NA	NA
41C-1	24369	13193	75	6	20	NA	NA	NA	NA	NA
41C-2	24369	13193	225	35	32	NA	NA	NA	NA	NA
41C-3	24369	13193	380	501	32	1140.00	NA	NA	NA	NA
41C-4	24369	13193	530	539	20	1060.00	NA	NA	NA	NA
41C-5	24369	13193	680	355	18	NA	NA	NA	NA	NA
41C-6	24369	13193	840	208	55	NA	NA	NA	NA	NA
41C-7	24369	13193	995	140	24	335.00	NA	NA	NA	NA
41C-8	24369	13193	1145	85	63	NA	NA	NA	NA	NA
41NE-1	24382	13193	75	3	11	NA	NA	NA	NA	NA
41NE-2	24382	13193	225	3	0	1.90	NA	NA	NA	NA
41NE-3	24382	13193	380	4	3	NA	NA	NA	NA	NA
41NE-4	24382	13193	530	4	11	2.60	NA	NA	NA	NA
41NE-5	24382	13193	680	105	46	90.00	NA	NA	NA	NA
41NE-6	24382	13193	840	22	41	NA	NA	NA	NA	NA
41NE-7	24382	13193	995	14	39	NA	NA	NA	NA	NA
41NE-8	24382	13193	1145	19	34	NA	NA	NA	NA	NA
41NW-1	24371	13199	75	4	20	NA	NA	NA	NA	NA
41NW-2	24371	13199	225	4	13	0.23	NA	NA	NA	NA
41NW-3	24371	13199	380	4	13	NA	NA	NA	NA	NA
41NW-4	24371	13199	530	4	6	0.30	NA	NA	NA	NA
41NW-5	24371	13199	680	4	24	NA	NA	NA	NA	NA
41NW-6	24371	13199	840	4	51	0.32	NA	NA	NA	NA
41NW-7	24371	13199	995	5	55	NA	NA	NA	NA	NA
41NW-8	24371	13199	1145	6	55	NA	NA	NA	NA	NA
41SE-1	24369	13185	75	4	15	2.46	NA	NA	NA	NA
41SE-2	24369	13185	225	3	0	1.04	NA	NA	NA	NA
41SE-3	24369	13185	380	3	1	NA	NA	NA	NA	NA
41SE-4	24369	13185	530	10	32	NA	NA	NA	NA	NA
41SE-5	24369	13185	680	5	20	NA	NA	NA	NA	NA
41SE-6	24369	13185	840	4	32	NA	NA	NA	NA	NA
41SE-7	24369	13185	995	5	56	NA	NA	NA	NA	NA

TABLE B-3 DATA USED FOR TA-10 KRIGING IN THE CENTRAL, TA-10-44, AND TA-10-48 AREAS (CONTINUED)

Point Name	LASL Grid East	LASL Grid North	Depth (cm)	Gross Beta	Gross Alpha (pCi/g)	^{90}Sr (pCi/g)	^{137}Cs (pCi/g)	U-T (µg/g)	^{238}Pu (pCi/g)	^{239}Pu (pCi/g)
41SE-8	24369	13185	1145	6	56	NA	NA	NA	NA	NA
41SW-1	24359	13192	75	3	32	NA	NA	NA	NA	NA
41SW-2	24359	13192	225	3	39	NA	NA	NA	NA	NA
41SW-3	24359	13192	380	4	6	NA	NA	NA	NA	NA
41SW-4	24359	13192	530	3	11	0.10	NA	NA	NA	NA
41SW-5	24359	13192	680	4	18	0.50	NA	NA	NA	NA
41SW-6	24359	13192	840	3	17	0.61	NA	NA	NA	NA
41SW-7	24359	13192	995	4	55	0.00	NA	NA	NA	NA
41SW-8	24359	13192	1145	4	74	NA	NA	NA	NA	NA
42C-1	24336	13217	75	6	8	NA	NA	NA	NA	NA
42C-2	24336	13217	225	17	6	NA	NA	NA	NA	NA
42C-3	24336	13217	380	4	27	NA	NA	NA	NA	NA
42C-4	24336	13217	530	185	17	NA	NA	NA	NA	NA
42C-5	24336	13217	680	47	22	NA	NA	NA	NA	NA
42C-6	24336	13217	840	52	32	NA	NA	NA	NA	NA
42C-7	24336	13217	995	39	8	NA	NA	NA	NA	NA
42C-8	24336	13217	1145	20	27	NA	NA	NA	NA	NA
42E-1	24347	13219	75	8	8	NA	NA	NA	NA	NA
42E-2	24347	13219	225	4	22	NA	NA	NA	NA	NA
42E-3	24347	13219	380	3	22	NA	NA	NA	NA	NA
42E-4	24347	13219	530	3	22	NA	NA	NA	NA	NA
42E-5	24347	13219	680	4	10	NA	NA	NA	NA	NA
42E-6	24347	13219	840	5	29	NA	NA	NA	NA	NA
42E-7	24347	13219	995	5	15	NA	NA	NA	NA	NA
42E-8	24347	13219	1145	7	17	NA	NA	NA	NA	NA
42N-1	24335	13225	75	6	8	NA	NA	NA	NA	NA
42N-2	24335	13225	225	3	17	2.90	NA	NA	NA	NA
42N-3	24335	13225	380	3	11	NA	NA	NA	NA	NA
42N-4	24335	13225	530	48	30	NA	NA	NA	NA	NA
42N-5	24335	13225	680	109	25	176.00	NA	NA	NA	NA
42N-6	24335	13225	840	49	30	NA	NA	NA	NA	NA
42N-7	24335	13225	995	4	43	NA	NA	NA	NA	NA
42N-8	24335	13225	1145	8	110	NA	NA	NA	NA	NA
42S-1	24338	13209	75	4	22	0.21	NA	NA	NA	NA
42S-2	24338	13209	225	5	22	NA	NA	NA	NA	NA
42S-3	24338	13209	380	4	13	NA	NA	NA	NA	NA
42S-4	24338	13209	530	4	22	NA	NA	NA	NA	NA
42S-5	24338	13209	680	3	32	NA	NA	NA	NA	NA
42S-6	24338	13209	840	4	32	NA	NA	NA	NA	NA
42S-7	24338	13209	995	4	36	NA	NA	NA	NA	NA

TABLE B-3 DATA USED FOR TA-10 KRIGING IN THE CENTRAL, TA-10-44, AND TA-10-48 AREAS (CONTINUED)

Point Name	LASL Grid		Depth (cm)	Gross Beta	Gross Alpha (pCi/g)	^{90}Sr (pCi/g)	^{137}Cs (pCi/g)	U-T (µg/g)	^{238}Pu (pCi/g)	^{239}Pu (pCi/g)
	East	North								
42S-8	24338	13209	1145	6	44	NA	NA	NA	NA	NA
42W-1	24325	13214	75	5	22	NA	NA	NA	NA	NA
42W-2	24325	13214	225	8	29	NA	NA	NA	NA	NA
42W-3	24325	13214	380	169	25	NA	NA	NA	NA	NA
42W-4	24325	13214	530	206	24	NA	NA	NA	NA	NA
42W-5	24325	13214	680	839	29	NA	NA	NA	NA	NA
42W-6	24325	13214	840	227	18	NA	NA	NA	NA	NA
42W-7	24325	13214	995	108	36	NA	NA	NA	NA	NA
42W-8	24325	13214	1145	138	22	NA	NA	NA	NA	NA
43C-1	24220	13237	75	5	24	NA	NA	NA	NA	NA
43C-2	24315	13223	225	5	51	NA	NA	NA	NA	NA
43C-3	24315	13223	380	69	18	NA	NA	NA	NA	NA
43C-4	24315	13223	530	33	30	NA	NA	NA	NA	NA
43C-5	24315	13223	680	12	22	NA	NA	NA	NA	NA
43C-6	24315	13223	840	20	20	NA	NA	NA	NA	NA
43C-7	24315	13223	995	30	15	NA	NA	NA	NA	NA
43C-8	24315	13223	1145	11	13	NA	NA	NA	NA	NA
43E-1	24325	13221	75	7	22	NA	NA	NA	NA	NA
43E-2	24325	13221	225	5	10	NA	NA	NA	NA	NA
43E-3	24325	13221	380	905	24	1290.00	NA	NA	NA	NA
43E-4	24325	13221	530	2214	27	4310.00	NA	NA	NA	NA
43E-5	24325	13221	680	389	8	NA	NA	NA	NA	NA
43E-6	24325	13221	840	224	43	NA	NA	NA	NA	NA
43E-7	24325	13221	995	318	18	NA	NA	NA	NA	NA
43E-8	24325	13221	1145	148	25	NA	NA	NA	NA	NA
43N-1	24315	13240	75	3	8	1.13	NA	NA	NA	NA
43N-2	24315	13240	225	3	5	0.04	NA	NA	NA	NA
43N-3	24315	13240	380	2	22	NA	NA	NA	NA	NA
43N-4	24315	13240	530	3	13	0.20	NA	NA	NA	NA
43N-5	24315	13240	680	3	13	0.09	NA	NA	NA	NA
43N-6	24315	13240	840	4	15	0.20	NA	NA	NA	NA
43N-7	24315	13240	995	4	20	0.00	NA	NA	NA	NA
43N-8	24315	13240	1145	5	55	NA	NA	NA	NA	NA
43S-1	24313	13214	75	4	46	0.31	NA	NA	NA	NA
43S-2	24313	13214	225	4	25	0.15	NA	NA	NA	NA
43S-3	24313	13214	380	3	24	NA	NA	NA	NA	NA
43S-4	24313	13214	530	3	29	0.00	NA	NA	NA	NA
43S-5	24313	13214	680	4	24	0.09	NA	NA	NA	NA

TABLE B-3 DATA USED FOR TA-10 KRIGING IN THE CENTRAL, TA-10-44, AND TA-10-48 AREAS (CONTINUED)

Point Name	LASL Grid		Depth (cm)	Gross Beta	Gross Alpha (pCi/g)	^{90}Sr (pCi/g)	^{137}Cs (pCi/g)	U-T (µg/g)	^{238}Pu (pCi/g)	^{239}Pu (pCi/g)
	East	North								
43S-6	24313	13214	840	4	32	0.00	NA	NA	NA	NA
43S-7	24313	13214	995	3	18	NA	NA	NA	NA	NA
43S-8	24313	13214	1145	5	36	NA	NA	NA	NA	NA
43W-1	24304	13223	75	5	15	NA	NA	NA	NA	NA
43W-2	24304	13223	225	2	17	NA	NA	NA	NA	NA
43W-3	24304	13223	380	4	15	NA	NA	NA	NA	NA
43W-4	24304	13223	530	4	27	0.00	NA	NA	NA	NA
43W-5	24304	13223	680	3	36	0.22	NA	NA	NA	NA
43W-6	24304	13223	840	4	39	0.10	NA	NA	NA	NA
43W-7	24304	13223	995	6	15	NA	NA	NA	NA	NA
43W-8	24304	13223	1145	6	25	NA	NA	NA	NA	NA
44C-1	24220	13224	75	2	20	NA	NA	NA	NA	NA
44C-2	24220	13224	225	2	22	NA	NA	NA	NA	NA
44C-3	24220	13224	380	3	43	NA	NA	NA	NA	NA
44C-4	24220	13224	530	3	49	NA	NA	NA	NA	NA
44C-5	24220	13224	680	3	41	NA	NA	NA	NA	NA
44C-6	24220	13224	840	3	36	NA	NA	NA	NA	NA
44C-7	24220	13224	995	3	48	NA	NA	NA	NA	NA
44C-8	24220	13224	1145	6	46	NA	NA	NA	NA	NA
44E-1	24228	13222	75	4	29	NA	NA	NA	NA	NA
44E-2	24228	13222	225	3	20	0.10	NA	NA	NA	NA
44E-3	24228	13222	380	3	1	NA	NA	NA	NA	NA
44E-4	24228	13222	530	3	13	NA	NA	NA	NA	NA
44E-5	24228	13222	680	2	20	NA	NA	NA	NA	NA
44E-6	24228	13222	840	4	13	NA	NA	NA	NA	NA
44E-7	24228	13222	995	4	29	NA	NA	NA	NA	NA
44E-8	24228	13222	1145	3	49	NA	NA	NA	NA	NA
44N-1	24227	13239	75	3	6	NA	NA	NA	NA	NA
44N-2	24227	13239	225	2	11	NA	NA	NA	NA	NA
44N-3	24227	13239	380	4	29	NA	NA	NA	NA	NA
44N-4	24227	13239	530	4	8	NA	NA	NA	NA	NA
44N-5	24227	13239	680	3	8	NA	NA	NA	NA	NA
44N-6	24227	13239	840	4	18	NA	NA	NA	NA	NA
44N-7	24227	13239	995	3	8	NA	NA	NA	NA	NA
44N-8	24227	13239	1145	5	24	NA	NA	NA	NA	NA
44S-1	24208	13221	75	4	8	NA	NA	NA	NA	NA
44S-2	24208	13221	225	4	20	NA	NA	NA	NA	NA
44S-3	24208	13221	380	2	17	NA	NA	NA	NA	NA

TABLE B-3 DATA USED FOR TA-10 KRIGING IN THE CENTRAL, TA-10-44, AND TA-10-48 AREAS (CONTINUED)

Point Name	LASL Grid		Depth (cm)	Gross Beta	Gross Alpha (pCi/g)	^{90}Sr (pCi/g)	^{137}Cs (pCi/g)	U-T (µg/g)	^{238}Pu (pCi/g)	^{239}Pu (pCi/g)
	East	North								
44S-4	24208	13221	530	5	15	NA	NA	NA	NA	NA
44S-5	24208	13221	680	4	15	NA	NA	NA	NA	NA
44S-6	24208	13221	840	5	25	NA	NA	NA	NA	NA
44S-7	24208	13221	995	3	29	NA	NA	NA	NA	NA
44S-8	24208	13221	1145	5	37	NA	NA	NA	NA	NA
44W-1	24208	13238	75	3	20	NA	NA	NA	NA	NA
44W-2	24208	13238	225	2	24	NA	NA	NA	NA	NA
44W-3	24208	13238	380	4	18	NA	NA	NA	NA	NA
44W-4	24208	13238	530	4	25	NA	NA	NA	NA	NA
44W-5	24208	13238	680	1	20	NA	NA	NA	NA	NA
44W-6	24208	13238	840	2	20	NA	NA	NA	NA	NA
44W-7	24208	13238	995	3	39	NA	NA	NA	NA	NA
44W-8	24208	13238	1145	4	56	NA	NA	NA	NA	NA
48A-1	24413	12977	75	2	29	NA	NA	NA	NA	NA
48A-2	24413	12977	225	3	42	NA	NA	NA	NA	NA
48A-3	24413	12977	380	3	23	NA	NA	NA	NA	NA
48A-4	24413	12977	530	5	24	NA	NA	NA	NA	NA
48A-5	24413	12977	680	2	32	NA	NA	NA	NA	NA
48A-6	24413	12977	840	3	31	NA	NA	NA	NA	NA
48A-7	24413	12977	995	5	22	0.50	NA	NA	NA	NA
48A-8	24413	12977	1145	3	16	NA	NA	NA	NA	NA
48A-9	24413	12977	1295	3	22	NA	NA	NA	NA	NA
48A-10	24413	12977	1450	4	16	NA	NA	NA	NA	NA
48AA-1	24411	12968	75	2	46	NA	NA	NA	NA	NA
48AA-2	24411	12968	225	4	17	NA	NA	NA	NA	NA
48AA-3	24411	12968	380	7	41	NA	NA	NA	NA	NA
48AA-4	24411	12968	530	4	17	NA	NA	NA	NA	NA
48AA-5	24411	12968	680	3	6	NA	NA	NA	NA	NA
48AA-6	24411	12968	840	2	36	NA	NA	NA	NA	NA
48AA-7	24411	12968	995	5	14	0.71	NA	NA	NA	NA
48AA-8	24411	12968	1145	4	6	NA	NA	NA	NA	NA
48AA-9	24411	12968	1295	2	4	NA	NA	NA	NA	NA
48AA-10	24411	12968	1450	3	10	NA	NA	NA	NA	NA
48B-1	24434	12962	75	2	17	NA	NA	NA	NA	NA
48B-2	24434	12962	225	2	51	NA	NA	NA	NA	NA
48B-3	24434	12962	380	15	12	NA	NA	2.8	NA	NA
48B-4	24434	12962	530	5	25	NA	NA	NA	NA	NA
48B-5	24434	12962	680	3	25	NA	NA	NA	NA	NA
48B-6	24434	12962	840	3	25	NA	NA	NA	NA	NA
48B-7	24434	12962	995	5	18	0.77	NA	NA	NA	NA

TABLE B-3 DATA USED FOR TA-10 KRIGING IN THE CENTRAL, TA-10-44, AND TA-10-48 AREAS (CONTINUED)

Point Name	LASL Grid East	LASL Grid North	Depth (cm)	Gross Beta	Gross Alpha (pCi/g)	^{90}Sr (pCi/g)	^{137}Cs (pCi/g)	U-T (µg/g)	^{238}Pu (pCi/g)	^{239}Pu (pCi/g)
48B-8	24434	12962	1145	3	12	NA	NA	NA	NA	NA
48B-9	24434	12962	1295	3	22	NA	NA	NA	NA	NA
48B-10	24434	12962	1450	3	14	NA	NA	NA	NA	NA
48BB-1	24435	12971	75	2	33	NA	NA	NA	NA	NA
48BB-2	24435	12971	225	5	39	NA	NA	NA	NA	NA
48BB-3	24435	12971	380	91	22	NA	NA	5.6	NA	NA
48BB-4	24435	12971	530	291	24	810.00	0.025	1.9	0	0.900
48BB-5	24435	12971	680	46	17	169.00	0.000	4.1	0	0.011
48BB-6	24435	12971	840	23	25	NA	NA	5.0	NA	NA
48BB-7	24435	12971	995	20	13	37.20	NA	NA	NA	NA
48BB-8	24435	12971	1145	5	10	NA	NA	NA	NA	NA
48BB-9	24435	12971	1295	8	14	NA	NA	NA	NA	NA
48BB-10	24435	12971	1450	8	4	NA	NA	NA	NA	NA
48C-1	24423	12969	75	0	36	NA	NA	NA	NA	NA
48C-2	24423	12969	225	4	20	NA	NA	NA	NA	NA
48C-3	24423	12969	380	3	38	NA	NA	NA	NA	NA
48C-4	24423	12969	530	2	27	NA	NA	NA	NA	NA
48C-5	24423	12969	680	3	22	NA	NA	NA	NA	NA
48C-6	24423	12969	840	2	29	NA	NA	NA	NA	NA
48C-7	24423	12969	995	3	10	0.16	NA	NA	NA	NA
50AL-1	24448	13172	75	8	30	NA	NA	NA	NA	NA
50AL-2	24448	13172	225	4	5	NA	NA	NA	NA	NA
50AL-3	24448	13172	380	2	10	NA	NA	NA	NA	NA
50AL-4	24448	13172	530	NA	NA	NA	NA	NA	NA	NA
50AL-5	24448	13172	680	NA	NA	NA	NA	NA	NA	NA
50AL-6	24448	13172	840	2	42	NA	NA	NA	NA	NA
50AL-7	24448	13172	995	4	58	0.31	NA	NA	NA	NA
50AL-8	24448	13172	1145	4	52	NA	NA	NA	NA	NA
50AL-9	24448	13172	1295	4	43	NA	NA	NA	NA	NA
50AL-10	24448	13172	1450	2	42	NA	NA	NA	NA	NA
50AL-11	24448	13172	1765	4	37	NA	NA	NA	NA	NA
50AL-12	24448	13172	1765	4	37	NA	NA	NA	NA	NA
50AL-13	24448	13172	1765	1	36	NA	NA	NA	NA	NA
50BL-1	24437	13190	75	1	14	NA	NA	NA	NA	NA
50BL-2	24437	13190	225	1	16	NA	NA	NA	NA	NA
50BL-3	24437	13190	380	2	13	NA	NA	NA	NA	NA
50BL-4	24437	13190	530	3	29	NA	NA	NA	NA	NA
50BL-5	24437	13190	680	2	61	NA	NA	NA	NA	NA
50BL-6	24437	13190	840	2	74	NA	NA	NA	NA	NA

TABLE B-3 DATA USED FOR TA-10 KRIGING IN THE CENTRAL, TA-10-44, AND TA-10-48 AREAS (CONTINUED)

Point Name	LASL Grid		Depth (cm)	Gross Beta	Gross Alpha (pCi/g)	^{90}Sr (pCi/g)	^{137}Cs (pCi/g)	U-T (µg/g)	^{238}Pu (pCi/g)	^{239}Pu (pCi/g)
	East	North								
50BL-7	24437	13190	995	5	38	0.07	NA	NA	NA	NA
50BL-8	24437	13190	1145	4	54	NA	NA	NA	NA	NA
50BL-9	24437	13190	1295	3	42	NA	NA	NA	NA	NA
50BL-10	24437	13190	1450	2	51	NA	NA	NA	NA	NA
50CL-1	24417	13173	75	4	10	NA	NA	NA	NA	NA
50CL-2	24417	13173	225	3	14	NA	NA	NA	NA	NA
50CL-3	24417	13173	380	1	12	NA	NA	NA	NA	NA
50CL-4	24417	13173	530	3	54	NA	NA	NA	NA	NA
50CL-5	24417	13173	680	1	31	NA	NA	NA	NA	NA
50CL-6	24417	13173	840	3	51	NA	NA	NA	NA	NA
50CL-7	24417	13173	995	4	61	0.12	NA	NA	NA	NA
50CL-8	24417	13173	1145	3	83	NA	NA	NA	NA	NA
50CL-9	24417	13173	1295	4	25	NA	NA	NA	NA	NA
50CL-10	24417	13173	1450	4	56	NA	NA	NA	NA	NA
50DL-1	24414	13185	75	2	32	NA	NA	NA	NA	NA
50DL-2	24414	13185	225	3	12	NA	NA	NA	NA	NA
50DL-3	24414	13185	380	2	16	NA	NA	NA	NA	NA
50DL-4	24414	13185	530	2	35	NA	NA	NA	NA	NA
50DL-5	24414	13185	680	1	44	NA	NA	NA	NA	NA
50DL-6	24414	13185	840	2	58	NA	NA	NA	NA	NA
50DL-7	24414	13185	995	4	77	0.16	NA	NA	NA	NA
50DL-8	24414	13185	1145	3	62	NA	NA	NA	NA	NA
50DL-9	24414	13185	1295	4	39	NA	NA	NA	NA	NA
50DL-10	24414	13185	1450	4	39	NA	NA	NA	NA	NA
50EL-1	24388	13174	75	3	27	NA	NA	NA	NA	NA
50EL-2	24388	13174	225	3	33	NA	NA	NA	NA	NA
50EL-3	24388	13174	380	1	17	NA	NA	NA	NA	NA
50EL-4	24388	13174	530	0	29	NA	NA	NA	NA	NA
50EL-5	24388	13174	680	2	25	NA	NA	NA	NA	NA
50EL-6	24388	13174	840	3	49	NA	NA	NA	NA	NA
50EL-7	24388	13174	995	6	57	0.18	NA	NA	NA	NA
50EL-8	24388	13174	1145	4	33	NA	NA	NA	NA	NA
50EL-9	24388	13174	1295	5	49	NA	NA	NA	NA	NA
50EL-10	24388	13174	1450	5	35	NA	NA	NA	NA	NA
50FL-1	24393	13153	75	2	23	NA	NA	NA	NA	NA
50FL-2	24393	13153	225	2	22	NA	NA	NA	NA	NA
50FL-3	24393	13153	380	3	13	NA	NA	NA	NA	NA
50FL-4	24393	13153	530	3	18	NA	NA	NA	NA	NA
50FL-5	24393	13153	680	2	41	NA	NA	NA	NA	NA
50FL-6	24393	13153	840	4	14	NA	NA	NA	NA	NA

TABLE B-3 DATA USED FOR TA-10 KRIGING IN THE CENTRAL, TA-10-44, AND TA-10-48 AREAS (CONTINUED)

Point Name	LASL Grid		Depth (cm)	Gross Beta	Gross Alpha (pCi/g)	^{90}Sr (pCi/g)	^{137}Cs (pCi/g)	U-T (µg/g)	^{238}Pu (pCi/g)	^{239}Pu (pCi/g)
	East	North								
50FL-7	24393	13153	995	4	38	0.22	NA	NA	NA	NA
50FL-8	24393	13153	1145	3	107	NA	NA	NA	NA	NA
50FL-9	24393	13153	1295	3	64	NA	NA	NA	NA	NA
50FL-10	24393	13153	1450	6	77	NA	NA	NA	NA	NA
50GL-1	24421	13163	75	10	33	NA	NA	NA	NA	NA
50GL-2	24421	13163	225	2	10	NA	NA	NA	NA	NA
50GL-3	24421	13163	380	2	36	NA	NA	NA	NA	NA
50GL-4	24421	13163	530	2	18	NA	NA	NA	NA	NA
50GL-5	24421	13163	680	1	45	NA	NA	NA	NA	NA
50GL-6	24421	13163	840	4	60	NA	NA	NA	NA	NA
50GL-7	24421	13163	995	4	41	0.12	NA	NA	NA	NA
50GL-8	24421	13163	1145	4	38	NA	NA	NA	NA	NA
50GL-9	24421	13163	1295	5	54	NA	NA	NA	NA	NA
50GL-10	24421	13163	1450	4	43	NA	NA	NA	NA	NA
BDH-1	24370	13016	90	4	47	5.08	NA	NA	NA	NA
BDH-2	24362	13018	90	2	26	NA	NA	NA	NA	NA
BDH-3	24348	13013	90	1	24	NA	NA	NA	NA	NA
BDH-4	24360	13038	90	4	20	NA	NA	NA	NA	NA
BDH-5	24354	13038	90	2	18	NA	NA	NA	NA	NA
BDH-7	24375	13061	90	4	27	NA	NA	NA	NA	NA
BDH-8	24361	13067	90	3	47	0.11	NA	NA	NA	NA
BDH-9	24361	13067	90	3	47	0.11	NA	NA	NA	NA
BDH-10	24357	13054	90	5	23	NA	NA	NA	NA	NA
BDH-11	24366	13076	90	2	49	NA	NA	NA	NA	NA
BDH-12	24372	13083	90	2	48	NA	NA	NA	NA	NA
BDH-13	24394	13100	90	2	39	NA	NA	NA	NA	NA
BDH-14	24399	13105	90	2	39	NA	NA	NA	NA	NA
BDH-15	24403	13108	90	1	25	NA	NA	NA	NA	NA
BDH-16	24408	13113	90	2	43	NA	NA	NA	NA	NA
BDH-17	24411	13115	90	2	33	NA	NA	NA	NA	NA
BDH-18	24415	13119	90	2	37	NA	NA	NA	NA	NA
BDH-19	24420	13124	90	4	26	NA	NA	NA	NA	NA
BDH-20	24426	13130	90	5	42	5.81	NA	NA	NA	NA
BDH-21	24426	13130	90	5	42	5.81	NA	NA	NA	NA
BDH-22	24417	13140	90	2	27	NA	NA	NA	NA	NA
BDH-23	24411	13147	90	1	30	NA	NA	NA	NA	NA
BDH-24	24403	13157	90	2	12	NA	NA	NA	NA	NA
BDH-25	24403	13157	90	3	20	9.46	NA	NA	NA	NA
BDH-26	24385	13179	90	4	49	NA	NA	NA	NA	NA
BDH-27	24378	13185	90	8	42	NA	NA	NA	NA	NA

TABLE B-3 DATA USED FOR TA-10 KRIGING IN THE CENTRAL, TA-10-44, AND TA-10-48 AREAS (CONTINUED)

Point Name	LASL Grid East	LASL Grid North	Depth (cm)	Gross Beta	Gross Alpha (pCi/g)	^{90}Sr (pCi/g)	^{137}Cs (pCi/g)	U-T (μg/g)	^{238}Pu (pCi/g)	^{239}Pu (pCi/g)
BDH-28	24374	13189	90	7	36	NA	NA	NA	NA	NA
BDH-29	24360	13203	90	2	37	NA	NA	NA	NA	NA
BDH-30	24352	13209	90	13	41	26.20	NA	NA	NA	NA
BDH-31	24345	13214	90	3	29	NA	NA	NA	NA	NA
BDH-32	24329	13226	90	3	39	NA	NA	NA	NA	NA
BDH-33	24454	13033	90	2	41	NA	NA	NA	NA	NA
BDH-34	24454	13033	90	4	22	NA	NA	NA	NA	NA
BDH-35	24446	13044	90	3	36	NA	NA	NA	NA	NA
BDH-35	24446	13044	90	4	38	NA	NA	NA	NA	NA
BDH-36	24433	13025	90	4	25	NA	NA	NA	NA	NA
BDH-36	24433	13025	90	4	38	NA	NA	NA	NA	NA
BDH-38	24423	13042	90	2	27	NA	NA	NA	NA	NA
BDH-39	24397	13048	90	2	29	NA	NA	NA	NA	NA
BDH-39	24397	13048	90	3	12	NA	NA	NA	NA	NA
BDH-40	24390	13045	90	3	49	NA	NA	NA	NA	NA
BDH-40	24390	13045	90	3	12	NA	NA	NA	NA	NA
BDH-41	24390	13035	90	3	36	NA	NA	NA	NA	NA
BDH-41	24390	13035	90	2	24	NA	NA	NA	NA	NA
BDH-42	24388	13029	90	3	22	NA	NA	NA	NA	NA
BDH-42	24388	13029	90	2	24	NA	NA	NA	NA	NA
BDH-43	24427	13055	90	3	30	NA	NA	NA	NA	NA
BDH-44	24430	13064	90	1	37	NA	NA	NA	NA	NA
BDH-45	24433	13073	90	3	26	NA	NA	NA	NA	NA
BDH-46	24436	13083	90	3	49	NA	NA	NA	NA	NA
BDH-47	24438	13093	90	2	39	NA	NA	NA	NA	NA
BDH-48	24440	13102	90	2	62	NA	NA	NA	NA	NA
BDH-49	24446	13122	90	4	26	0.37	NA	NA	NA	NA
BDH-50	24449	13129	90	4	26	0.37	NA	NA	NA	NA
BDH-51	24450	13135	90	3	35	NA	NA	NA	NA	NA
BDH-52	24452	13141	90	4	56	NA	NA	NA	NA	NA
BDH-53	24452	13144	90	2	20	NA	NA	NA	NA	NA
BDH-54	24453	13145	90	9	44	NA	NA	NA	NA	NA
BDH-55	24455	13150	90	2	23	NA	NA	NA	NA	NA
BDH-56	24457	13156	90	2	36	NA	NA	NA	NA	NA
BDH-57	24458	13163	90	3	51	NA	NA	NA	NA	NA
BDH-58	24460	13169	90	2	8	NA	NA	NA	NA	NA
BDH-59	24462	13174	90	12	6	NA	NA	NA	NA	NA
BDH-60	24464	13183	90	48	0	67.20	0	1	0	0
BDH-61	24371	13199	90	4	27	NA	NA	NA	NA	NA

TABLE B-3 DATA USED FOR TA-10 KRIGING IN THE CENTRAL, TA-10-44, AND TA-10-48 AREAS (CONTINUED)

Point Name	LASL Grid		Depth (cm)	Gross Beta	Gross Alpha (pCi/g)	^{90}Sr (pCi/g)	^{137}Cs (pCi/g)	U-T (μg/g)	^{238}Pu (pCi/g)	^{239}Pu (pCi/g)
	East	North								
BDH-62	24328	13217	90	2	23	NA	NA	NA	NA	NA
BDH-63	24315	13223	90	2	18	NA	NA	NA	NA	NA
BDH-64	24220	13237	90	3	32	NA	NA	NA	NA	NA
BDH-65	24107	13154	90	4	44	NA	NA	NA	NA	NA
BDH-66	24126	13163	90	2	14	NA	NA	NA	NA	NA
BDH-67	24132	13163	90	3	17	NA	NA	NA	NA	NA
BDH-69	24121	13163	90	3	4	0.06	NA	NA	NA	NA
BDH20-21	24426	13130	90	5	42	NA	NA	NA	NA	NA
BDH24-25	24403	13157	90	3	20	9.46	NA	NA	NA	NA
BDH33-34	24454	13033	90	2	32	NA	NA	NA	NA	NA
BDH8-9	24361	13067	90	3	47	NA	NA	NA	NA	NA

(Modified from Mayfield et al. 1979, 06-0041)

TABLE B-4 DATA USED FOR KRIGING ANALYSIS IN THE TA-10 FIRING SITES (0-5 cm DEPTH)

Point Name	LASL Grid		Gross Alpha (pCi/g)	Gross Beta (pCi/g)	^{90}Sr (pCi/g)	Total Uranium (μg/g)
	East	North				
C-0	22606	13808				
C1-1	22659	13785	3	44		
C1-2	22479	13779	2	48		
C1-3	22604	13875	4	27	3.45	9.5
C2-1	22716	13755	3	80	3.40	0.54
C2-2	22604	13689	3	27		
C2-3	22496	13743	2	50		
C2-4	22489	13871	4	36	4.13	7.8
C2-5	22603	13944	4	44		
C2-6	22714	13886	3	29		
C3-1	22788	13721	3	12		
C3-2	22670	13618	2	36		
C3-3	22508	13636	4	23		
C3-4	22416	13755	2	41		
C3-5	22419	13909	6	44	3.8	12.0
C3-6	22548	14028	2	31		
C3-7	22704	14000	4	30		
C3-8	22804	13872	2	16		
C4-1	22867	13682	4	47		
C4-2	22735	13559	1	5		
C4-3	22551	13530	6	30		
C4-4	22391	13613	3	20		
C4-5	22321	13770	3	20		
C4-6	22345	13956	8	25		
C4-7	22476	14087	3	12		
C4-8	22664	14138	3	23		
C4-9	22745	14030	3	18		
C4-10	22893	13860	3	30		
C5-1	22956	13627	1	26		
C5-2	22856	13502	6	14	3.27	4.3
C5-3	22707	13431	3	36		
C5-4	22461	13425	4	20		
C5-5	22388	13484	3	74	0.60	4.0
C5-6	22271	13607	4	27		
C5-7	22209	13758	3	23		
C5-8	22228	13924	4	16		

TABLE B-4 DATA USED FOR KRIGING ANALYSIS IN THE TA-10 FIRING SITES (0-5 cm DEPTH) (CONTINUED)

Point Name	LASL Grid East	LASL Grid North	Gross Alpha (pCi/g)	Gross Beta (pCi/g)	^{90}Sr (pCi/g)	Total Uranium (µg/g)
C5-9	22302	14081	4	41		
C5-10	22433	14186	3	29		
C5-11	22593	14225	4	29	1.95	8.9
C5-12	22756	14204	3	29		
C5-13	22890	14102	3	26		
C5-14	22970	13956	4	45		
C5-15	23000	13785	2	35		
C6-1	23065	13570	3	13		
C6-2	22975	13446	2	32		
C6-3	22839	13346	2	25		
C6-4	22681	13300	4	14		
C6-5	22514	13304	3	12		
C6-6	22359	13352	0	23		
C6-7	22230	13454	2	13		
C6-8	22133	13586	2			
C6-9	22079	13741	2	27		
C6-10	22089	13900	1	19		
C6-11	22142	14072	5	5	.41	4.6
C6-12	22166	14201	2	19		
C6-13	22375	14292	2	30		
C6-14	22544	14346	2	14		
C6-15	22696	14341	2	30		
C6-16	22855	14289	2	36		
C6-17	22981	14190	3	11	0.218	2.9
C6-18	23074	14054	3	22		
C6-19	23121	13885	1	24		
C6-20	23119	13725	2	30		
C7-1	23217	13493	2	20		
C7-2	23136	13328	2	45		
C7-3	23033	13272	1	29		
C7-4	22916	13201	3	22		
C7-5	22779	13146	3	8		
C7-6	22634	13122	3	16		
C7-7	22483	13135	1	17		
C7-8	22350	13170	2	2		
C7-9	22219	13239	2	16	0.61	4.7

TABLE B-4 DATA USED FOR KRIGING ANALYSIS IN THE TA-10 FIRING SITES (0-5 cm DEPTH) (CONTINUED)

Point Name	LASL Grid East	LASL Grid North	Gross Alpha (pCi/g)	Gross Beta (pCi/g)	^{90}Sr (pCi/g)	Total Uranium (μg/g)
C7-10	22105	13341	2	7		
C7-11	22019	13454	1	29		
C7-12	21940	13574	4	2		
C7-13	21911	13716	4	13		
C7-14	21902	13851	3	10		
C7-15	21922	14018	3	13		
C7-16	21980	14148	2	25		
C7-17	22065	14262	3	11		
C7-18	22176	14295	3	13	0.62	4.1
C7-19	22302	14446	2	27		
C7-20	22433	14490	2	25		
C7-21	22581	14516	1	18	0.23	7.0
C7-22	22726	14501	4	22		
C7-23	22864	14460	3	23		
C7-24	22987	14316	3	8		
C7-25	23095	14301	3	19		
C7-26	23190	14186	2	17		
C7-27	23178	14060	2	10		
C7-28	23284	13911	3	10		
C7-29	23299	13775	2	14		
C7-30	23195	13625	3	35		
C8-1	23356	13389	6	8	0.89	3.6
C8-2	23315	13219	5	10	0.55	2.5
C8-3	23176	13088	6	11		
C8-4	23014	12984	6	19		
C8-5	22834	12912	5	25		
C8-6	22643	12883	6	8		
C8-7	22447	12907	4	27		
C8-8	22268	12960	5	35		
C8-9	22090	13049	3	37		
C8-10	21928	13170	3	7		
C8-11	21815	13325	5	10		
C8-12	21742	13505	7	30		
C8-13	21681	13681	5	21		
C8-14	21679	13874	6	1	0.207	3.0
C8-15	21716	14078	5	25		
C8-16	21777	14255	5	10	0.79	4.5
C8-17	21882	14418	6	10	2.5	3.7

TABLE B-4 DATA USED FOR KRIGING ANALYSIS IN THE TA-10 FIRING SITES (0-5 cm DEPTH) (CONTINUED)

Point Name	LASL Grid East	LASL Grid North	Gross Alpha (pCi/g)	Gross Beta (pCi/g)	^{90}Sr (pCi/g)	Total Uranium (µg/g)
C8-18	22034	14479	4	9		
C8-19	22129	14650	4	29		
C8-20	22379	14716	4	4		
C8-21	22572	14743	3	25		
C8-22	22766	14737	2	20		
C8-23	22947	14681	3	5		
C8-24	23119	14586	3	0		
C8-25	23271	14465	3	16		
C8-26	23386	14313	1			
C8-27	23474	14146	4	16		
C8-28	23523	13958	1	7		
C8-29	23538	13762	2			
C8-30	23499	13569	3	32		
C9-1	23786	13195	4	12		
C9-2	23683	13035	3	18		
C9-3	23486	12891	5	26	0.63	3.9
C9-4	23426	12765	4	15		
C9-5	23192	12666	4	18		
C9-6	23171	12617	5	22		
C9-7	22935	12479	1	60		
C9-8	22748	12494	4	57	0.45	3.5
C9-9	22558	12484	7	32		
C9-10	22378	12509	4	53	0.49	3.3
C9-11	22202	12551	5	38		
C9-12	22034	12624	5	36		
C9-13	21876	12718	4	24		
C9-14	21692	12796	7	18	0.69	4.5
C9-15	21565	12934	3	44		
C9-16	21478	13106	4	23		
C9-17	21397	13272	4	34		
C9-18	21333	13447	3	33		
C9-19	21290	13625	3	54	1.00	3.2
C9-20	21202	13805	2	38		
C9-21	21301	14027	1	14		
C9-22	21325	14181	5	24		
C9-23	21321	14357	5	10		
C9-24	21481	14518	3	18		
C9-25	21585	14666	3	10		

TABLE B-4 DATA USED FOR KRIGING ANALYSIS IN THE TA-10 FIRING SITES (0-5 cm DEPTH) (CONTINUED)

Point Name	LASL Grid East	LASL Grid North	Gross Alpha (pCi/g)	Gross Beta (pCi/g)	^{90}Sr (pCi/g)	Total Uranium (μg/g)
C9-26	21711	14801	4	5		
C9-27	21846	14913	4	16		
C9-28	22021	15004	4	32		
C9-29	22190	15081	5	10		
C9-30	22367	15127	5	2		
C9-31	22556	15135	5	22		
C9-32	22718	15138	4	2		
C9-33	22918	15108	4	17	3.7	5.9
C9-34	23086	15045	3	27		
C9-35	23166	14968	3	14		
C9-36	23268	14862	5	16		
C9-37	23555	14743	8	10		
C9-38	23683	14589	6	13		
C9-39	23775	14447	4	20		
C9-40	23902	14311	5	12		
C9-41	23900	14099	5	7		
C9-42	23920	13911	7	15		
C9-43	23946	13726	4	10		
C9-44	23906	13552	3	9		
C9-45	23849	13371	5	15	0.34	6.8
EA-1	23791	12952	1	4		
EA-2	24064	12794	1	24		
EA-3	24325	12673	1	20		
EA-4	24590	12529	5	24	0.30	3.7
EA-5	24858	12391	3	10		
EA-6	25123	12178	2	30		
EB-1	23926	13135	3	14		
EB-2	24193	13073	2	23	0.09	3.4
EB-3	24466	12932	36	2	132.0	2.4
EB-4	24727	12796	3	8		
EB-5	25000	12652	2	6		
EB-6	25270	12516	2	18		
EC-1	24072	13473	6	22	0.98	2.9
EC-2	24345	13337	2	7		
EC-3	24597	13201	2	17		
EC-4	24874	13055	1	8		
EC-5	25138	12917	0	22		

TABLE B-4 DATA USED FOR KRIGING ANALYSIS IN THE TA-10 FIRING SITES (0-5 cm DEPTH) (CONTINUED)

Point Name	LASL Grid		Gross Alpha (pCi/g)	Gross Beta (pCi/g)	^{90}Sr (pCi/g)	Total Uranium (µg/g)
	East	North				
EC-6	25404	12779	4	17	0.221	2.6
ED-1	24150	13742	1	6		
ED-2	24481	13607	6	14	0.29	4.6
ED-3	24744	13464	1	22		
ED-4	25017	13326	3	10		
ED-5	25283	13192	1	11		
ED-6	25467	13054	2	18		
NO-1	22384	13936				
NO-2	22684	13970				
SC-0	22308	14019				
WA-1	20020	14934	5	44	0.87	3.6
WA-2	20279	14801	2	14		
WA-3	20542	14659	1	12		
WA-4	20811	14515	1	16		
WA-5	21085	14376	5	14	0.48	3.4
WB-1	20157	15118	3	23		
WB-2	20415	15061	1	10		
WB-3	20684	14919	3	8		
WB-4	20956	14783	2	11		
WB-5	21145	14646	2	24	0.191	3.9
WC-1	20292	15467	4	8		
WC-2	20560	15325	3	17		
WC-3	20824	15189	7	11	0.73	4.8
WC-4	21102	15048	1	7		
WC-5	21287	14906	3	6		
WD-5	21502	15172	2	8		
WD-6	21763	15034	7	6	0.97	5.6
TA10-1 #1	24476	13028	2	18	5.40	3.2
TA10-1 #2			2	14	2.81	2.3
TA10-3	24518	13102	4	19	1.54	1.7
TA10-4	24512	13119	3	19	1.92	1.3
TA10-5	24548	13114	3	4	1.87	1.5
TA10-7	24375	13199	2	7	0.69	2.1

TABLE B-4 DATA USED FOR KRIGING ANALYSIS IN THE TA-10 FIRING SITES (0-5 cm DEPTH) (CONTINUED)

Point Name	LASL Grid East	LASL Grid North	Gross Alpha (pCi/g)	Gross Beta (pCi/g)	^{90}Sr (pCi/g)	Total Uranium (µg/g)
TA10-21	23593	13602	3	26	0.47	2.4
SC-2B	22413	13974	4	17	8.20	7.6
SC-4C	22957	13822	2	14	0.0	4.7
SC-6C	23406	13704	1	0	.078	2.1
SC-7C	23887	13426	3	4	0.36	2.5

(Modified from Mayfield et al. 1979, 06-0041)

TABLE B-5 DATA USED FOR KRIGING ANALYSIS AT THE TA-10 FIRING SITES (0-30 cm DEPTH)

Point Name	LASL Grid East	LASL Grid North	Gross Beta (pCi/g)	Gross Alpha (pCi/g)	^{90}Sr (pCi/g)	Total Uranium (μg/g)
C-0	22606	13808	0	0	0	0
C1-1	22659	13785	2	52		
C1-2	22479	13779	3	51		
C1-3	22604	13875	2	32		
C2-1P	22716	13755	1	29	0.70	2.69
C2-2	22604	13689	2	62		
C2-3	22496	13743	2	29		
C2-4	22489	13871	2	39		
C2-5	22603	13944	3	23		
C2-6	22714	13886	1	39		
C3-1P	22788	13721	1	20	0	0
C3-2	22670	13618	3	25		
C3-3	22508	13636	2	24	0.41	7.0
C3-4	22416	13755	1	47		
C3-5P	22419	13909	3	25	0.99	4.98
C3-6	22548	14028	4	16		
C3-7	22704	14000	4	30	4.05	12.0
C3-8	22804	13872	4	32		
C4-1	22867	13682	3	51		
C4-2	22735	13559	2	12	0.36	6.9
C4-3	22551	13530	3	38		
C4-4	22391	13613	4	25		
C4-5	22321	13770	3	26		
C4-6	22345	13956	2	45		
C4-7	22476	14087	2	47		
C4-8	22664	14138	2	30		
C4-9	22745	14030	2	35		
C4-10	22893	13860	4	48		
C5-1	22956	13627	2	30		
C5-2	22856	13502	2	27		
C5-3	22707	13431	4	26		
C5-4	22461	13425	1	29		
C5-5	22388	13484	4	38		
C5-6	22271	13607	3	23		
C5-7	22209	13758	3	26		
C5-8	22228	13924	3	12		

TABLE B-5 DATA USED FOR KRIGING ANALYSIS AT THE TA-10 FIRING SITES (CONTINUED)
(0-30 cm DEPTH)

Point Name	LASL Grid East	LASL Grid North	Gross Beta (pCi/g)	Gross Alpha (pCi/g)	^{90}Sr (pCi/g)	Total Uranium (µg/g)
C5-9	22302	14081	4	19	0.61	4.6
C5-10	22433	14186	7	42		
C5-11	22593	14225	4	32		
C5-12	22756	14204	3	12		
C5-13	22890	14102	3	23		
C5-14	22970	13956	3	24		
C5-15	23000	13785	0	35		
C6-1	23065	13570	2	36		
C6-2	22975	13446	6	10	1.23	4.9
C6-3	22839	13346	3	24		
C6-4	22681	13300	1	16		
C6-5	22514	13304	1	22		
C6-6	22359	13352	5	26	0.49	3.8
C6-7	22230	13454				
C6-8	22133	13586	1	19		
C6-9	22079	13741	2	44		
C6-10	22089	13900	3	22		
C6-11	22142	14072	3	17		
C6-12	22166	14201	3	23		
C6-13	22375	14292	2	32		
C6-14	22544	14346	3	37		
C6-15	22696	14341	2	19	0.23	4.9
C6-16	22855	14289	2	22		
C6-17P	22981	14190	1	29	0.15	2.80
C6-18	23074	14054	1	23		
C6-19	23121	13885	2	29		
C6-20	23119	13725	2	26		
C7-1	23217	13493	2	41		
C7-2	23136	13328	5	14	0.54	4.4
C7-3	23033	13272	5	27		
C7-4	22916	13201	4	27		
C7-5	22779	13146	1	17		
C7-6	22634	13122				
C7-7	22483	13135	2	29		
C7-8	22350	13170	2	19		
C7-9	22219	13239				
C7-10	22105	13341	2	22		
C7-11	22019	13454	1	18		

TABLE B-5 DATA USED FOR KRIGING ANALYSIS AT THE TA-10 FIRING SITES (CONTINUED) (0-30 cm DEPTH)

Point Name	LASL Grid East	LASL Grid North	Gross Beta (pCi/g)	Gross Alpha (pCi/g)	^{90}Sr (pCi/g)	Total Uranium (µg/g)
C7-12	21940	13574	3	13		
C7-13	21911	13716	2	13		
C7-14	21902	13851	5	0		
C7-15	21922	14018	2	17		
C7-16	21980	14148	6	9	0.79	5.5
C7-17	22065	14262	3	30		
C7-18P	22176	14295	2	41	0.20	3.70
C7-19	22302	14446	3	12		
C7-20	22433	14490	4	23		
C7-21	22581	14516	4	23		
C7-22	22726	14501	2	22		
C7-23	22864	14460	2	7		
C7-24	22987	14316	3	11		
C7-25	23095	14301	2	10		
C7-26	23190	14186	4	20		
C7-27	23178	14060	2	14		
C7-28	23284	13911	1	0		
C7-29	23299	13775	2	30		
C7-30	23195	13625	2	23		
C8-1	23356	13389	2	36	0	0
C8-2P	23315	13219	6	25	0.29	2.38
C8-3	23176	13088	6	20		
C8-4	23014	12984	3	15		
C8-5	22834	12912	5	10		
C8-6	22643	12883	6	26		
C8-7	22447	12907	5	8		
C8-8	22268	12960	4	46		
C8-9	22090	13049	4	42	0.27	3.4
C8-10	21928	13170	5	26		
C8-11	21815	13325	5	17		
C8-12	21742	13505				
C8-13	21681	13681	5	4		
C8-14P	21679	13874	4	15	0.30	3.18
C8-15	21716	14078	5	11		
C8-16	21777	14255	4	20		
C8-17	21882	14418	4	35		
C8-18	22034	14479	6	25		
C8-19	22129	14650	5	19		
C8-20	22379	14716	5	11		

TABLE B-5 DATA USED FOR KRIGING ANALYSIS AT THE TA-10 FIRING SITES (CONTINUED)
(0-30 cm DEPTH)

Point Name	LASL Grid East	LASL Grid North	Gross Beta (pCi/g)	Gross Alpha (pCi/g)	^{90}Sr (pCi/g)	Total Uranium (µg/g)
C8-21	22572	14743	4	20	0.23	7.8
C8-22	22766	14737	3	5		
C8-23	22947	14681	3	5		
C8-24	23119	14586	3	2		
C8-25	23271	14465	3	14		
C8-26	23386	14313	3	1		
C8-27	23474	14146	4	11		
C8-28	23523	13958	2	4		
C8-29	23538	13762	2	22		
C8-30	23499	13569	2	32		
C9-1	23786	13195	7	15	0.43	3.3
C9-2	23683	13035	2	15		
C9-3P	23486	12891	4	21	0.49	3.63
C9-4	23426	12765	4	24		
C9-5	23192	12666	4	45		
C9-6	23171	12617	3	12		
C9-7	22935	12479				
C9-8	22748	12494	4	53		
C9-9	22558	12484	3	45		
C9-10	22378	12509	3	73		
C9-11	22202	12551	5	50		
C9-12	22034	12624				
C9-13	21876	12718	4	16		
C9-14	21692	12796	3	23		
C9-15	21565	12934	4	21		
C9-16	21478	13106	3	54		
C9-17	21397	13272	3	36		
C9-18	21333	13447				
C9-19	21290	13625				
C9-20	21202	13805				
C9-21	21301	14027	4	22		
C9-22	21325	14181	4	14		
C9-23	21321	14357	9	8		
C9-24	21481	14518	6	21	0.45	4.5
C9-25	21585	14666	4	24		
C9-26	21711	14801	5	4		
C9-27	21846	14913	4	10		
C9-28	22021	15004	5	10		
C9-29	22190	15081	5	9		

TABLE B-5 DATA USED FOR KRIGING ANALYSIS AT THE TA-10 FIRING SITES (CONTINUED) (0-30 cm DEPTH)

Point Name	LASL Grid East	LASL Grid North	Gross Beta (pCi/g)	Gross Alpha (pCi/g)	^{90}Sr (pCi/g)	Total Uranium (µg/g)
C9-30	22367	15127				
C9-31	22556	15135				
C9-32	22718	15138	4	10		
C9-33	22918	15108				
C9-34	23086	15045	3	19		
C9-35	23166	14968	2	30		
C9-36	23268	14862	4	15		
C9-37	23555	14743	5	24		
C9-38	23683	14589	6	10		
C9-39	23775	14447	5	36		
C9-40	23902	14311				
C9-41	23900	14099	6	28		
C9-42	23920	13911	5	23		
C9-43	23946	13726	6	6		
C9-44	23906	13552	4	7		
C9-45	23849	13371	5	12	0.29	3.40
EA-1	23791	12952	2	47		
EA-2	24064	12794	2	7		
EA-3	24325	12673	1	29		
EA-4	24590	12529	3	22		
EA-5	24858	12391	4	24		
EA-6	25123	12178	2	41		
EB-1	23926	13135	4	24		
EB-2P	24193	13073	2	32	0.34	3.2
EB-3	24466	12932	4	10		
EB-4	24727	12796	3	22		
EB-5	25000	12652	1	23		
EB-6	25270	12516	6	22	0.267	3.3
EC-1P	24072	13473	1	6	0.26	2.4
EC-2	24345	13337	1	0		
EC-3	24597	13201	1	13		
EC-4	24874	13055	5	1	0.60	1.6
EC-5	25138	12917	3	10		
EC-6	25404	12779	2	16		
ED-1	24150	13742	2	20		
ED-2	24481	13607	2	0		

TABLE B-5 DATA USED FOR KRIGING ANALYSIS AT THE TA-10 FIRING SITES (CONTINUED) (0-30 cm DEPTH)

Point Name	LASL Grid East	LASL Grid North	Gross Beta (pCi/g)	Gross Alpha (pCi/g)	^{90}Sr (pCi/g)	Total Uranium (µg/g)
ED-3	24744	13464	2	17		
ED-4	25017	13326	2	10		
ED-5	25283	13192	2	12		
ED-6	25467	13054	5	26	0.144	4.1
NO-1	22384	13936				
NO-2	22684	13970				
SC-0	22308	14019				
WA-1	20020	14934	2	38		
WA-2	20279	14801	1	23		
WA-3	20542	14659	1	18		
WA-4	20811	14515	1	12		
WA-5	21085	14376	3	25		
WB-1	20157	15118	3	13		
WB-2	20415	15061	1	12		
WB-3	20684	14919	5	10	0.237	2.9
WB-4	20956	14783	1	19		
WB-5P	21145	14646	2	22	0.19	3.3
WC-1	20292	15467	5	13	0.223	3.8
WC-2	20560	15325	2	12		
WC-3P	20824	15189	2	14	0.23	4.60
WC-4	21102	15048	3	0		
WC-5	21287	14906	1	10		
WD-5	21502	15172	2	20		
WD-6	21763	15034	2	6		

(Modified from Mayfield et al. 1979, 06-0041)

ATTACHMENT 2

TA-45 DATA SET

TABLE B-6 DATA USED FOR TA-45 KRIGING ANALYSIS

	LA GRID CALCULATED								<------ Radiological Analysis								------>
POINT NAME	EAST	NORTH	Depth (mid cm)	Depth (cm)	Range Depth (mid ft)	Gross Alpha (pCi/g)	Gross Beta rel	^{90}Sr (pCi/g)	^{137}Cs (pCi/g)	Gross Alpha (pCi/g)	^{239}Pu (pCi/g)	^{238}Pu (pCi/g)	^{241}Pu (pCi/g)	^{241}Am (pCi/g)	^{226}Ra (pCi/g)	Total U (µg/g)	^{232}Th (µg/g)
6.3.1	6749	11173	2.5	5	0.08					8.5					5.4		
6.3.10	6673	11124	2.5	5	0.08						190	0.5					
6.3.11	6670	11127	2.5	5	0.08						370	1.4					
6.3.12	6684	11108	2.5	5	0.08						2	0.1					
6.3.13	6681	11111	2.5	5	0.08						11	0.1					
6.3.14	6677	11114	2.5	5	0.08						31	0.2					
6.3.15	6674	11117	2.5	5	0.08						7	0.2					
6.3.16	6670	11120	2.5	5	0.08						2	0.1					
6.3.17	6667	11123	2.5	5	0.08						4	0					
6.3.18	6681	11105	2.5	5	0.08						2	0					
6.3.19	6678	11108	2.5	5	0.08						6	0.1					
6.3.2	6740	11155	2.5	5	0.08				1.2					0.4			
6.3.20	6674	11110	2.5	5	0.08						21	0.2					
6.3.21	6671	11113	2.5	5	0.08						17	0.4					
6.3.22	6667	11116	2.5	5	0.08						0.4	0.1					
6.3.23	6664	11119	2.5	5	0.08						0.3	0					
6.3.24	6675	11104	2.5	5	0.08						11	0.1					
6.3.25	6671	11107	2.5	5	0.08						6	0.5					
6.3.26	6668	11110	2.5	5	0.08						7	0.1					
6.3.27	6664	11113	2.5	5	0.08						5	0.4					
6.3.28	6661	11116	2.5	5	0.08						2.4	0.1					
6.3.29	6675	11097	2.5	5	0.08			0.9	1		40	0.8		1			
6.3.3	6679	11128	2.5	5	0.08						140	0.7					
6.3.30	6671	11100	2.5	5	0.08						17	0.2					
6.3.31	6668	11103	2.5	5	0.08						20	0.6					
6.3.32	6665	11106	2.5	5	0.08						5	0					
6.3.33	6661	11109	2.5	5	0.08						3	0.2					
6.3.34	6658	11112	2.5	5	0.08						0.5	0					
6.3.35	6654	11115	2.5	5	0.08			1.2	2.3		16	0.07		1			
6.3.36	6706	11071	2.5	5	0.08			1	1		0.9	0.06		1			
6.3.37	6696	11080	2.5	5	0.08			0.6	0.1		0.6	0.003		1			
6.3.38	6685	11089	2.5	5	0.08			0.6	0.6		2.2	0.4		0.3			
6.3.39	6668	11097	2.5	5	0.08						24	0.1					
6.3.4	6680	11124	2.5	5	0.08						200	2					
6.3.40	6665	11099	2.5	5	0.08						11	0.1					
6.3.41	6662	11102	2.5	5	0.08						0.5	0					
6.3.42	6658	11105	2.5	5	0.08						5	0.1					

TABLE B-6 DATA USED FOR TA-45 KRIGING ANALYSIS (CONTINUED)

POINT NAME	LA GRID CALCULATED EAST	NORTH	Depth (mid cm)	Depth (cm)	Range Depth (mid ft)	Gross Alpha (pCi/g)	Gross Beta rel	^{90}Sr (pCi/g)	<---- Radiological Analysis ---- ^{137}Cs (pCi/g)	Gross Alpha (pCi/g)	^{239}Pu (pCi/g)	^{238}Pu (pCi/g)	^{241}Pu (pCi/g)	^{241}Am (pCi/g)	^{226}Ra (pCi/g)	Total U (µg/g)	^{232}Th (µg/g) ---->
6.3.43	6697	11060	2.5	5	0.08			0.7	0.1		0.09	0.05		1			
6.3.44	6687	11069	2.5	5	0.08			0.9	0.3		2	0.08		1			
6.3.45	6676	11078	2.5	5	0.08			0.6	1		6	0.4		1			
6.3.46	6666	11086	2.5	5	0.08			0.6	0.3		2.5	0.3		0.3			
6.3.47	6653	11078	2.5	5	0.08			0.7	1		0.3	0.2		1			
6.3.5	6676	11127	2.5	5	0.08						230	1.2					
6.3.6	6673	11130	2.5	5	0.08						1.9	0.3					
6.3.7	6684	11115	2.5	5	0.08						18	0.2					
6.3.8	6680	11118	2.5	5	0.08						82	0.5					
6.3.9	6677	11121	2.5	5	0.08						77	0.2					
1	6664	11105	2.5	5	0.08	40	4										
4	6666	11110	2.5	5	0.08	30	9										
5	6662	11113	2.5	5	0.08	40	4										
17	6901	11423	2.5	5	0.08	20	4	0.79	1.22	20	0.22	0.023			1.03	4.8	11.5
18	6677	11141	2.5	5	0.08	20	3										
19	6676	11147	2.5	5	0.08	20	1										
20	6671	11163	2.5	5	0.08	580	5	1.1	0.79	580	629	3.13		43.4	1.1	10	13
21	6657	11185	2.5	5	0.08	460	5										
22	6688	11211	2.5	5	0.08	20	9										
23	6609	11269	2.5	5	0.08	30	6										
25	6679	11329	2.5	5	0.08	60	5	0.7	0.2	60	33.5	0.15		1.67	1.3	3	15
26	6620	11341	2.5	5	0.08	50	6	4.5	12.1	50	38.4	0.1		1.82	1.1	3.7	9.7
27	6724	11424	2.5	5	0.08	40	4	0.4	0.54	40	8.2	0		0.41	1.9	3.9	14
28	6677	11481	2.5	5	0.08	40	3	0.4	1.64	40	5.2	0.04		0.33	2	2.8	13
29	6668	11273	2.5	5	0.08	110	5										
30	6543	11283	2.5	5	0.08	80	3										
A-1	6833	11155	12.5	25	0.41	40	2	0.31	0.28	40	0.12	0			1.15	2.5	13.7
A-2	6852	11194	12.5	25	0.41	20	4										
A-3	6868	11227	12.5	25	0.41	30	3										
A-4	6885	11265	12.5	25	0.41	30	2										
A-5	6901	11301	12.5	25	0.41	40	4										
A-6	6917	11336	12.5	25	0.41	40	3	0.29	0.45	40	0.18	0.006			0.7	2.6	13.9
A-7	6934	11373	12.5	25	0.41	20	2										
A-8	6951	11409	12.5	25	0.41			0.62	0.99		0.15	0.1			0.52	2	13.4
B-1	6800	11174	12.5	25	0.41	30	4	0.45	0.41	30	0.42	0			1.13	4.2	14.9
B-2	6816	11208	12.5	25	0.41	30	3										
B-8	6915	11427	12.5	25	0.41	40	4										

TABLE B-6 DATA USED FOR TA-45 KRIGING ANALYSIS (CONTINUED)

	LA GRID CALCULATED							<------------Radiological Analysis------------>									
POINT NAME	EAST	NORTH	Depth (mid cm)	Depth (cm)	Range Depth (mid ft)	Gross Alpha (pCi/g)	Gross Beta rel	^{90}Sr (pCi/g)	^{137}Cs (pCi/g)	Gross Alpha (pCi/g)	^{239}Pu (pCi/g)	^{238}Pu (pCi/g)	^{241}Pu (pCi/g)	^{241}Am (pCi/g)	^{226}Ra (pCi/g)	Total U (μg/g)	^{232}Th (μg/g)
C-2	6783	11227	12.5	25	0.41	40	1										
C-3	6797	11259	12.5	25	0.41	40	3										
C-5	6830	11334	12.5	25	0.41			0.27	0.14		0.45	0.01			0.61	2.3	13.3
D-2	6744	11242	12.5	25	0.41	60	1										
D-3	6762	11278	12.5	25	0.41	40	0										
E-2	6709	11258	12.5	25	0.41	80	4	0.41	0.23	80	0.61	0.012			1.12	3.4	12.4
E-3	6726	11293	12.5	25	0.41	60	3										
E-7	6792	11440	12.5	25	0.41	40	1										
E-8	6774	11403	12.5	25	0.41	30	3										
F-2	6681	11272	12.5	25	0.41			0.33	0.88		0.29	0.005			0.34	1.7	10.2
F-3	6689	11309	12.5	25	0.41	40	2										
F-4	6707	11347	12.5	25	0.41	30	1										
F-5	6723	11382	12.5	25	0.41	20	3										
14	6678	11129	12.5	25	0.41					20							
14	6678	11129	12.5	25	0.41					50							
B-1	6724	11336	30	60	0.98	40	3										
Ba-1	6724	11336	30	60	0.98	10	2										
C-1	6763	11322	30	60	0.98	60	3										
D-1	6751	11291	30	60	0.98	60	4										
Eb-1	6778	11278	30	60	0.98	40	3										
Ea-1	6778	11278	30	60	0.98	50	3										
HB-1	6774	11297	30	60	0.98	60	3										
SB-1	6767	11334	30	60	0.98	10	3										
SP1-1	6745	11324	30	60	0.98	30	2										
B5-1	6864	11318	30	60	0.98	40	2										
B6-1	6881	11354	30	60	0.98	40	3										
C5-1	6830	11334	30	60	0.98	60	2										
C6-1	6844	11371	30	60	0.98	40	1										
D7-1	6827	11424	30	60	0.98	50	1										
B3-1	6833	11246	45.5	91	1.49	40	2										
45-06	6736	11109	60	120	1.97	20	4	0.43	0.16	20	0.15	0.006			1.16	2.2	12.3
45-08	6750	11144	60	120	1.97	50	3										
45-10	6766	11181	60	120	1.97	60	4										
45-11	6773	11197	60	120	1.97	50	2										
45-12	6781	11216	60	120	1.97	50	5										
45-13	6792	11237	60	120	1.97	20	2	0.55	0.18	20	0.12	0.003			0.68	3.8	9.1
45-14	6788	11253	60	120	1.97	50	4										

TABLE B-6 DATA USED FOR TA-45 KRIGING ANALYSIS (CONTINUED)

POINT NAME	LA GRID CALCULATED EAST	NORTH	Depth (mid cm)	Depth (cm)	Range Depth (mid ft)	Gross Alpha (pCi/g)	Gross Beta rel	<---- ^{90}Sr (pCi/g)	^{137}Cs (pCi/g)	Gross Alpha (pCi/g)	^{239}Pu (pCi/g)	Radiological Analysis ^{238}Pu (pCi/g)	^{241}Pu (pCi/g)	^{241}Am (pCi/g)	^{226}Ra (pCi/g)	Total U (µg/g)	^{232}Th (µg/g) ---->
45-15	6797	11267	60	120	1.97	30	2										
45-16	6785	11270	60	120	1.97	80	3	0.42	0.21	80	35.2	0.33			0.78	2.1	12.1
45-17	6765	11276	60	120	1.97	60	2										
45-18	6748	11280	60	120	1.97	60	3	0.56	0.18	60	2	0.036			0.72	3.5	10.9
45-19	6739	11296	60	120	1.97	40	1										
45-20	6743	11318	60	120	1.97	60	2										
45-21	6713	11319	60	120	1.97	50	2										
45-22	6724	11335	60	120	1.97	40	3	0.52	0.25	40	2.64	0.032			0.92	3.8	11.6
45-23	6777	11397	60	120	1.97	40	6										
45-24	6760	11405	60	120	1.97	40	7	9.62	3.2	40	24.4	0.27			0.39	36	11.4
45-25	6743	11412	60	120	1.97	40	2										
45-26	6732	11417	60	120	1.97	30	4	0.51	0.44	30	0.26	0.01			0.97	2.5	11.7
PA-1	6737	11328	75	150	2.46	40	2										
PB-A-1	6749	11302	75	150	2.46	70	2										
PB-B-1	6749	11302	75	150	2.46	70	1	0.24	0.07	70	12.3	0.15			1.03	2	11.9
PC-1	6730	11310	75	150	2.46	40	2										
SP2b-1	6812	11321	75	150	2.46	40	2										
A-2	6737	11368	90	60	2.95	20	3										
Ba-2	6724	11336	90	60	2.95	20	2										
B-2	6724	11336	90	60	2.95	30	1										
C-2	6763	11322	90	60	2.95	30	3										
D-2	6751	11291	90	60	2.95	50	2										
Eb-2	6778	11278	90	60	2.95	60	3										
Ea-2	6778	11278	90	60	2.95	40	1										
Hb-2	6774	11297	90	60	2.95	40	2										
Sb-2	6767	11334	90	60	2.95	40	1										
SP1-2	6745	11324	90	60	2.95	40	2										
B4-1	6848	11280	90	180	2.95	60	3										
B5-2	6864	11318	90	60	2.95	40	1										
B6-2	6881	11354	90	60	2.95	40	2										
C5-2	6830	11334	90	60	2.95	30	1										
C6-2	6844	11371	90	60	2.95	50	3										
C7-2	6862	11408	90	60	2.95	60	2										
D7-2	6827	11424	90	60	2.95	50	3										
B3-2	6833	11246	35	90	4.43	80	3										
B-4	6848	11280	35	90	4.43	60	3										
C7-1	6862	11408	35	90	4.43	40	3										

TABLE B-6 DATA USED FOR TA-45 KRIGING ANALYSIS (CONTINUED)

POINT NAME	LA GRID CALCULATED EAST	NORTH	Depth (mid cm)	Depth (cm)	Range Depth (mid ft)	Gross Alpha (pCi/g)	Gross Beta rel	<------- ^{90}Sr (pCi/g)	^{137}Cs (pCi/g)	Gross Alpha (pCi/g)	^{239}Pu (pCi/g)	^{238}Pu (pCi/g)	Radiological Analysis ^{241}Pu (pCi/g)	^{241}Am (pCi/g)	^{226}Ra (pCi/g)	Total U (µg/g)	^{232}Th (µg/g) ------->
A-3	6737	11368	50	60	4.92	40	2	0.11	0	40	0	0			0.94	1.8	13.5
Ba-3	6724	11336	50	60	4.92	50	1	0	0	50	0.11	.006			0.84	1.8	14
C-3	6763	11322	50	60	4.92	40	1	0.08	0	40	0.25	.005			1.02	2.7	12
D-3	6751	11291	50	60	4.92	40	4	0.18	0	40	5.95	0.08			0.69	1.3	10.5
HB-3	6774	11297	50	60	4.92	40	2	0.09	0	40	0.36	.018			1.37	1.5	11.6
SB-3	6767	11334	50	60	4.92	40	2	0.17	0	40	1.82	.041			0.94	1.8	13.2
SP1-3	6745	11324	50	60	4.92	60	3										
B5-3	6864	11318	50	60	4.92	20	2										
B6-3	6881	11354	50	60	4.92	20	1										
C5-3	6830	11334	50	60	4.92	20	1										
C6-3	6844	11371	50	60	4.92	30	3										
C7-3	6862	11408	50	60	4.92	30	1										
D7-3	6827	11424	50	60	4.92	20	3										
Eb-3	6778	11278	80	120	5.91	30	3	0	0	30	0.046	0			1	1.5	11.9
SP2a-a	6812	11321	80	365	5.91	40	3										
A-4	6737	11368	10	60	6.89	50	3										
Ba-4	6724	11336	10	60	6.89	30	4										
C-4	6763	11322	10	60	6.89	20	2										
D-4	6751	11291	10	60	6.89	80	3										
HB-4	6774	11297	10	60	6.89	30	1										
SB-4	6767	11334	10	60	6.89	30	1										
SP1-4	6745	11324	10	60	6.89	50	2										
C5-4	6830	11334	10	60	6.89	90	0										
C6-3	6844	11371	10	60	6.89	30	3										
C7-4	6862	11408	10	60	6.89	60	2										
D7-4	6827	11424	10	60	6.89	60	3										
PA-2	6737	11328	25	150	7.38	70	3										
PB-A-2	6749	11302	25	150	7.38	30	2	0.14	0	30	.028	.004			0.75	0.7	8.5
PC-2	6730	11310	25	150	7.38	30	3	0.14	0	30	0.18	0			0.18	1.5	10.7
F-1	6791	11305	45	490	8.04	40	2	0.14	0	40	1.56	.017			0.76	1.6	13.1
SP2b-2	6812	11321	55	210	8.37	30	2										
A-5	6737	11368	70	60	8.86	30	3										
Ba-5	6724	11336	70	60	8.86	20	3										
C-5	6763	11322	70	60	8.86	40	4										
D-5	6751	11291	70	60	8.86	40	4										
SB-5	6767	11334	70	60	8.86	30	3										
SP1-5	6745	11324	70	60	8.86	40	2	0.35	0	40	0.47	0.012			0.89	1.3	10.73

TABLE B-6 DATA USED FOR TA-45 KRIGING ANALYSIS (CONTINUED)

	LA GRID CALCULATED				Range	Gross	Gross		<-------------------------------	---------Radiological	Analysis---------						------------------------>
POINT NAME	EAST	NORTH	Depth (mid cm)	Depth (cm)	Depth (mid ft)	Alpha (pCi/g)	Beta rel	^{90}Sr (pCi/g)	^{137}Cs (pCi/g)	Gross Alpha (pCi/g)	^{239}Pu (pCi/g)	^{238}Pu (pCi/g)	^{241}Pu (pCi/g)	^{241}Am (pCi/g)	^{226}Ra (pCi/g)	Total U (µg/g)	^{232}Th (µg/g)
C5-5	6830	11334	70	60	8.86	90	1										
C7-5	6862	11408	70	60	8.86	40	3										
D7-5	6827	11424	70	60	8.86	50	2										
A-6	6737	11368	30	60	0.83	40	2										
C-6	6763	11322	30	60	0.83	30	4										
SB1-6	6767	11334	30	60	0.83	40	3										
SP1-6	6745	11324	30	60	0.83	40	2										
C7-6	6862	11408	30	60	0.83	60	2										
Ba-6	6724	11336	45	90	1.32	40	3										
D7-6	6827	11424	45	90	1.32	60	2										
PA-3	6737	11328	75	150	2.30			0.2	0.04		0.95	0.027			.36	.7	11.92
PBA-3	6749	11302	75	150	2.30	30	2	0.09	0	30	0.08	0.012			0.96	1.6	12.56
PB-B-3	6749	11302	75	150	2.30	90	2	0	0	90	0	0			1.1	2.2	15.59
PC-3	6730	11310	75	150	2.30	20	2	0	0	20	0.011	0			0.8	1.6	11.55
C7-7	6862	11408	90	60	2.80	50	2										
C7-8	6862	11408	50	60	4.76	50	3										
SP2a-2	6812	11321	05	310	6.57	20	2	0.1	0.05	20	0.171	0			0.59	1.1	6.6
C7-9	6862	11408	10	60	6.73	50	3										
PA-4	6737	11328	25	50	7.22	50	1	0.16	0	50	0.062	0			0.91	1.8	10.09
PB-B-4	6749	11302	25	150	7.22	70	2	0	0	70	0.032	0			0.64	1.3	7.24
PB-A-4	6749	11302	25	150	7.22	50	1	0	0	50	0.16	0.011			0.75	1.3	10.55
PC-4	6730	11310	25	150	7.22	40	1	0.17	0	40	0.033	0.003			0.88	1.5	10.73
C7-10	6862	11408	70	60	8.70	40	3										
C7-11	6862	11408	30	60	0.67	60	3										
PA-5	6737	11328	75	150	2.15	40	2	0.4	0.9	40	0.15	0			0.9	1.7	11.5
PBA-5	6749	11302	75	150	2.15	30	3	0	0	30	0.074	0			0.8	2.2	11.83
PC-5	6730	11310	75	150	2.15	50	1	0.1	0	50	0.029	0.004			1.03	1.4	13.48
C7-12																	

(Modified from LANL 1981, 0141; Bechtel National Inc. 1983, 06-0037; and Gunderson et al. 1983, 0671)

APPENDIX C

Environmental Surveillance Data for Stations in Acid and Pueblo Canyons - 1973-1990

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1.0 INTRODUCTION

This appendix contains a compilation of water and sediment sampling data from sampling stations located in Acid and Pueblo Canyons (Figure C-1). The sampling data, which include radionuclides in surface water, chemicals and metals in surface water, and radionuclides in canyon sediment, are compiled from Laboratory Environmental Surveillance Reports for the years 1973 through 1990 (Schiager and Apt 1974, 0615; Apt and Lee 1975, 0616; Apt and Lee 1976, 0617; ESG 1977, 0618; ESG 1978, 0095; Hakonson et al. 1979, 0119; ESG 1980, 0406; Gunderson 1981, 0424; ESG 1982, 0620; ESG 1983, 0621; Purtymun et al. 1984, 0210; ESG 1985, 0407; Becker 1986, 0027; Purtymun and Maes 1987, 0203; ESG 1988, 0408; ESG 1989, 0308; Environmental Protection Group 1990, 0497; Environmental Protection Group 1992, 0740).

Surface water samples are collected whenever possible from water running in the stream channel. Sampling is usually conducted in the late spring or summer, when running water is most likely to be present (IT Corporation 1992, 06-0066). The stream in Acid Canyon is intermittent; however, standing water is usually present at the Acid Weir sampling location. The stream in Pueblo Canyon is perennial between the Pueblo 1 and Pueblo 2 sampling locations, but is intermittent downgradient of Pueblo 2 (Figure C-1) (ESG 1983, 0621). Where surface water data are not presented in the data tables (Tables C-1 through C-3) for a particular sample location or year, samples were not collected because water was not present at the sampling station that year. If two sets of data for a given year are listed, then water samples were collected at the location in the spring and fall of that year (IT Corporation 1992, 06-0066). Sediment samples are collected from the active channel of the stream.

2.0 RADIONUCLIDES IN SURFACE WATER

Table C-1 contains concentrations of various radionuclides and gross radioactivity types in surface water samples collected from one sampling station in Acid Canyon (Acid Weir) and four sampling locations in Pueblo Canyon (Pueblo 1, Pueblo 2, Hamilton Bend, and Pueblo 3). The samples were collected annually between 1973 and 1990 (no data are presented for years when the stream was dry). The data show that while there are minor temporal fluctuations in aqueous radionuclide concentrations, there is no marked change in concentration from one sampling location to another. Figure C-2 is a plot of annual concentrations of ^{90}Sr, ^{137}Cs, and gross-beta activity at the Acid Weir location, and Figure C-3 shows concentrations of ^{239,240}Pu, total uranium, and gross-alpha activity in samples collected at the Acid Weir location. The data presented for water samples from Acid Canyon are representative of water in Pueblo Canyon as well. Radionuclide concentrations and radioactivity levels are below DOE's Derived Concentration Guidelines (DCGs) for water in uncontrolled areas. Maximum concentrations for each radionuclide and radioactivity type over the period from 1973 to 1990 are 1 to 4 orders of magnitude less than the established DCGs for each constituent.

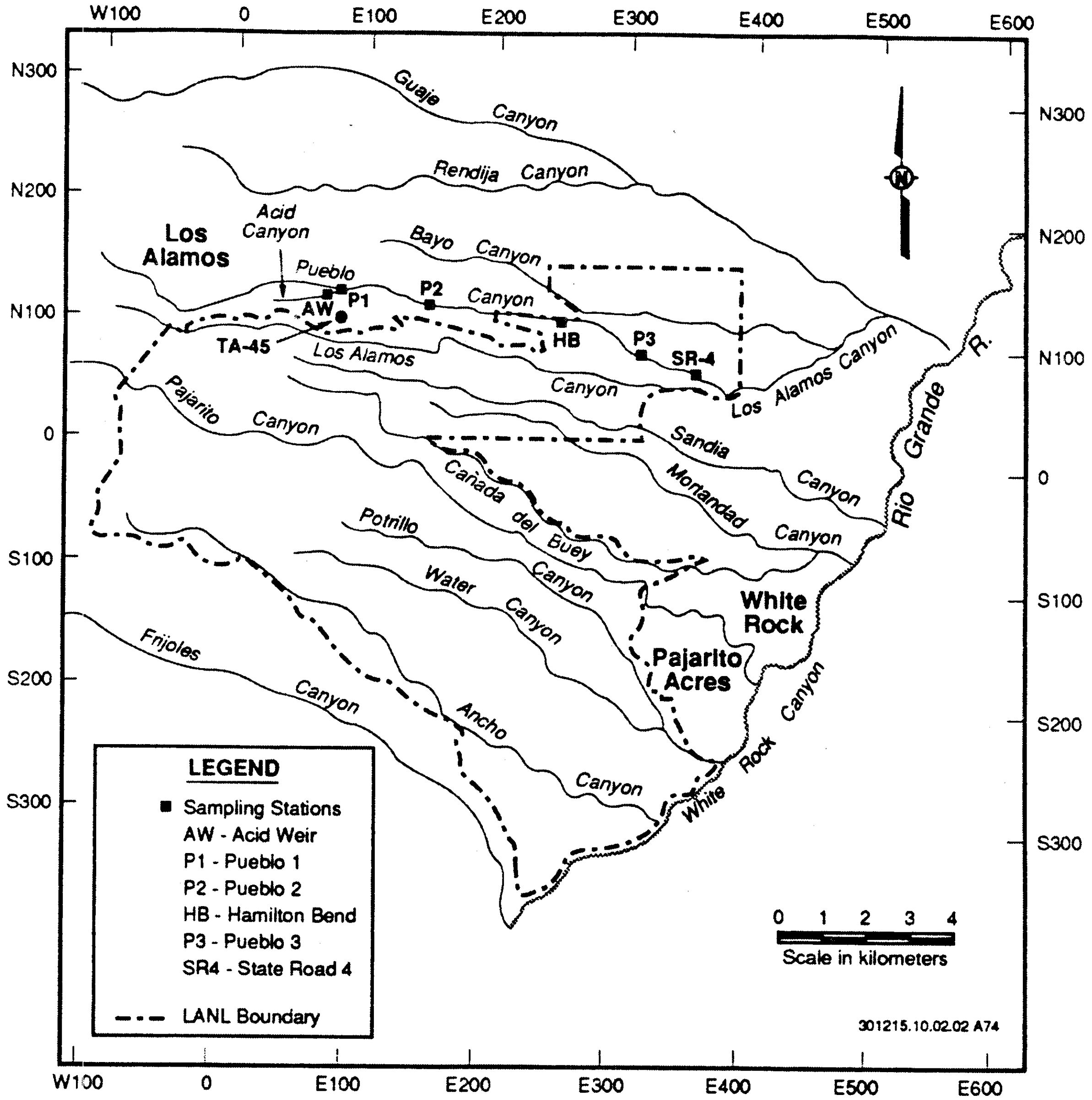


Figure C-1. Sediment and surface water sampling locations in Acid and Pueblo Canyons.

TABLE C-1 RADIONUCLIDES IN SURFACE WATER IN ACID AND PUEBLO CANYONS

Date	Location		90-Sr		137-Cs		238-Pu		239,240-Pu		Gross alpha		Gross beta		Gross gamma		Total U		3-H	
			Val	SD	Val	SD	Val	SD	Val	SD	Val	SD	Val	SD	Val	SD	Val	SD	Val	SD
			10 e-9 µCi/ml		(10 e-9 µCi/ml)		(10 e-9 µCi/ml)		(10 e-9 µCi/ml)		(10 e-9 µCi/ml)		(10 e-9 µCi/ml)		(counts/min/l)		(µg/l)		(10 e-6 µCi/ml)	
1973	Acid Weir		--	--	0.01	0.3	0.05	0.03	0.2	0.2	4.6	1.2	86	3	--	--	0.07	--	1.4	0.6
1974	Acid Weir		--	--	0.06	0.11	0.02	0.03	1.4	0.2	3.2	1	140	4	--	--	1.2	1.4	1	0.8
1975	Acid Weir		--	--	--	--	-0.02	0.02	0.04	0.1	2.3	4.7	61	100	--	--	1.3	1	2.3	2.5
1976	Acid Weir		60	6.6	8	14	0	0.02	0.74	0.07	1.2	3.6	115	24	--	--	0.1	0.1	2.6	0.7
1977	Acid Weir		--	--	57	81	0	0.01	0.88	1.6	1.6	1.3	119	140	--	--	2.5	4.2	1.1	0.3
1978	Acid Weir		77	6	15	71	0.02	0.06	2.11	5.96	3.2	6.1	118	290	--	--	0.4	0.7	1.3	0.4
1979	Acid Weir		--	--	-10	28	0	0.05	0.28	0.62	1.9	1.8	56	115	--	--	0.4	1.3	--	--
1980	Acid Weir		61	6	-24	46	0.014	0.06	1.18	3.1	6.8	9.2	171	252	--	--	1.6	1.3	3.7	7.6
1981	Acid Weir	1	70	6	0	40	-0.013	0.02	0.01	0.06	-0.3	2.8	210	40	--	--	0.8	0.8	1.5	0.6
1981	Acid Weir	2	--	--	30	120	0.03	0.02	2.15	0.22	2.9	2.2	51	10	--	--	--	--	0.8	0.8
1982	Acid Weir	1	6.1	2.3	30	60	0.006	0.02	0.028	0.03	0.4	2.8	145	30	--	--	2	0.8	3	0.6
1982	Acid Weir	2	--	--	-11	110	0.005	0.02	1.19	0.16	2.4	2	44	10	--	--	2.5	0.8	8.8	0.6
1983	Acid Weir	1	--	--	-4	71	0.006	0.04	-0.012	0.02	--	--	--	--	32	36	0	0.8	1.9	0.6
1983	Acid Weir	2	--	--	66	84	0.011	0.02	1.6	0.16	--	--	--	--	54	36	1.6	1	3.9	0.8
1984	Acid Weir	1	--	--	29	51	0.02	0.02	0.035	0.06	--	--	--	--	103	38	< 0.7	1.4	1.4	0.6
1984	Acid Weir	2	--	--	69	83	0.015	0.03	0.005	0.03	--	--	--	--	0	200	0.4	0.4	2.4	0.8
1985	Acid Weir	1	--	--	-47	53	-0.005	0.01	0.446	0.05	--	--	--	--	80	60	1.1	0.4	-0.2	0.3
1985	Acid Weir	2	--	--	23	37	-0.006	0.01	0.017	0.01	--	--	--	--	-30	60	0.7	0.2	2.7	0.5
1986	Acid Weir	1	--	--	-57	28	0.004	0.01	0.22	0.04	--	--	--	--	-140	70	0.1	0.1	0.9	0.4
1986	Acid Weir	2	--	--	46	37	0.019	0.02	0.005	0.01	--	--	--	--	-200	100	4	1	4.6	0.6
1987	Acid Weir	1	--	--	2	43	0.01	0.02	0.068	0.02	--	--	--	--	300	100	0.6	0.1	-2.2	0.7
1987	Acid Weir	2	--	--	-58	50	0.017	0.02	2.38	0.13	--	--	--	--	130	80	2	1	0	0.3
1988	Acid Weir		--	--	-50	52	0.011	0.01	0.339	0.04	--	--	--	--	30	90	1	1	-0.7	0.3
1989	Acid Weir		--	--	145	84	-0.008	0.01	0.082	0.02	--	--	--	--	100	70	1	1	0.2	0.3
1990	Acid Weir		--	--	115	73	0.005	0.01	0.36	0.04	--	--	--	--	490	90	0.9	0.1	0.4	0.3
1973	Pueblo 1		--	--	0	0.3	0.09	0.02	0.33	0.06	0.9	0.8	21	1	--	--	0.06	--	0.3	0.3
1974	Pueblo 1		--	--	0.2	0.21	-0.001	0.01	0.03	0.02	9.8	1.2	24	2	--	--	0.8	1.4	0.1	0.8
1975	Pueblo 1		--	--	--	--	-0.01	0.01	0.01	0.01	1.1	2.4	11	8.2	--	--	1	0.6	1.5	0.6
1976	Pueblo 1		0.5	3	6	14	0.01	0.02	0.01	0.02	1.2	2.4	13	3.2	--	--	-0.1	0.1	1.8	0.7
1977	Pueblo 1		--	--	-11	69	0	0.03	0.01	0.04	0	0.5	16	5.3	--	--	0.4	0.2	1.2	1.8
1978	Pueblo 1		3.7	0.8	1	3	0	0.03	0.1	0.26	1.1	1.8	56	102	--	--	0.9	1.4	1.8	0.8
1979	Pueblo 1		--	--	31	25	-0.01	0	0	0.03	0.7	1.1	14	20	--	--	0.4	1.1	--	--
1980	Pueblo 1		5.1	0.8	28	36	0.01	0.01	-0.001	0.02	1.8	6.6	19	32	--	--	0.4	1	0.8	0.7
1981	Pueblo 1	1	1.5	0.4	50	100	0.018	0.03	-0.014	0.03	-0.5	1.2	13	3	--	--	0	0.8	0.1	0.6
1981	Pueblo 1	2	--	--	30	80	0.01	0.02	0	0.04	-0.5	1.4	7.2	2.2	--	--	--	--	3.6	0.8
1982	Pueblo 1	1	0.6	1.8	8	80	-0.009	0.03	-0.013	0.02	0.5	2	10	2.8	--	--	0.6	0.8	6.9	0.8
1982	Pueblo 1	2	--	--	262	272	0.005	0.02	-0.005	0.02	0.4	1.8	56	12	--	--	0	0.8	20	10
1983	Pueblo 1	1	--	--	67	56	0.006	0.03	-0.006	0.03	--	--	--	--	45	36	0	0.8	1.7	0.6
1983	Pueblo 1	2	--	--	-2	84	0.01	0.02	0.005	0.02	--	--	--	--	15	36	0	1	2.8	0.6
1984	Pueblo 1	1	--	--	52	49	0.013	0.02	0.16	0.08	--	--	--	--	67	38	0.7	1.4	1	0.4
1984	Pueblo 1	2	--	--	47	78	-0.02	0.02	-0.013	0.03	--	--	--	--	0	200	0.2	0.4	6.4	1.4
1985	Pueblo 1	1	--	--	89	39	0.011	0.01	0.011	0.01	--	--	--	--	60	50	1.1	0.4	-0.9	0.3
1985	Pueblo 1	2	--	--	-47	40	0.008	0.01	-0.008	0.01	--	--	--	--	40	60	0.8	0.2	0.7	0.4
1986	Pueblo 1	1	--	--	-50	33	0	0.02	0.026	0.01	--	--	--	--	-100	60	0.1	0.1	1.9	0.4
1986	Pueblo 1	2	--	--	-40	31	0.031	0.02	0.004	0.01	--	--	--	--	0	100	2	1	0.4	0.4
1987	Pueblo 1	1	--	--	-15	42	0.007	0.02	0.083	0.03	--	--	--	--	200	100	0.6	0.1	-1.7	0.7
1987	Pueblo 1	2	--	--	44	60	-0.009	0.01	0.006	0.01	--	--	--	--	-10	80	1	1	-0.2	0.4
1988	Pueblo 1		--	--	-15	60	0.015	0.01	0	0.01	--	--	--	--	-250	100	1	1	-0.7	0.3
1989	Pueblo 1		--	--	0.4	67	0.009	0.01	0.009	0.01	--	--	--	--	10	70	1	1	0.3	0.3
1990	Pueblo 1		--	--	141	72	0.008	0.01	0.004	0.01	--	--	--	--	500	90	<1.0		0	0.3

TABLE C-1 RADIONUCLIDES IN SURFACE WATER IN ACID AND PUEBLO CANYONS (CONTINUED)

Date	Location		90-Sr		137-Cs		238-Pu		239,240-Pu		Gross alpha		Gross beta		Gross gamma		Total U		3-H	
			Val	SD	Val	SD	Val	SD	Val	SD	Val	SD	Val	SD	Val	SD	Val	SD	Val	SD
			10 e-9 μCi/ml		(10 e-9 μCi/ml)		(10 e-9 μCi/ml)		(10 e-9 μCi/ml)		(10 e-9 μCi/ml)		(10 e-9 μCi/ml)		(counts/min/l)		(μg/l)		(10 e-6 μCi/ml)	
1973	Pueblo 2		--	--	0.02	0.3	0.1	0.07	0.7	0.2	1.1	0.6	14	2	--	--	0.02	--	-0.1	0.3
1974	Pueblo 2		--	--	0.03	0.11	0.01	0.01	0.12	0.06	1.6	0.4	17	2	--	--	0.7	1.4	-0.1	0.8
1975	Pueblo 2		--	--	--	--	0	0.01	0.34	0.56	0.5	0.1	17	10	--	--	0.8	2	0.9	0.5
1976	Pueblo 2		2.5	4.4	0	16	-0.01	0.01	0.03	0.03	1.4	3.2	21	4.6	--	--	0.3	1.2	1.4	0.7
1977	Pueblo 2		--	--	40	299	-0.01	0.04	0	0	1.9	5.4	21	22	--	--	0.6	0.2	2.3	1.7
1978	Pueblo 2		4.6	0.8	69	117	-0.01	0.06	0.04	0.01	2.5	3.4	24	1.4	--	--	0.2	0.4	1.1	0
1979	Pueblo 2		--	--	0	27	0	0	0.04	0.01	0.2	1	13	11	--	--	0.2	0.4	--	--
1980	Pueblo 2		-0.9	1	6	100	0.013	0.01	1.29	3.64	4.4	10	38	42	--	--	0	0	0.4	0.3
1981	Pueblo 2	1	3.2	0.4	30	100	0.008	0.03	0.16	0.06	-0.2	1.4	21	4	--	--	0	0.8	0.3	0.6
1981	Pueblo 2	2	--	--	40	60	0	0	0.23	0.08	0.8	2.2	19	4	--	--	--	--	1.4	0.8
1982	Pueblo 2		3.7	2.6	30	120	0.004	0.03	0.038	0.04	0.9	2	22	4	--	--	1.4	0.8	3.5	0.6
1983	Pueblo 2	1	--	--	15	93	0.006	0.02	0.07	0.04	--	--	--	--	40	36	0.8	0.8	1.3	0.6
1983	Pueblo 2	2	--	--	-26	82	0.011	0.03	0.051	0.04	--	--	--	--	-28	36	0	1	1.1	0.4
1984	Pueblo 2	1	--	--	53	48	0.004	0.02	0.071	0.06	--	--	--	--	71	38	< 0.7	1.4	1	0.4
1984	Pueblo 2	2	--	--	57	97	-0.014	0.02	0.389	0.09	--	--	--	--	-30	100	< 0.1	0	--	--
1985	Pueblo 2	1	--	--	21	48	0	0.01	0.056	0.02	--	--	--	--	60	50	0.5	0.2	0.5	0.3
1985	Pueblo 2	2	--	--	66	44	-0.017	0.01	0.207	0.03	--	--	--	--	-120	60	1.4	0.2	0.2	0.4
1986	Pueblo 2	1	--	--	61	33	0.004	0.01	0	0.01	--	--	--	--	-120	70	0	0.1	0.6	0.4
1986	Pueblo 2	2	--	--	-96	34	0.004	0.01	0.044	0.02	--	--	--	--	75	100	1	1	1.1	0.4
1987	Pueblo 2	1	--	--	-8	43	-0.062	0.06	0.062	0.07	--	--	--	--	-2500	300	0.6	0.1	-1.5	0.7
1987	Pueblo 2	2	--	--	62	70	-0.01	0.01	0.031	0.01	--	--	--	--	700	100	1	1	0.1	0.3
1988	Pueblo 2		--	--	14	46	-0.004	0.01	0.039	0.02	--	--	--	--	-60	90	1	1	-0.9	0.3
1989	Pueblo 2		--	--	30	83	-0.004	0.01	0.012	0.01	--	--	--	--	-40	70	1	1	0	0.3
1973	Hamilton Bend		--	--	0.01	0.3	0.16	0.02	0.01	0.06	4.3	1	14	2	--	--	0.01	--	0.7	0.6
1974	Hamilton Bend		--	--	0.03	0.1	0.02	0.02	0.03	0.03	0.7	0.6	8.3	1.6	--	--	-0.3	1.6	0.2	0.8
1975	Hamilton Bend		--	--	--	--	0	0.02	0.01	0.03	1.1	1.2	7.3	1.6	--	--	1.7	2	0.9	1.6
1976	Hamilton Bend		-0.4	3.1	-6	14	0.01	0.02	0.01	0.02	1.1	3.2	12	3	--	--	0.3	0.4	2.1	0.7
1977	Hamilton Bend		--	--	13	101	-0.02	0.04	1.6	5.4	-0.6	4.4	25	5.8	--	--	1.1	2.2	2.1	1.6
1978	Hamilton Bend		1.7	1	20	57	-0.03	0.04	0.03	0.06	12	31	55	112	--	--	2.1	5.8	0.9	0.4
1979	Hamilton Bend		--	--	10	28	0	0.04	0.01	0.05	0.5	3.4	30	52	--	--	0.3	0.7	--	--
1980	Hamilton Bend		1.3	0.6	0	80	0.007	0.04	0.014	0.04	5.8	3	14	3.2	--	--	3.4	0.8	1	0.6
1982	Hamilton Bend	1	0.2	0.4	-4	38	-0.013	0.02	-0.004	0.02	4	2.6	12	3.2	--	--	3.1	0.8	1.4	0.6
1982	Hamilton Bend	2	--	--	106	94	0.004	0.02	0.004	0.03	5.6	3.7	21	4	--	--	8	1.6	38	1.4
1983	Hamilton Bend		--	--	44	70	0.006	0.03	0.03	0.04	--	--	--	--	48	36	1.9	0.8	2.1	0.6
1985	Hamilton Bend	1	--	--	62	35	-0.004	0.01	-0.009	0.01	--	--	--	--	10	50	1.5	0.5	-0.6	0.3
1985	Hamilton Bend	2	--	--	-96	36	-0.006	0.01	0.038	0.02	--	--	--	--	30	60	1.3	0.2	0.4	0.4
1986	Hamilton Bend	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1986	Hamilton Bend	2	--	--	-69	37	0.02	0.03	0.02	0.02	--	--	--	--	150	100	1	1	1	0.4
1987	Hamilton Bend	1	--	--	46	21	-0.009	0.01	-0.004	0.01	--	--	--	--	100	100	0.6	0.1	-2.3	0.7
1987	Hamilton Bend	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
1989	Hamilton Bend		--	--	43	81	-0.017	0.01	0.009	0.01	--	--	--	--	-10	70	1	1	0.2	0.3

TABLE C-1 RADIONUCLIDES IN SURFACE WATER IN ACID AND PUEBLO CANYONS (CONTINUED)

Date	Location		90-Sr		137-Cs		238-Pu		239,240-Pu		Gross alpha		Gross beta		Gross gamma		Total U		3-H	
			Val 10 e-9 µCi/ml	SD	Val (10 e-9 µCi/ml)	SD	Val (10 e-9 µCi/ml)	SD	Val (10 e-9 µCi/ml)	SD	Val (10 e-9 µCi/ml)	SD	Val (10 e-9 µCi/ml)	SD	Val (counts/min/l)	SD	Val (µg/l)	SD	Val (10 e-6 µCi/ml)	SD
1973	Pueblo 3		--	--	0.01	0.3	6.8	0.1	0.21	0.06	0.6	0.6	14	2	--	--	0.02	--	0.7	0.6
1974	Pueblo 3		--	--	0.04	0.11	0.1	0.02	0.1	0.03	1.3	0.8	17	2	--	--	0.6	1.4	0.6	0.8
1975	Pueblo 3		--	--	--	--	0	0.02	0.01	0.02	1.3	1.8	19	11	--	--	2.3	1.8	0.9	0.8
1976	Pueblo 3		-1.9	3.1	13	12	-0.01	0.01	0.01	0.02	0.7	3.2	17	3.6	--	--	0.1	0.1	1.4	0.7
1977	Pueblo 3		--	--	40	100	0.03	0.04	-0.01	0.01	2.2	3	18	4	--	--	0.4	0.6	0.7	0.6
1978	Pueblo 3		-0.7	0.8	40	60	-0.03	0.02	-0.01	0.02	15	6	26	6	--	--	50	10	1.6	0.6
1979	Pueblo 3		--	--	-4	13	-0.02	0.01	0.05	0.08	2.1	2.4	14	7.9	--	--	1.5	4.2	--	--
1980	Pueblo 3		0.8	1.2	2	32	-0.014	0.06	0.136	0.41	37	46	60	106	--	--	6	8.5	0.5	0.4
1981	Pueblo 3		--	--	0	80	-0.004	0.02	0.018	0.04	-0.5	1.4	14	3.2	--	--	0	0.8	0.1	0.6
1982	Pueblo 3	1	3.6	2.6	-10	80	-0.008	0.01	0.039	0.03	6	4	29	6	--	--	5.8	1.2	1.7	0.6
1982	Pueblo 3	2	--	--	225	252	0.015	0.03	0.29	0.08	10	6	33	8	--	--	5.4	0.8	97	3
1983	Pueblo 3	1	--	--	84	101	-0.015	0.02	0.02	0.03	--	--	--	--	65	36	1.1	0.8	1	0.6
1983	Pueblo 3	2	--	--	29	48	0.027	0.03	0.13	0.06	--	--	--	--	1	36	0.5	1	2.5	0.6
1984	Pueblo 3	1	--	--	30	60	-0.008	0.01	0.12	0.06	--	--	--	--	95	38	1.4	0.2	4	0.5
1984	Pueblo 3	2	--	--	61	111	0.006	0.03	0.089	0.05	--	--	--	--	10	100	3	1	--	--
1985	Pueblo 3	1	--	--	56	37	-0.004	0	0.033	0.01	--	--	--	--	70	50	0.9	0.4	0.7	0.3
1985	Pueblo 3	2	--	--	-94	52	0.006	0.02	0	0.01	--	--	--	--	40	60	1.7	0.2	0	0.4
1986	Pueblo 3	1	--	--	6	33	0.004	0.01	0.017	0.01	--	--	--	--	-75	60	0.1	0.1	0.4	0.4
1986	Pueblo 3	2	--	--	-43	28	0	0.01	0.059	0.02	--	--	--	--	75	100	2	1	3.2	0.5
1987	Pueblo 3	1	--	--	41	43	0.012	0.03	0.092	0.04	--	--	--	--	-90	100	0.9	0.1	-1.8	0.7
1987	Pueblo 3	2	--	--	118	63	0	0.01	0.031	0.02	--	--	--	--	580	100	1	1	-0.3	0.3
1988	Pueblo 3		--	--	11	63	0	0.01	0.011	0.01	--	--	--	--	-20	90	1	1	-1	0.3
1989	Pueblo 3		--	--	44	66	0.005	0.02	0.014	0.01	--	--	--	--	-80	70	1	1	0.4	0.3
1990	Pueblo 3		--	--	141	100	0.009	0.01	0.019	0.01	--	--	--	--	490	90	1.2	0.1	-0.1	0.3

TABLE C-2 CHEMICALS IN SURFACE WATER IN ACID AND PUEBLO CANYONS[a]

Date	Location	SIO2	Ca	Mg	Na	CO3	HCO3	SO4	Cl	F	NO3-N	K	P	PO4	TDS	Hard	pH[b]	Cond[c]
1973	Acid Weir		12	2	68	0	122		41	0.9	4.9				326	38	7.4	36
1974	Acid Weir		18	3	80	0	92		89	0.8	7.3				316	56	7.4	47.5
1975	Acid Weir		22	4	59	0	95		50	0.7	26				324	74	7.7	50.5
1976	Acid Weir		17	2	54	0	96		42	0.6	4.8				214	54	7.6	43
1977	Acid Weir		17	5	44	5	68		53	0.5	24				308	59	8.2	44.5
1978	Acid Weir	27	117	3	63	5	116	16	60	0.3	13	7.9		4	393	110	7.3	43
1979	Acid Weir	66	11	2	58	0	71	14	61	0.5	8	4.8		< 0.1	276	45	8.3	37
1980	Acid Weir	22	26	3.5	80	0	64	17	129	0.5	7.4	9.5		5.2	388	84	6.1	46
1981	Acid Weir - 1	21	32	4.3	108	0	61	16	64	0.4	15	6.1		< 3	406	88	6.9	69
1981	Acid Weir - 2	29	12	1.7	62	0	124	2	39	0.4	2.4	4.7		4	226	38	6.9	36
1982	Acid Weir	24	25	3.9	93	0	111	19	123	0.4	6.6	6.3		- -	350	75	6.5	63
1983	Acid Weir	54	20	4	74	0	86	24	83	0.3	24	8.9		19	329	64	7.2	12
1984	Acid Weir	17	50	7	153	0	32	50	300	0.2	6.8	8.1		1.6	621	161	7	118
1985	Acid Weir	18	17	2.4	110	0	42	11	153	0.6	0.3	4	< 0.5		356	48	7.5	67
1986	Acid Weir	19	24	3.2	88	0	32	8	138	0.4	1.3	5.4	0.4		326	70	6.8	63
1987	Acid Weir	25	18	3.6	70	0	56	19	85	0.5	2	5	1.7		265	59	7.4	45
1988	Acid Weir	14	34	4.8	125	0	34	20	262	0.6	0.8	5.7	< 0.2		517	112	6.9	95
1989	Acid Weir	16	26	4.9	140	0	44	16	239	0.2	0.7	7.4	0.3		452	85	7.7	84
1990	Acid Weir	18	16	1	115	5	41	6	42	0.3	1.3	4	0.4		52	47	7	33.2
1973	Pueblo 1		16	4	75	0	176		33	6	16				430	56	7.3	50
1974	Pueblo 1		16	4	78	0	106		45	1	32				426	58	7.6	45.5
1975	Pueblo 1		8	6	61	0	64		39	0.7	42				362	50	7.3	46.5
1976	Pueblo 1		18	4	67	0	132		44	0.6	32				369	58	7.4	51
1977	Pueblo 1		12	5	64	0	51		38	0.5	73				394	50	7	49.5
1978	Pueblo 1	60	8	3	75	7	79	34	43	0.6	40	14		30	463	85	8.4	48.5
1979	Pueblo 1	20	9	3	34	0	90	20	20	0.3	22	5.4		10	258	45	8.3	25
1980	Pueblo 1	41	11	3.5	49	0	103	28	44	0.6	20	12		12	354	4.8	7.4	19
1981	Pueblo 1 - 1	64	14	2.7	71	0	84	13	65	0.5	33	9.2		28	356	51	7.5	49
1981	Pueblo 1 - 2	59	13	2.2	83	0	75	32	64	0.4	45	11		27	386	41	7.3	52
1982	Pueblo 1	59	17	3.1	78	0	48	31	61	0.8	76	11		- -	395	51	6.9	51
1983	Pueblo 1	55	19	4	66	0	86	25	79	0.3	25	8.9		18	324	64	7.5	52
1984	Pueblo 1	43	24	11	92	0	141	31	83	0.4	54	12		20	43	77	7.5	65
1985	Pueblo 1	43	16	3	56	0	60	21	35	0.6	8.3	8.1	6		270	48	6.5	40
1986	Pueblo 1	61	20	3	78	0	66	30	68	0.9	10	11	8.8		357	57	7.6	54
1987	Pueblo 1	26	18	3.7	69	0	56	20	86	0.5	2	5.3	1.7		277	60	7.3	44
1988	Pueblo 1	21	27	5	69	0	45	15	125	0.4	< 0.2	4.4	0.8		330	96	7.7	55
1989	Pueblo 1	64	22	3.8	100	0	130	32	76	0.6	2.5	9.7	6.6		373	76	7.4	60
1990	Pueblo 1	28	31	5	156	5	50	70	174	0.4	1.2	8	0.7		362	99	7.4	43.9

[a] All concentrations presented in milligrams per liter (mg/l) unless otherwise indicated.

[b] No units.

[c] Data presented in micromhos per centimeter (μmho/cm)

TABLE C-2 CHEMICALS IN SURFACE WATER IN ACID AND PUEBLO CANYONS (CONTINUED)[a]

Date	Location	SiO2	Ca	Mg	Na	CO3	HCO3	SO4	Cl	F	NO3-N	K	P	PO4	TDS	Hard	pH[b]	Cond[c]
1973	Pueblo 2		15	5	59	0	110		36	4.8	18				344	56	7.6	38
1974	Pueblo 2		16	2	86	0	120		44	1	22				387	48	7.5	48
1975	Pueblo 2		14	4	64	0	79		38	0.6	36				225	54	7.2	45.5
1976	Pueblo 2		12	5	64	0	85		30	0.6	59				300	50	8	51.5
1977	Pueblo 2		14	5	59	0	67		40	0.5	50				357	54	7.1	48
1978	Pueblo 2	49	9	3	73	12	95	33	30	0.6	36	13		24	472	65	8	45
1979	Pueblo 2	34	8	2	31	0	71	18	22	0.3	10	4.7		5	222	45	8.3	22
1980	Pueblo 2	49	14	3	78	0	116	34	39	0.9	28	14		27	419	57	7.2	35
1981	Pueblo 2 - 1	59	17	3.5	76	0	137	42	38	0.5	42	10		16	324	62	8	49
1981	Pueblo 2 - 2	53	16	2.7	82	0	115	31	43	0.5	47	10		24	330	48	8	44
1982	Pueblo 2	57	20	4.1	82	0	142	21	61	0.8	19	11		--	335	63	7.4	51
1983	Pueblo 2	46	21	4	75	0	95	20	85	0.3	14	8.5		13	318	66	7.6	49
1984	Pueblo 2	42	28	5	96	0	105	32	148	0.5	58	11		24	506	100	7.1	70
1985	Pueblo 2	48	14	2.8	53	0	51	19	54	0.6	3.8	6.5	4.5		242	44	7.3	35
1986	Pueblo 2	66	15	2.3	85	0	99	31	53	1	3.3	12	1		346	42	7.2	55
1987	Pueblo 2	26	18	3.5	68	0	56	20	85	0.5	2	4.9	1.7		274	58	7.5	45
1988	Pueblo 2	38	22	4.2	85	0	65	24	121	0.9	4.2	8.1	4.6		375	76	7.7	60
1989	Pueblo 2	45	26	3.2	100	0	106	26	83	0.6	1.8	11	6		356	75	7.6	57
1973	Hamilton Bend		16	5	66	0	104		52	4.2	18				370	60	7.5	40
1974	Hamilton Bend		16	4	72	0	116		51	3.9	16				374	56	7.4	46.5
1975	Hamilton Bend		11	6	70	0	90		37	0.9	22				359	51	7.7	46.5
1976	Hamilton Bend		24	8	60	0	108		15	0.8	27				304	66	7.4	43.2
1977	Hamilton Bend		10	7	61	0	96		39	0.6	39				354	54	7.7	53
1978	Hamilton Bend	50	7	4	74	5	120	29	40	0.9	26	9.3		22	464	356	8.1	44
1979	Hamilton Bend	34	8	4	69	0	110	29	40	0.9	31	7.3		21	370	50	8	42
1980	Hamilton Bend	49	4	4	70	0	86	24	40	0.3	0.8	15			304	52	6.5	40
1983	Hamilton Bend	52	14	4	75	0	114	26	48	0.9	17	8.4		23	315	53	7.3	45
1985	Hamilton Bend	58	16	4.9	77	0	96	24	66	0.9	3.6	9.1	8.3		314	58	7.3	51
1987	Hamilton Bend	55	15	4.3	74	0	110	23	47	0.9	2	9.2	6.5		287	51	8	44
1989	Hamilton Bend	64	17	3.5	74	0	114	26	52	0.8	1.5	9	6		297	59	7.8	46

[a] All concentrations presented in milligrams per liter (mg/l) unless otherwise indicated.

[b] No units.

[c] Data presented in micromhos per centimeter (µmho/cm).

TABLE C-2 CHEMICALS IN SURFACE WATER IN ACID AND PUEBLO CANYONS (CONTINUED)[a]

Date	Location	SiO2	Ca	Mg	Na	CO3	HCO3	SO4	Cl	F	NO3-N	K	P	PO4	TDS	Hard	pH[b]	Cond[c]
1973	Pueblo 3		16	4	78	0	110		35	5.7	66				453	56	7.1	49
1974	Pueblo 3		18	4	92	0	134		54	1.1	31				434	60	7.5	55.6
1975	Pueblo 3		12	6	72	0	97		36	0.8	48				380	56	7.2	53.5
1976	Pueblo 3		14	4	72	0	94		36	0.6	44				319	50	7.5	52
1977	Pueblo 3		14	3	68	0	107		35	0.6	31				343	43	8.3	25.5
1978	Pueblo 3	47	10	3	81	3	157	14	3	0.8	20	14		24	471	64	8	48
1979	Pueblo 3	34	9	3	49	0	88	21	30	0.5	22	7.1		14	292	90	8.2	16
1980	Pueblo 3	50	15	3	70	0	94	36	40	0.7	38	16			362	49	6.9	39
1981	Pueblo 3	54	13	2.4	76	0	89	27	44	0.9	60	10		27	334	42	7.5	45
1982	Pueblo 3	62	15	2.5	95	0	168	39	43	1.2	26	11		- -	353	45	7	52
1983	Pueblo 3	60	18	3	74	0	105	24	54	0.6	50	10		21	325	57	7.5	48
1984	Pueblo 3	50	17	3	99	0	140	41	54	0.8	28	13		13	378	55	7.2	55
1985	Pueblo 3	54	18	3.3	66	0	73	21	52	0.7	7	9.5	8.3		299	54	7.1	46
1986	Pueblo 3	51	21	3.2	79	0	147	27	63	0.7	1.4	11	0.7		349	57	7.3	56
1987	Pueblo 3	32	19	3.5	76	0	75	23	74	0.8	6	6.8	3.7		302	60	7.7	48
1988	Pueblo 3	58	12	2.6	85	0	101	29	45	1.3	5.7	12	10		339	47	7.9	48
1989	Pueblo 3	72	17	2	99	0	188	37	43	0.8	3.7	13	10.9		392	52	7.3	60
1990	Pueblo 3	58	25	2	148	5	165	42	48	1	10.6	62	5.8		344	73	7.9	54.6

[a] All concentrations presented in milligrams per liter (mg/l) unless otherwise indicated.

[b] No units.

[c] Data presented in micromhos per centimeter (µmho/cm).

TABLE C-3 METALS IN SURFACE WATER IN ACID AND PUEBLO CANYONS[a]

Date	Location	Ag	Al	As	B	Ba	Be	Br	Cd	Co	Cr	Cu	Fe	Hg	Mn	Pb	Mo	Se	Ni	Zn	Li	COD	NH3
1973	Acid Weir																						
1974	Acid Weir										<0.006							0.004					
1975	Acid Weir																						
1976	Acid Weir																						
1977	Acid Weir																						
1978	Acid Weir	< 10	18		< 5	110		17500	240	2	< 3	< 300	< 300	< 0.2	< 300	5	< 10	< 5	7	< 300			
1979	Acid Weir																						
1980	Acid Weir				0.07				0.0006		0.033	0.053		< 0.0001		0.007				0.056	0.025	34	< 0.1
1981	Acid Weir - 1																						
1981	Acid Weir - 2																						
1982	Acid Weir																						
1983	Acid Weir				< 0.05				0.01		< 0.01	< 0.001		< 0.0001		< 0.01				0.05	0.02	42	
1984	Acid Weir																						
1985	Acid Weir																						
1986	Acid Weir																						
1987	Acid Weir																						
1988	Acid Weir	< 0.001		0.012		0.083	< 0.001		< 0.001		< 0.001		0.19		0.015	0.002	0.002	0.001		0.015			
1989	Acid Weir																						
1990	Acid Weir	0.0001	1.06	0.002	0.1	0.0457	0.0003		0.0041	0.007	1.1	0.0002	0.082	0.0269		0.001	0	0.0274					
1973	Pueblo 1																						
1974	Pueblo 1										<0.006							0.009					
1975	Pueblo 1																						
1976	Pueblo 1																						
1977	Pueblo 1																						
1978	Pueblo 1	< 10	18		11	60		< 2000	4	< 1	4	< 300	< 300	< 0.2	< 300	4	< 10	< 5	10	< 300			
1979	Pueblo 1																						
1980	Pueblo 1				0.31				0.0005		< 0.005	0.077		0.0003		0.034				0.231	0.066	54	13
1981	Pueblo 1 - 1																						
1981	Pueblo 1 - 2																						
1982	Pueblo 1																						
1983	Pueblo 1				0.28				0.03		< 0.01	0.002		< 0.0001		< 0.01				0.8	0.02	59	
1984	Pueblo 1																						
1985	Pueblo 1																						
1986	Pueblo 1			0.019	0.25	0.06	< 0.001		< 0.001		0.007	0.013	0.05	<0.0001	0.041	0.004		< 0.002		0.04	0.029	57	
1987	Pueblo 1																						
1988	Pueblo 1	< 0.001		0.009		0.058	< 0.001		< 0.001		< 0.001		0.16		0.063	< 0.001	<0.001	< 0.001		0.012			
1989	Pueblo 1																						
1990	Pueblo 1	0.0001	0.034	0.005	0.14	0.0432	0.0001		0.0001		0.0013	0.0094	0.12	0.00031	0.186	0.0007		0.001	0				

[a] All concentrations presented in milligrams per liter (mg/l) unless otherwise indicated.

TABLE C-3 METALS IN SURFACE WATER IN ACID AND PUEBLO CANYONS (CONTINUED)[a]

Date	Location	Ag	Al	As	B	Ba	Be	Br	Cd	Co	Cr	Cu	Fe	Hg	Mn	Pb	Mo	Se	Ni	Zn	Li	COD	NH3
1973	Pueblo 2																						
1974	Pueblo 2										<0.006							0.008					
1975	Pueblo 2																						
1976	Pueblo 2																						
1977	Pueblo 2																						
1978	Pueblo 2	< 10	10		10	60		< 2000	9	1	3	< 300	< 300	< 0.2	< 300	3	< 10	< 5	10	< 300			
1979	Pueblo 2																						
1980	Pueblo 2				0.21				0.0004		< 0.005	0.047		0.0002		0.005				0.113	0.077	41	11
1981	Pueblo 2 - 1																						
1981	Pueblo 2 - 2																						
1982	Pueblo 2																						
1983	Pueblo 2				0.15				0.03		0.05	0.002		< 0.0001		< 0.01				0.14	0.02	62	
1984	Pueblo 2																						
1985	Pueblo 2																						
1986	Pueblo 2																						
1987	Pueblo 2																						
1988	Pueblo 2	< 0.001		0.016		0.039	< 0.001		< 0.001		< 0.001		0.21		0.152	0.002	0.002	< 0.001		0.028			
1989	Pueblo 2																						
1973	Hamilton Bend																						
1974	Hamilton Bend										<0.006							0.005					
1975	Hamilton Bend																						
1976	Hamilton Bend																						
1977	Hamilton Bend																						
1978	Hamilton Bend	< 10	56		7	250		< 2000	12	1	< 3	< 300	< 300	- -	< 300	3	< 10	< 5	5	< 300			
1979	Hamilton Bend																						
1980	Hamilton Bend				0.29				0.0003		0.073	0.07		< 0.0001		0.005				0.13	0.013	20	< 0.1
1983	Hamilton Bend																						
1985	Hamilton Bend																						
1987	Hamilton Bend																						
1989	Hamilton Bend																						
1973	Pueblo 3																						
1974	Pueblo 3										<0.006							0.006					
1975	Pueblo 3																						
1976	Pueblo 3																						
1977	Pueblo 3																						
1978	Pueblo 3	< 10	10		8	30		< 2000	7	< 1	4	< 300	< 300	< 0.2	< 300	5	< 10	< 5	9	< 300			
1979	Pueblo 3																						
1980	Pueblo 3				0.18				0.001		< 0.005	0.073		0.0002		0.014				0.044	0.029	34	1.9
1981	Pueblo 3																						
1982	Pueblo 3																						
1983	Pueblo 3				0.22				0.01		0.04	0.001		< 0.0001		0.02				0.11	0.02	48	
1984	Pueblo 3																						
1985	Pueblo 3																						
1986	Pueblo 3			0.017	0.23	0.06	< 0.001		< 0.001		0.018	0.017	0.17	<0.0001	0.148	0.009		< 0.002		0.11	0.031	49	
1987	Pueblo 3																						
1988	Pueblo 3	< 0.001		0.016		0.012	< 0.001		< 0.001		< 0.001		0.16		0.099	0.001	0.003	< 0.001		0.02			
1989	Pueblo 3																						
1990	Pueblo 3	0.0025	0.261	0.013	0.37	0.0343	0.0001		0.0001		0.0087	0.0244	0.39	0.00027	0.0523	0.0023		0.001	0				

[a] All concentrations presented in milligrams per liter (mg/l) unless otherwise indicated.

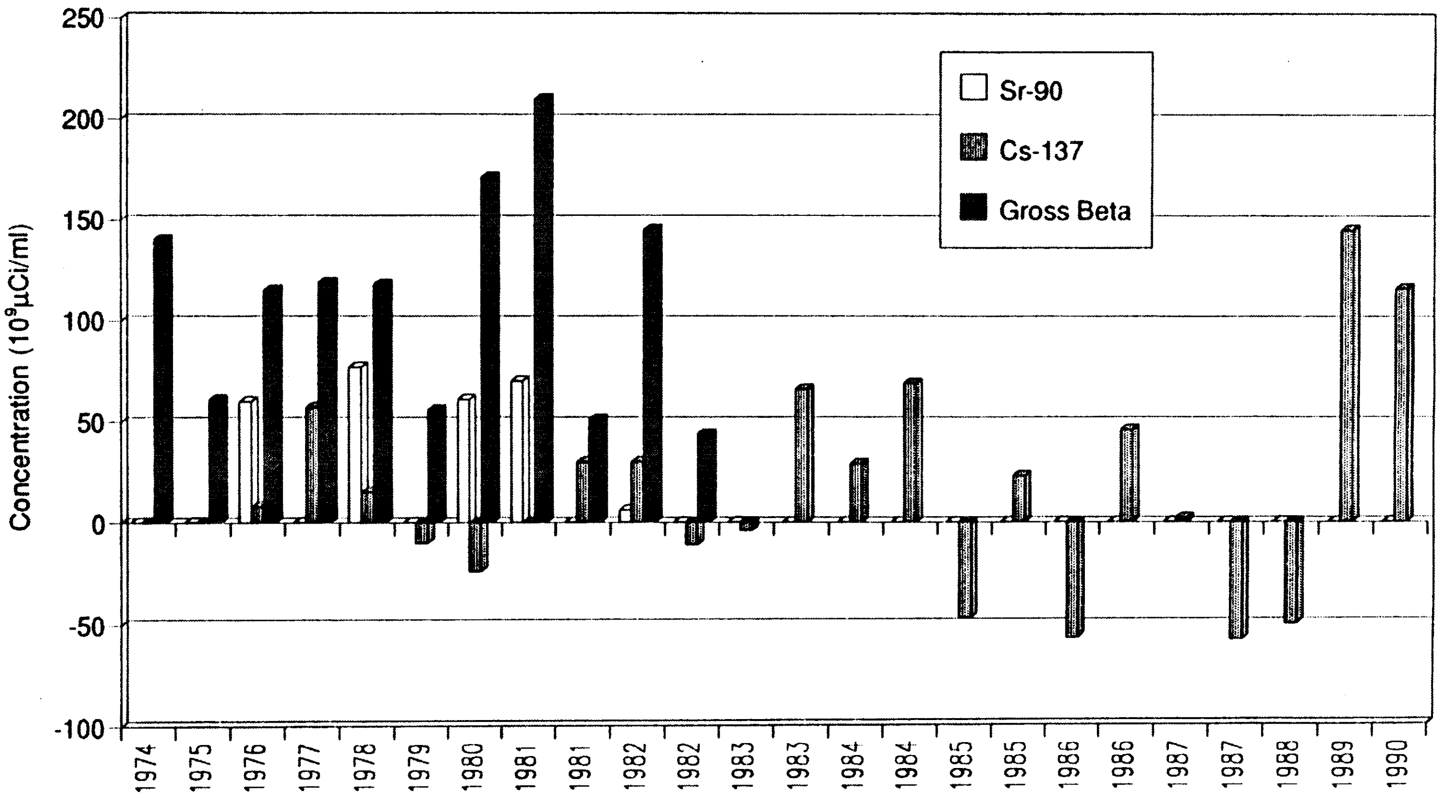


Figure C-2. Sr-90, Cs-137, and gross beta concentrations in surface water at Acid Weir. DOE's Derived Concentration Guidelines for radioactivity in water in uncontrolled areas are 1 x 10^6 µCi/ml for Sr-90 and gross beta; and 3 x 10^6 µCi/ml for Cs-137.

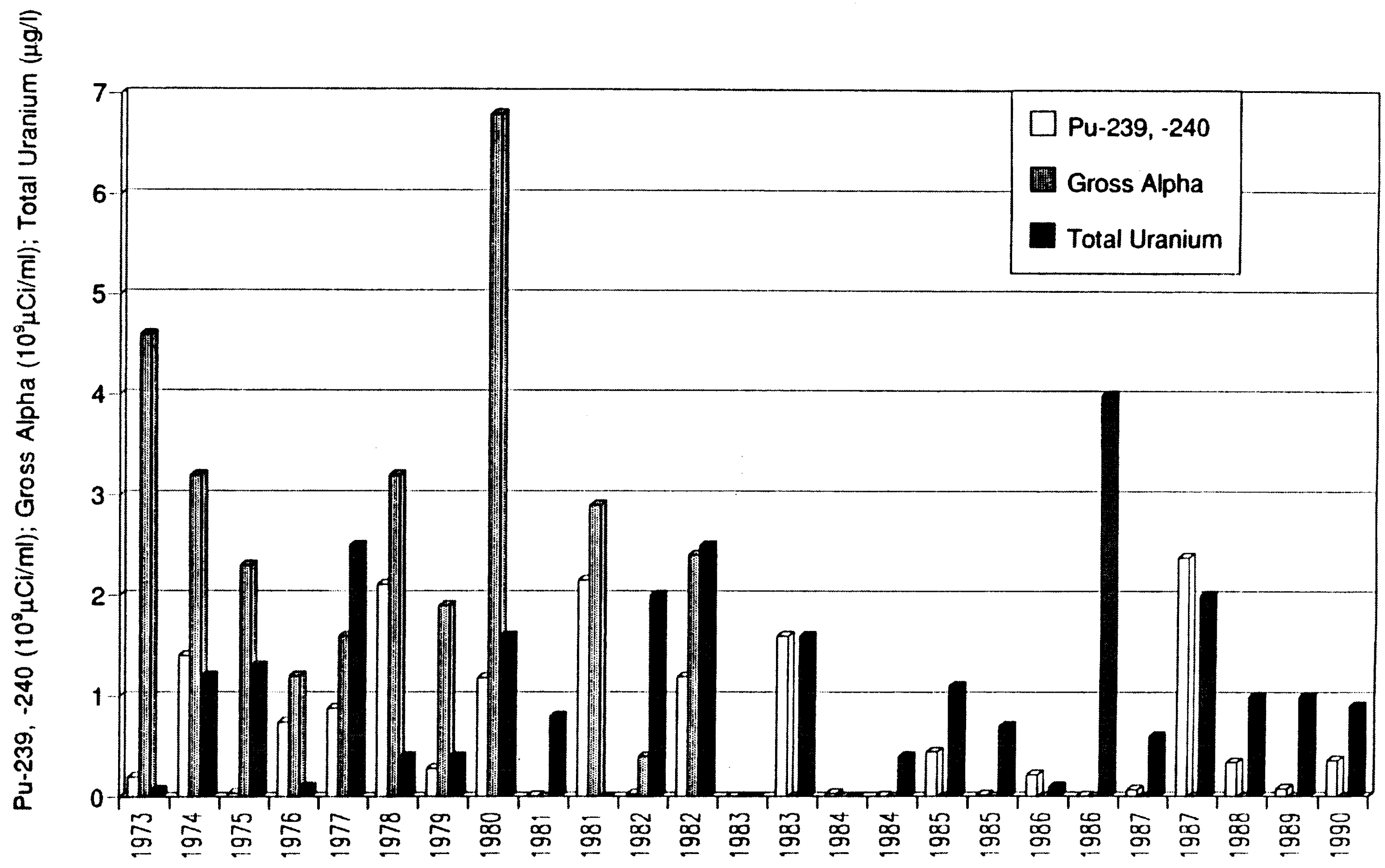


Figure C-3. Pu-239 and -240, total uranium, and gross alpha concentrations in surface water at Acid Weir. DOE's Derived Concentration Guidelines for radioactivity in water in uncontrolled areas are 3 x 10^7 µCi/ml for Pu-239, Pu-240, and gross alpha; and 6 x 10^7 µCi/ml for U-235 and U-238.

3.0 CHEMICALS IN SURFACE WATER

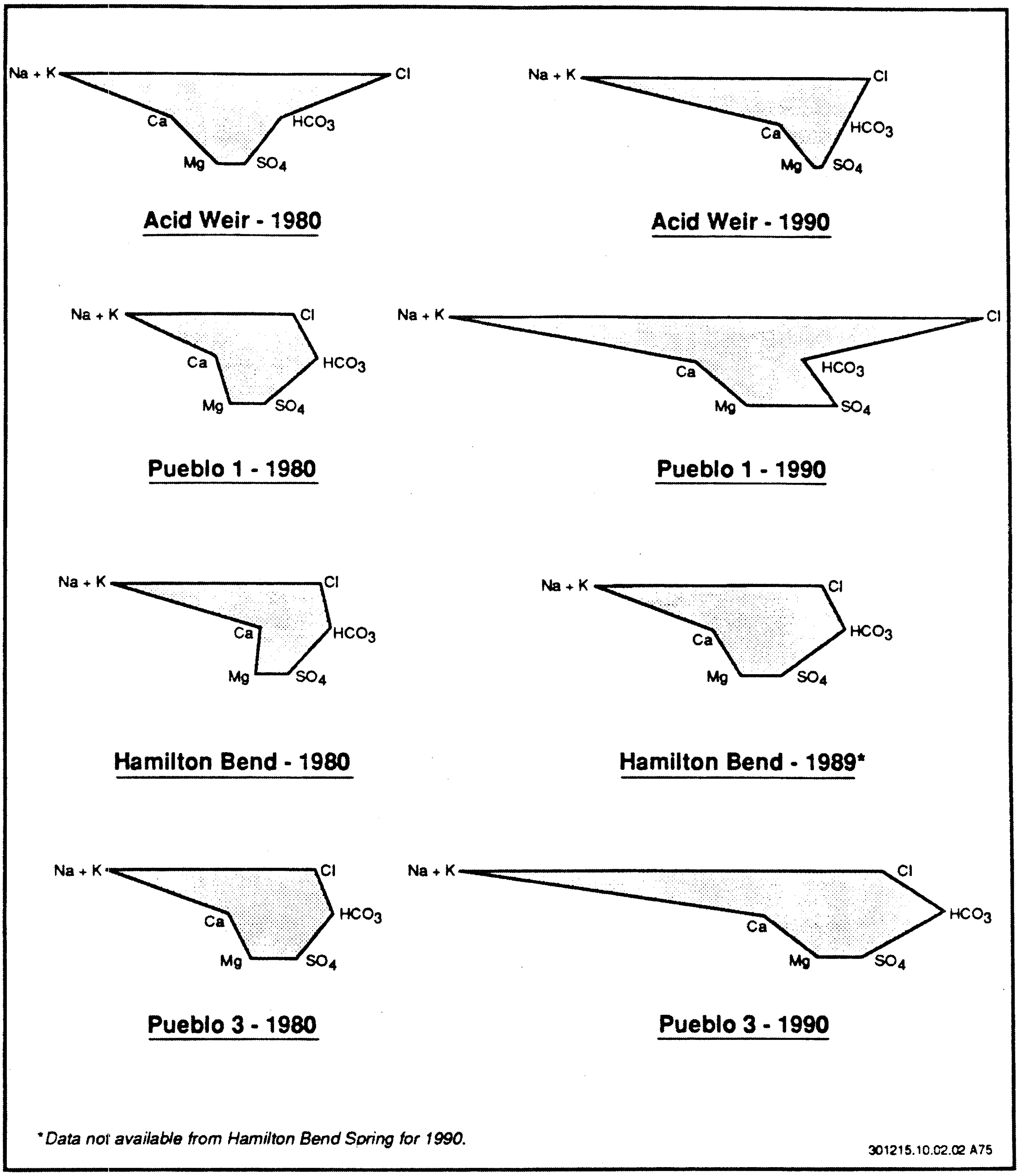
Tables C-2 and C-3 contain concentrations of inorganic chemicals and metals, respectively, in surface water samples collected at five locations in Acid and Pueblo Canyons between 1973 and 1990. Stiff diagrams presented in Figure C-4 illustrate the chemical nature of the water in the canyons. These diagrams show the water to be enriched in sodium and chloride relative to other common chemical constituents. The Stiff diagrams also indicate the water quality is fairly consistent from one sampling location to another, and that the chemistry of the water has not changed significantly between 1980 and 1990, except for temporal fluctuations in sodium and chloride content. The data indicate that the chemical quality of the water generally falls within EPA standards for drinking water. In certain years, the concentrations of total dissolved solids, chloride, and nitrate exceeded EPA's Maximum Contaminant Levels (MCLs) or secondary (aesthetic) standards for drinking water. However, the stream is not used as a source of water for municipal, industrial, or agricultural use.

Seven surface water samples collected in Acid and Pueblo Canyons in 1989 were also analyzed for organic chemicals. The samples were analyzed for 65 volatile organic compounds (VOCs), 68 semivolatile organic compounds (SVOCs), 13 pesticide compounds, 4 herbicide compounds, and 4 polychlorinated biphenyl (PCB) compounds. Only one of these organic compounds, 2-Butanone (methyl ethyl ketone), a VOC and a common laboratory contaminant, was found to be present in quantities that only slightly exceeded the limits of quantification (LOQs) (Environmental Protection Group 1990, 0497).

4.0 RADIONUCLIDES IN SEDIMENT

Table C-4 consists of concentrations of radionuclides and gross radioactivity types in sediment samples collected from six locations in Acid and Pueblo Canyons between 1978 and 1990. Concentrations of ^{239,240}Pu, total uranium, and ^{241}Am versus time at each of the six sampling locations are plotted in Figures C-5 through C-10. Figures C-11 through C-16 are plots of gross-alpha, gross-beta, and gross-gamma concentrations in sediment versus time at each of the six sampling locations. The data indicate that radionuclide concentrations are considerably higher in the sediment samples than in the surface water samples. The higher radionuclide concentrations in sediments are likely related to the tendency of radionuclides to adhere or adsorb to sediment particles, and the insolubility of most of the radionuclides in water of normal pH and normal redox conditions. Figures C-5 through C-16 indicate the following conditions and trends:

1. Concentrations of certain radionuclides (especially ^{239,240}Pu) are significantly higher than regional background levels (e.g., ~0.008 pCi/g for ^{239,240}Pu) in the sediment in Acid and Pueblo Canyons. However, even the highest plutonium concentration recorded in the environmental surveillance data (18.5 picocuries per gram (pCi/g) in 1982 at Acid Weir; see Figure C-5) is less than 20 percent of the level of concern established for ^{239,240}Pu (100 pCi/g) for the Formerly Utilized Sites



Acid Weir - 1980

Acid Weir - 1990

Pueblo 1 - 1980

Pueblo 1 - 1990

Hamilton Bend - 1980

Hamilton Bend - 1989*

Pueblo 3 - 1980

Pueblo 3 - 1990

**Data not available from Hamilton Bend Spring for 1990.*

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Figure C - 4. Stiff diagrams illustrating chemical quality of surface water collected from sampling locations in Acid and Pueblo Canyons.

TABLE C-4 RADIONUCLIDES IN SEDIMENT IN ACID AND PUEBLO CANYONS

Date	Location		90-Sr		137-Cs		238-Pu		239,240-Pu		Gross alpha		Gross beta		Gross gamma		Total U		241-Am	
			Val	SD	Val	SD	Val	SD	Val	SD	Val	SD	Val	SD	Val	SD	Val	SD	Val	SD
			pCi/gr		pCi/gr		pCi/gr		pCi/gr		pCi/gr		pCi/gr		pCi/gr		ug/g		pCi/gr	
1978	Acid Weir		--	--	0.68	0.06	0.034	0.02	5.62	2.39	7.5	3.2	4.5	1.2	--	--	--	--	0.351	0.02
1979	Acid Weir		0.68	0.2	1.03	0.18	0.068	0.01	10.6	0.6	12	4	6	1.4	--	--	2.7	0.6	--	--
1980	Acid Weir	1	1.23	0.28	0.8	0.2	0.039	0.01	6.46	0.32	7.7	3.2	4.2	1.2	--	--	2.1	0.4	0.449	0.03
1980	Acid Weir	2	--	--	--	--	--	--	--	--	17	8	9.2	2	--	--	--	--	--	--
1981	Acid Weir		--	--	1	0.12	0.095	0.03	14.9	1	11	4	3.9	1	--	--	--	--	--	--
1982	Acid Weir	1	1.4	0.16	1.26	0.12	0.08	0.08	18.5	1.4	17	6	9.5	2.2	--	--	4	0.8	1.03	0.08
1982	Acid Weir	2	--	--	0.99	0.08	0.04	0.02	7.6	1.2	8.5	3.6	4.1	1.2	--	--	2.9	0.6	--	--
1983	Acid Weir		0.89	0.12	0.99	0.2	0.005	0.01	7.39	0.26	17	3	9.3	2	3.5	0.22	0.9	0.8	0.4	0.02
1984	Acid Weir		0.9	0.12	0.9	0.3	0.059	0	7.51	0.24	--	--	--	--	3.7	0.6	1.9	0.38	0.01	0
1985	Acid Weir		0.63	0.08	0.78	0.12	0.087	0.01	13.3	0.37	--	--	--	--	--	--	3	0.2	0.494	0.08
1986	Acid Weir		0.59	0.05	0.83	0.15	0.063	0.01	10.1	0.3	--	--	--	--	6.3	0.7	2.9	0.3	2.64	0.41
1987	Acid Weir		--	--	0.18	0.1	0.001	0	0.004	0	--	--	--	--	0.8	0.6	3.2	0.3	1.28	0.25
1988	Acid Weir		--	--	0.35	0.11	0.052	0.01	12.4	0.47	--	--	--	--	1.7	0.5	2.2	0.2	--	--
1989	Acid Weir		0.4	0.25	0.41	0.09	0.053	0.02	9.32	0.39	--	--	--	--	1.7	0.4	2.8	0.3	--	--
1990	Acid Weir		--	--	0.25	0.09	0.043	0.01	5.17	0.23	--	--	--	--	4.8	0.6	1.8	0.2	--	--
1978	Pueblo 1		--	--	0.5	0.3	0.022	0.01	3.72	1.3	4.1	2	2.1	0.8	--	--	--	--	--	--
1979	Pueblo 1		2.25	0.3	0.29	0.08	-0.004	0.01	0.27	0.06	6.4	3	12	2.6	--	--	3.8	0.9	--	--
1980	Pueblo 1	1	0.98	0.2	0.98	0.18	0.06	0.01	7.5	0.6	13	6	5.9	1.4	--	--	2.1	0.4	--	--
1980	Pueblo 1	2	--	--	--	--	0	0	0.002	0	2.6	1.2	3.1	0.4	--	--	--	--	--	--
1981	Pueblo 1		--	--	0.5	0.1	0.03	0.01	3.93	0.12	10	4	2.3	0.8	--	--	--	--	--	--
1982	Pueblo 1	1	0.02	0.1	0.2	0.06	0.002	0	0.009	0.01	2.9	1.4	--	--	--	--	2.7	0.6	0.004	0
1982	Pueblo 1	2	--	--	0.02	0.14	0.002	0	0	0	1.5	0.8	2.2	0.8	--	--	2.2	0.6	--	--
1983	Pueblo 1		0.13	0.08	0.25	0.12	0.002	0.01	0.006	0	5.8	2.8	5.1	1.2	5.8	0.26	--	--	0.14	0.01
1984	Pueblo 1		0.5	0.08	0	0.3	0.002	0	0.01	0	--	--	--	--	2	0.6	1.8	0.36	-0.01	0
1985	Pueblo 1		0.11	0.03	0.11	0.03	0.001	0	0.027	0	--	--	--	--	--	--	2.3	0.2	-0.098	0.03
1986	Pueblo 1		-0.08	0.07	0.16	0.08	0.002	0	0.004	0	--	--	--	--	3.4	0.5	1.8	0.2	0.221	0.1
1987	Pueblo 1		--	--	0.2	0.1	-0.036	0.02	0.009	0.03	--	--	--	--	-2.2	0.6	2.4	0.2	-1.83	0.33
1988	Pueblo 1		--	--	0.14	0.07	0.001	0	0.002	0	--	--	--	--	1.1	0.5	1.5	0.2	--	--
1989	Pueblo 1		0.2	0.24	0.2	0.13	0.002	0	0.007	0	--	--	--	--	3.4	0.5	2.5	0.3	--	--
1990	Pueblo 1		--	--	0.19	0.08	0.054	0	0.563	0.02	--	--	--	--	3.4	0.5	3.1	0.3	--	--
1978	Pueblo 2		--	--	0.18	0.03	0.007	0.01	1.07	1.93	3.1	1.4	2.9	1	--	--	--	--	0.59	0.02
1979	Pueblo 2		0.3	0.16	0.13	0.06	0.001	0.01	0.63	0.08	2.7	1.4	3.3	1.6	--	--	3.9	0.8	--	--
1980	Pueblo 2		0.05	0.2	0.27	0.22	0.001	0	0.195	0.02	1.9	1	2	0.8	--	--	1.9	0.4	--	--
1981	Pueblo 2		--	--	0.29	0.08	0.011	0.01	2.77	0.12	5.3	2.4	2.8	1	--	--	--	--	--	--
1982	Pueblo 2	1	0.12	0.14	0.19	0.04	0.024	0.02	4.3	0.8	7.9	3.4	3.6	1	--	--	4	0.8	0.145	0.02
1982	Pueblo 2	2	--	--	0.13	0.06	0.026	0.01	4.39	0.12	6.2	2.6	4	1.2	--	--	3.6	0.8	--	--
1983	Pueblo 2		0.18	0.14	0.16	0.1	0.016	0.01	4.39	0.12	9	2	4.4	1	9	0.3	--	--	--	--
1985	Pueblo 2		0.11	0.06	0.09	0.02	0.016	0	1.76	0.09	--	--	--	--	--	--	2.6	0.2	0.299	0.05
1986	Pueblo 2		0.11	0.07	0.04	0.04	0	0	0.177	0.01	--	--	--	--	5.2	0.6	3.4	0.3	-0.15	0.05
1987	Pueblo 2		--	--	-0.02	0.06	0.026	0.01	0.612	0.06	--	--	--	--	-0.8	0.6	2.9	0.3	2.51	0.4
1988	Pueblo 2		0.28	0.05	0.06	0.11	0.004	0	0.904	0.04	--	--	--	--	4.5	0.7	3.8	0.4	--	--
1989	Pueblo 2		0.25	0.23	0.18	0.07	0.003	0	0.674	0.03	--	--	--	--	3.2	0.5	2.8	0.3	--	--
1990	Pueblo 2		--	--	0.42	0.38	0.004	0	0.453	0.02	--	--	--	--	1.9	0.4	1.8	0.2	--	--

TABLE C-4 RADIONUCLIDES IN SEDIMENT IN ACID AND PUEBLO CANYONS (CONTINUED)

Date	Location		90-Sr		137-Cs		238-Pu		239,240-Pu		Gross alpha		Gross beta		Gross gamma		Total U		241-Am	
			Val	SD	Val	SD	Val	SD	Val	SD	Val	SD	Val	SD	Val	SD	Val	SD	Val	SD
			pCi/gr		pCi/gr		pCi/gr		pCi/gr		pCi/gr		pCi/gr		pCi/gr		ug/g		pCi/gr	
1978	Hamilton Bend		--	--	0.12	0.01	0.001	0	0.432	0.13	2.5	1.2	1.5	0.8	--	--	--	--	0.016	0.01
1979	Hamilton Bend		1.1	0.26	0.05	0.06	0.002	0.01	0.47	0.04	4.2	2	2.6	0.8	--	--	4.3	0.8	--	--
1980	Hamilton Bend	1	0.01	0.18	0.12	0.1	0	0	0.196	0.02	3.6	1.6	2	0.8	--	--	1.6	0.4	--	--
1980	Hamilton Bend	2	--	--	--	--	0.004	0	0.291	0.02	3.3	1.4	2.6	0.8	--	--	--	--	--	--
1981	Hamilton Bend		--	--	0.12	0.08	0.013	0.01	0.7	0	2.1	1.2	64	12	--	--	--	--	--	--
1982	Hamilton Bend	1	0.09	0.14	0.12	0.04	0.002	0	0.64	0.04	2.3	1.2	1.5	0.8	--	--	1.8	0.4	0.029	0.01
1982	Hamilton Bend	2	--	--	0.13	0.1	0.004	0	0.488	0.03	1.9	1	2.4	0.8	--	--	1.8	0.4	--	--
1983	Hamilton Bend		0.3	0.18	0.05	0.04	0.008	0.01	0.74	0.04	5.3	1.2	1.9	0.6	3.9	0.22	--	--	0.05	0.01
1985	Hamilton Bend		0.18	0.04	0.11	0.03	0.006	0	1.75	0.12	--	--	--	--	--	--	3.8	0.3	-0.114	0.04
1986	Hamilton Bend		0.12	0.08	0.23	0.07	0.002	0	0.297	0.02	--	--	--	--	5.4	0.7	3.2	0.3	-0.141	0.07
1987	Hamilton Bend		--	--	0.27	0.09	0.001	0.01	0.167	0.01	--	--	--	--	-0.3	0.6	3.4	0.3	2.29	0.37
1988	Hamilton Bend		--	--	0.23	0.08	0.004	0	0.459	0.03	--	--	--	--	3.5	0.6	2.9	0.3	--	--
1989	Hamilton Bend		0.05	0.31	0.15	0.15	0	0	0.152	0.01	--	---	--	--	2.7	0.5	3	0.3	--	--
1990	Hamilton Bend		--	--	0.68	0.38	0.002	0	0.21	0.01	--	--	--	--	5	0.6	3.5	0.4	--	--
1978	Pueblo 3		--	--	0.14	0.17	0.001	0	0.44	0.18	2.1	1	1.1	0.8	--	--	--	--	0.015	0.01
1979	Pueblo 3		0.03	0.16	0.02	0.08	0.001	0	0.215	0.02	1.5	0.8	1.8	0.4	--	--	1.8	0.4	--	--
1980	Pueblo 3	1	0.1	0.22	0.1	0.14	0	0	0.201	0.02	0.9	0.6	0.9	0.6	--	--	1.2	0.4	--	--
1980	Pueblo 3	2	--	--	--	--	0.012	0.01	2.73	0.08	14	6	14	3	--	--	--	--	--	--
1982	Pueblo 3	1	0.17	0.18	0.44	0.12	0.06	0.03	15.5	2.4	18	8	5.8	1.4	--	--	4.6	1	0.241	0.02
1982	Pueblo 3	2	--	--	0.15	0.11	0	0	0.002	0	2.1	1	2	0.8	--	--	2.8	0.6	--	--
1983	Pueblo 3		0.21	0.18	0.13	0.08	0.004	0	0.006	0.01	4.7	2.2	3.1	0.8	4.1	0.24	--	--	0.03	0.01
1985	Pueblo 3		0.23	0.04	0.58	0.09	0.025	0.02	6.33	0.27	--	--	--	--	--	--	7	0.5	0.137	0.03
1986	Pueblo 3		-0.02	0.08	0.14	0.07	0.001	0	0.005	0	--	--	--	--	2.3	0.4	1.7	0.2	-0.066	0.09
1987	Pueblo 3		--	--	0.02	0.07	0	0	0.004	0	--	--	--	--	-1.3	0.6	3.2	0.3	1.31	0.25
1988	Pueblo 3		--	--	0.09	0.1	0	0.01	0.004	0	--	--	--	--	3.1	0.6	2.5	0.3	--	--
1989	Pueblo 3		-0.26	0.39	0.15	0.06	0	0	0.003	0	--	--	--	--	2.2	0.4	2.2	0.2	--	--
1990	Pueblo 3		--	--	0.12	0.06	0	0	0.004	0	--	--	--	--	2.4	0.5	2.9	0.3	--	--
1979	Pueblo at SR-4		0.04	0.11	0.14	0.28	0.001	0	0.493	0.1	1.4	1.2	1.1	1.3	--	--	2.1	0.4	--	--
1980	Pueblo at SR-4	1	0.12	0.16	0.22	0.14	0.002	0	0.557	0.04	2.7	1.4	23.7	0.8	--	--	2	0.4	0.03	0.01
1980	Pueblo at SR-4	2	--	--	--	--	0.003	0	0.453	0.02	4.6	2	4.7	1	--	--	--	--	--	--
1981	Pueblo at SR-4		0.1	0.12	0.14	0.06	0.001	0	0.6	0	11	4	3.5	1	--	--	--	--	--	--
1982	Pueblo at SR-4	1	0.41	0.22	0.06	0.06	0.004	0.01	0.64	0.12	6.5	2.8	5.9	1.4	--	--	2.8	0.6	0.03	0.01
1982	Pueblo at SR-4	2	--	--	0.13	0.05	0.004	0.01	0.7	--	1.5	0.8	0.7	0.6	--	--	2.6	0.6	--	--
1983	Pueblo at SR-4		0.08	0.08	0.1	0.06	0.002	0	0.065	0.04	2.8	1.2	1.8	0.6	3.3	0.22	2.7	0.6	0.02	0
1984	Pueblo at SR-4		0.36	0.08	0	0.3	0.016	0.01	3.17	0.1	--	--	--	--	2.6	0.6	2.4	0.2	0	0
1985	Pueblo at SR-4		-0.05	0.05	0.01	0.02	0.002	0	0.61	0.03	--	--	--	--	--	--	2.2	0.2	-0.056	0.04
1986	Pueblo at SR-4		0	0.06	0.01	0.07	0.002	0	0.433	0.02	--	--	--	--	2.2	0.4	1.4	0.2	0.023	0.08
1987	Pueblo at SR-4		1.05	0.32	0.16	0.11	0.001	0	0.521	0.42	2.7	1.4	3.1	1	--	--	--	--	--	--
1987	Pueblo at SR-4		--	--	-0.01	0.09	0.002	0	0.399	0.02	--	--	--	--	-3.4	0.7	2.7	0.3	2.37	0.38
1988	Pueblo at SR-4		0.1	0.05	0.05	0.08	0.002	0	0.419	0.02	--	--	--	--	1	0.5	1.6	0.2	--	--
1989	Pueblo at SR-4		-0.08	0.33	25	0.14	0	0	0.002	0	--	--	--	--	1.2	0.4	1.8	0.2	--	--
1990	Pueblo at SR-4		--	--	0.44	0.41	0.015	0	0.81	0.03	--	--	--	--	7.2	0.8	4	0.4	--	--

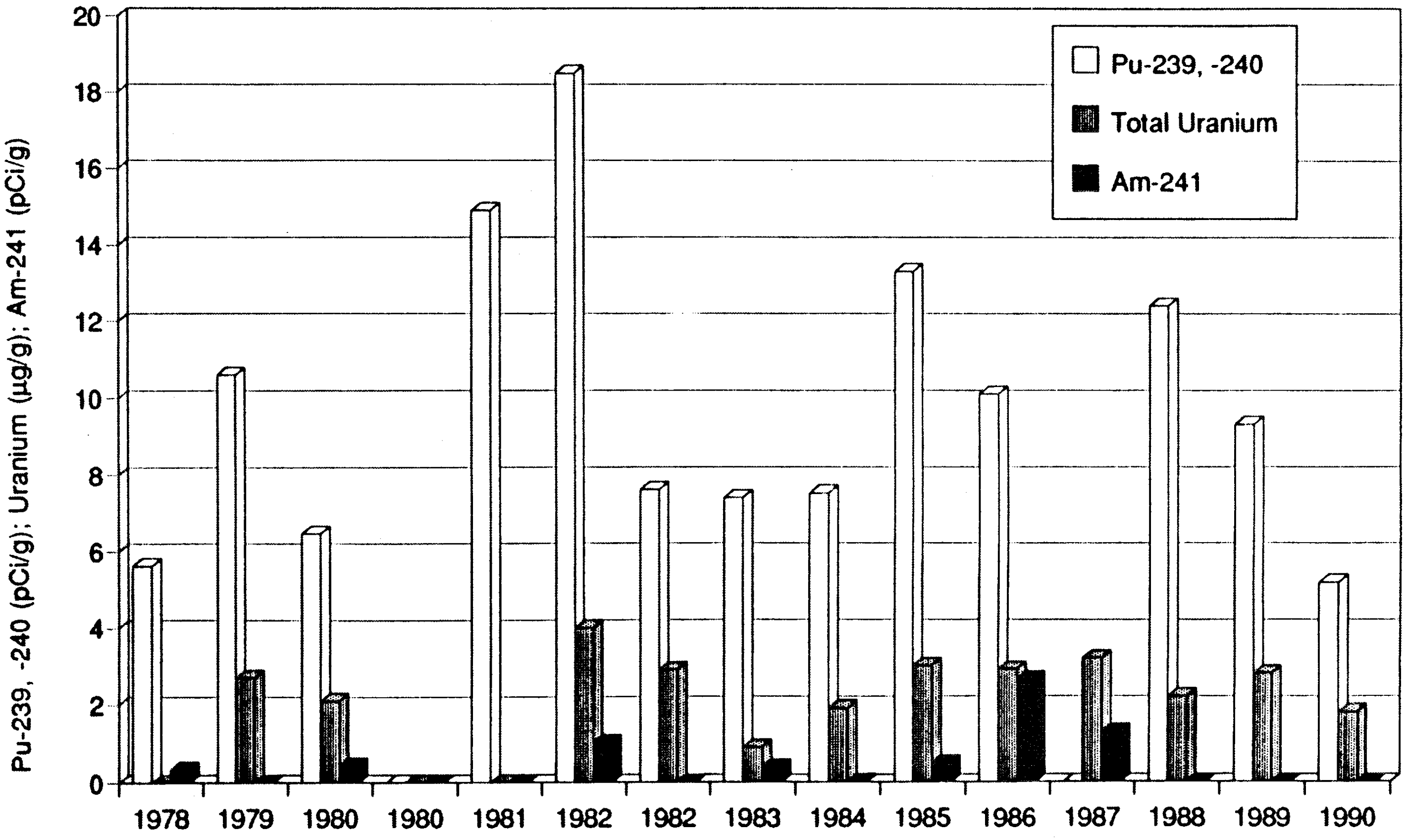

Figure C-5. Pu-239 and -240, total uranium, and Am-241 in sediment at Acid Weir. Guidelines for radionuclides in surface soil used in the 1982 FUSRAP clean-up were 100 pCi/g for Pu-239, -240; 75 pCi/g for natural and depleted uranium; and 20 pCi/g for Am-241.

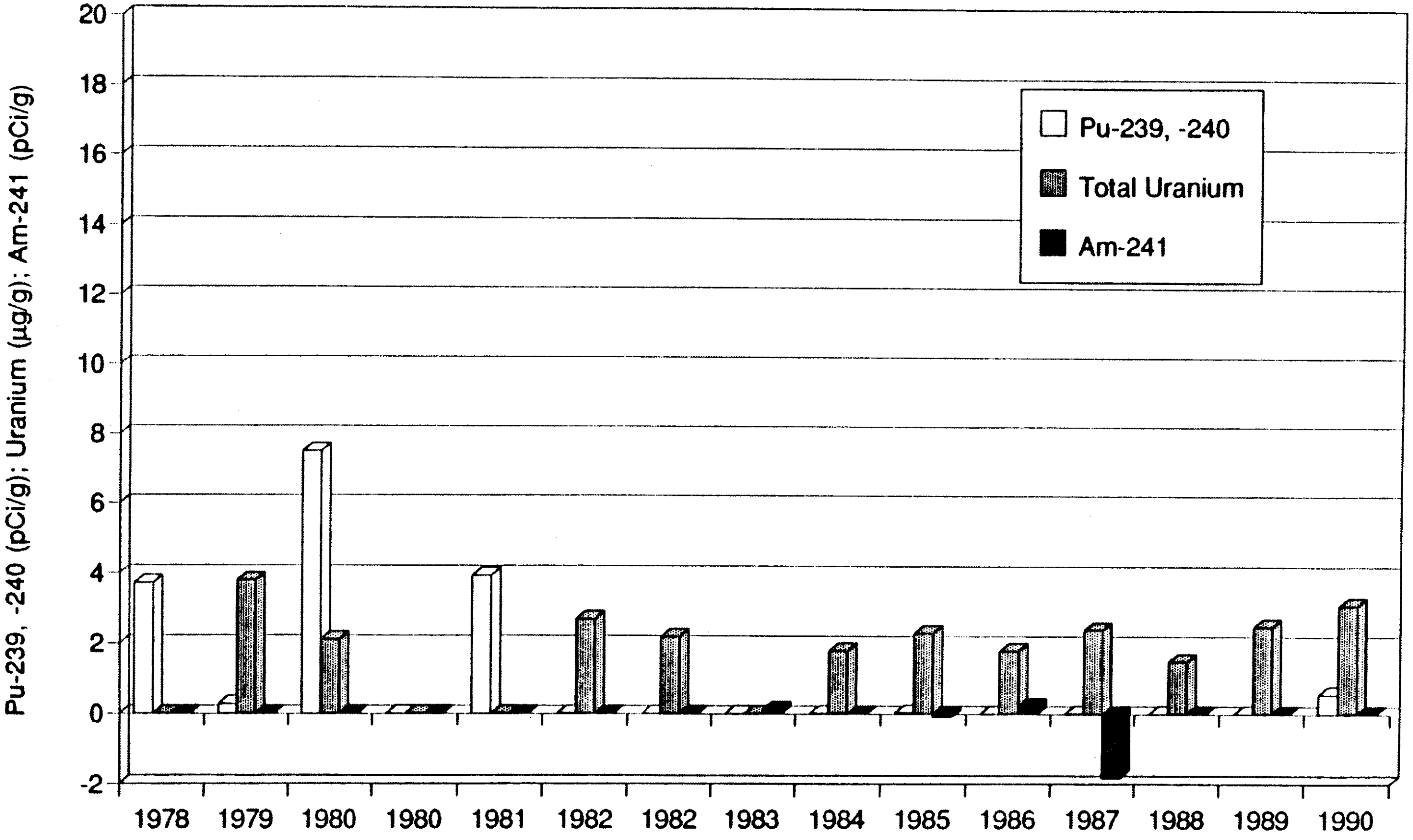

Figure C-6. Pu-239 and -240, total uranium, and Am-241 in sediment at Pueblo 1. Guidelines for radionuclides in surface soil used in the 1982 FUSRAP cleanup were 100 pCi/g for Pu-239, -240; 75 pCi/g for natural and depleted uranium; and 20 pCi/g for Am-241.

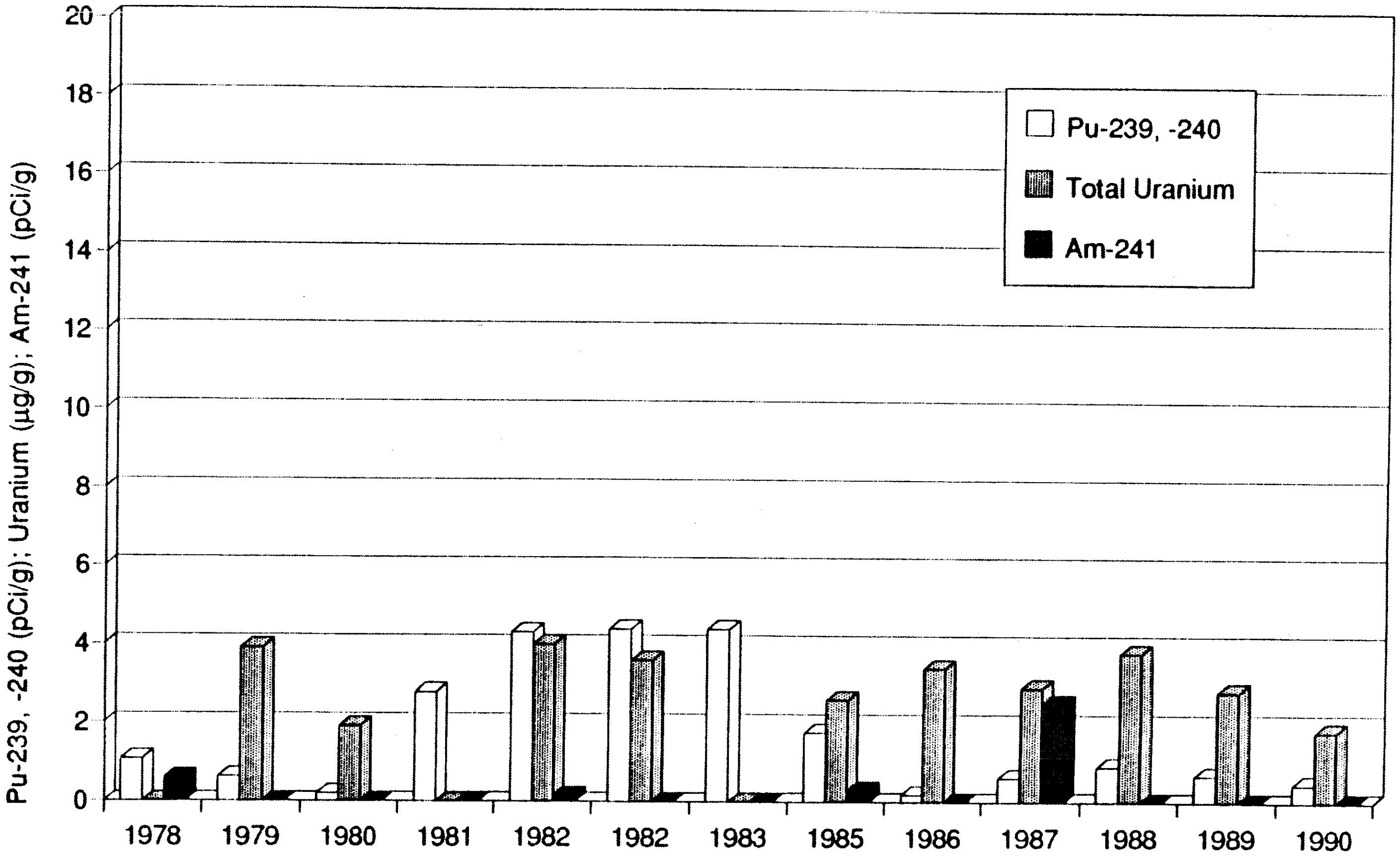

Figure C-7. Pu-239 and -240, total uranium, and Am-241 in sediment at Pueblo 2. Guidelines for radionuclides in surface soil used in the 1982 FUSRAP cleanup were 100 pCi/g for Pu-239, -240; 75 pCi/g for natural and depleted uranium; and 20 pCi/g for Am-241.

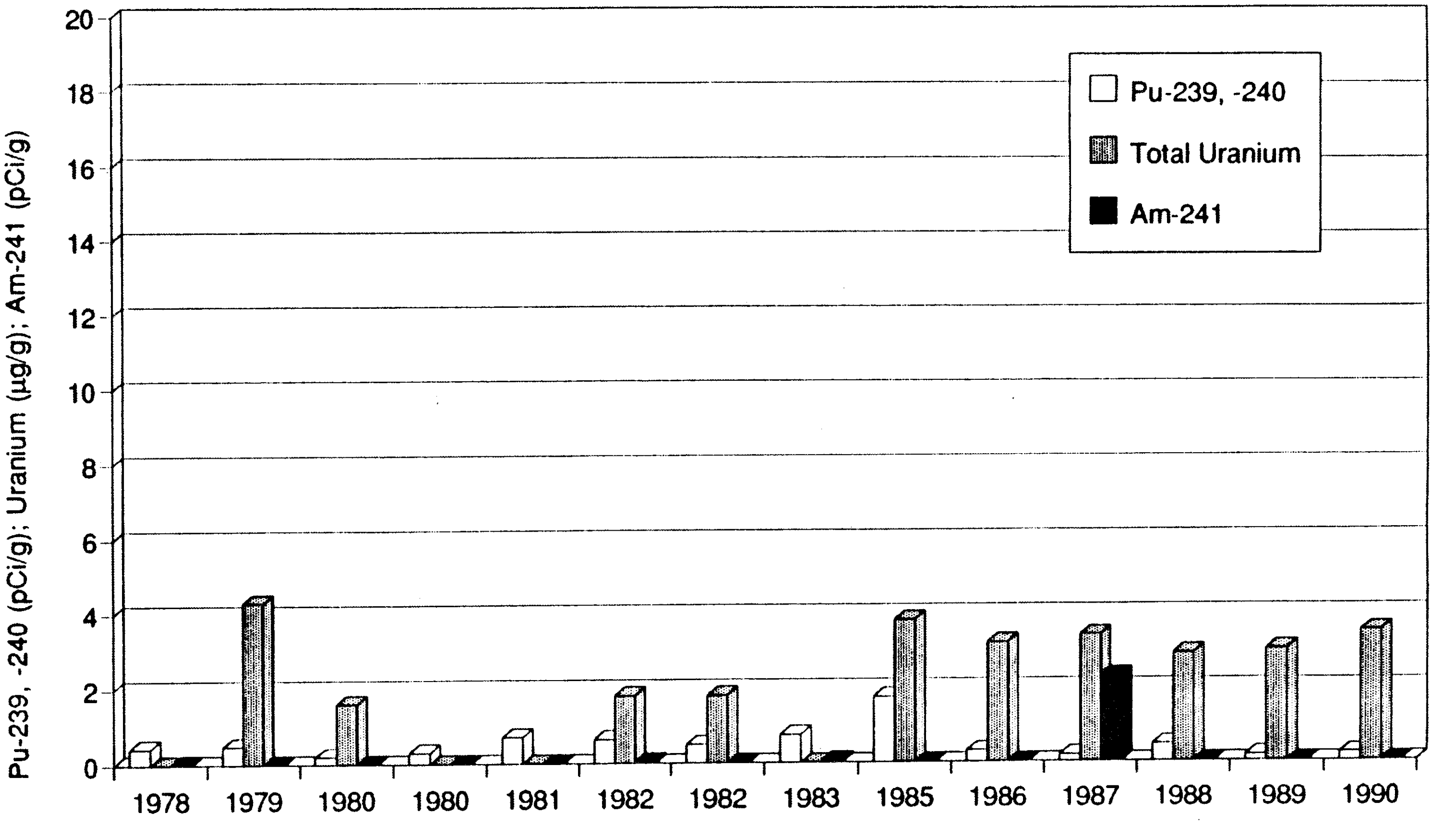

Figure C-8. Pu-239 and -240, total uranium, and Am-241 in sediment at Hamilton Bend. Guidelines for radionuclides in surface soil used in the 1982 FUSRAP cleanup were 100 pCi/g for Pu-239, -240; 75 pCi/g for natural and depleted uranium; and 20 pCi/g for Am-241.

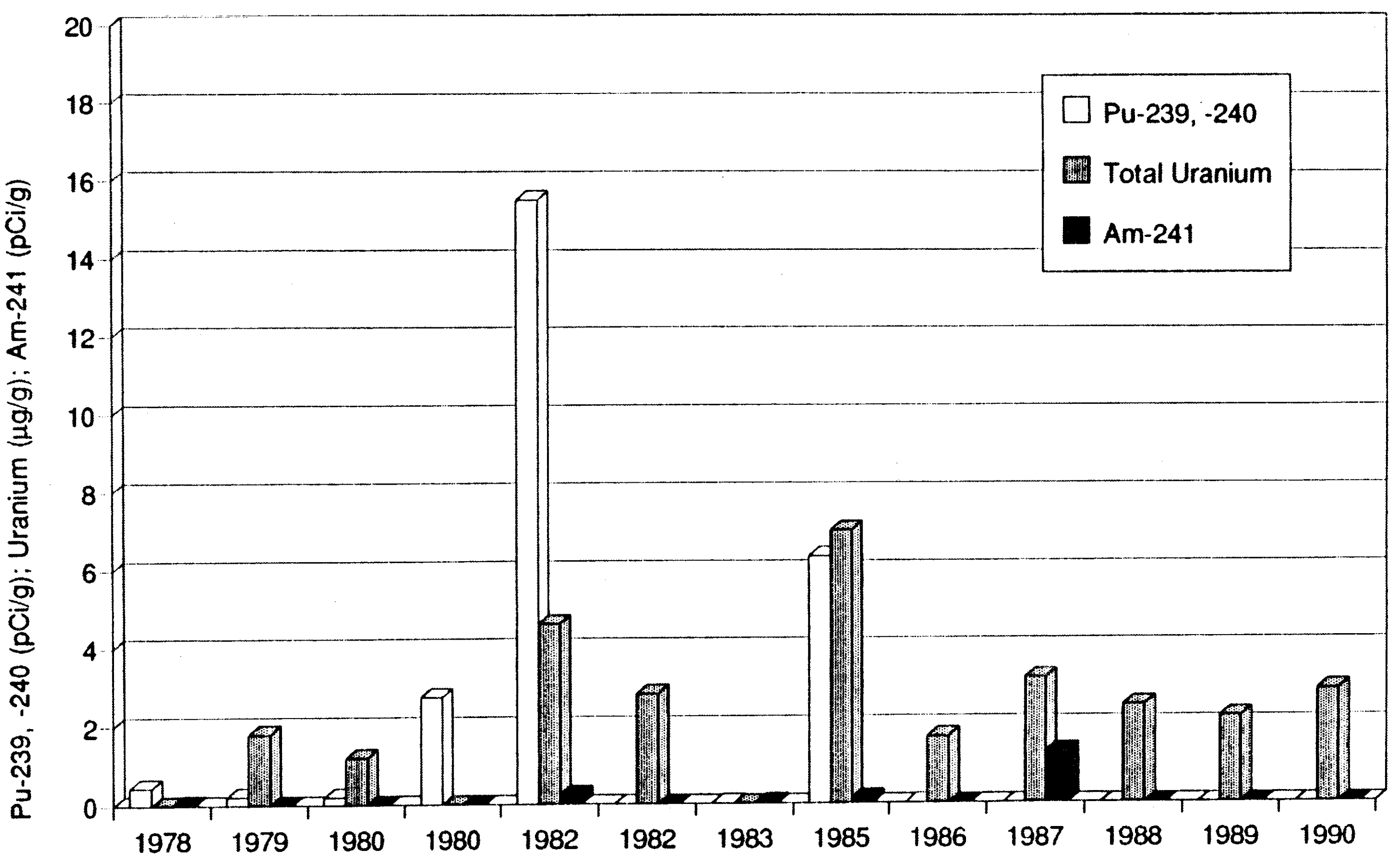

Figure C-9. Pu-239 and -240, total uranium, and Am-241 in sediment at Pueblo 3. Guidelines for radionuclides in surface soil used in the 1982 FUSRAP cleanup were 100 pCi/g for Pu-239, -240; 75 pCi/g for natural and depleted uranium; and 20 pCi/g for Am-241.

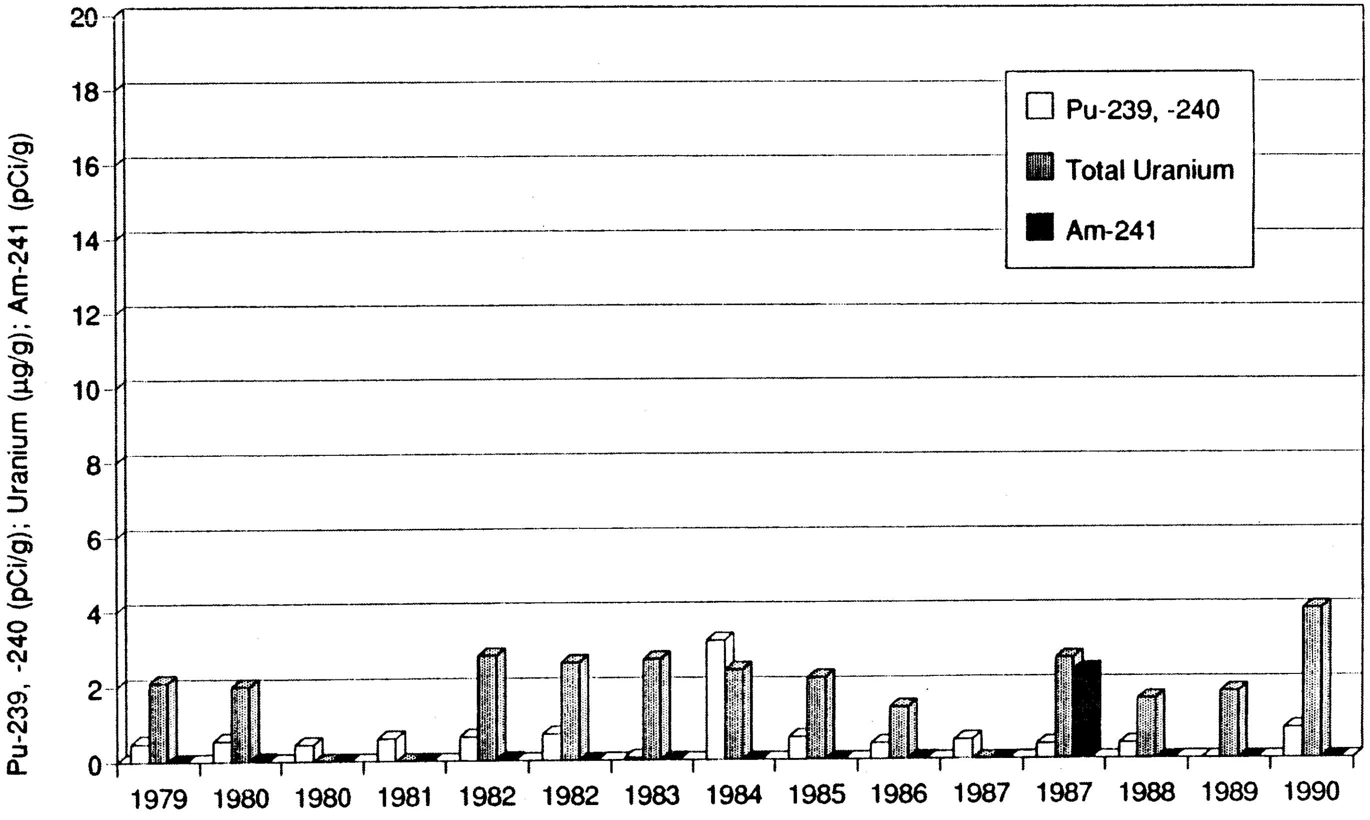

Figure C-10. Pu-239 and -240, total uranium, and Am-241 in sediment in Pueblo Canyon at State Road 4. Guidelines for radionuclides in surface soil used in the 1982 FUSRAP cleanup were 100 pCi/g for Pu-239, -240; 75 pCi/g for natural and depleted uranium; and 20 pCi/g for Am-241.

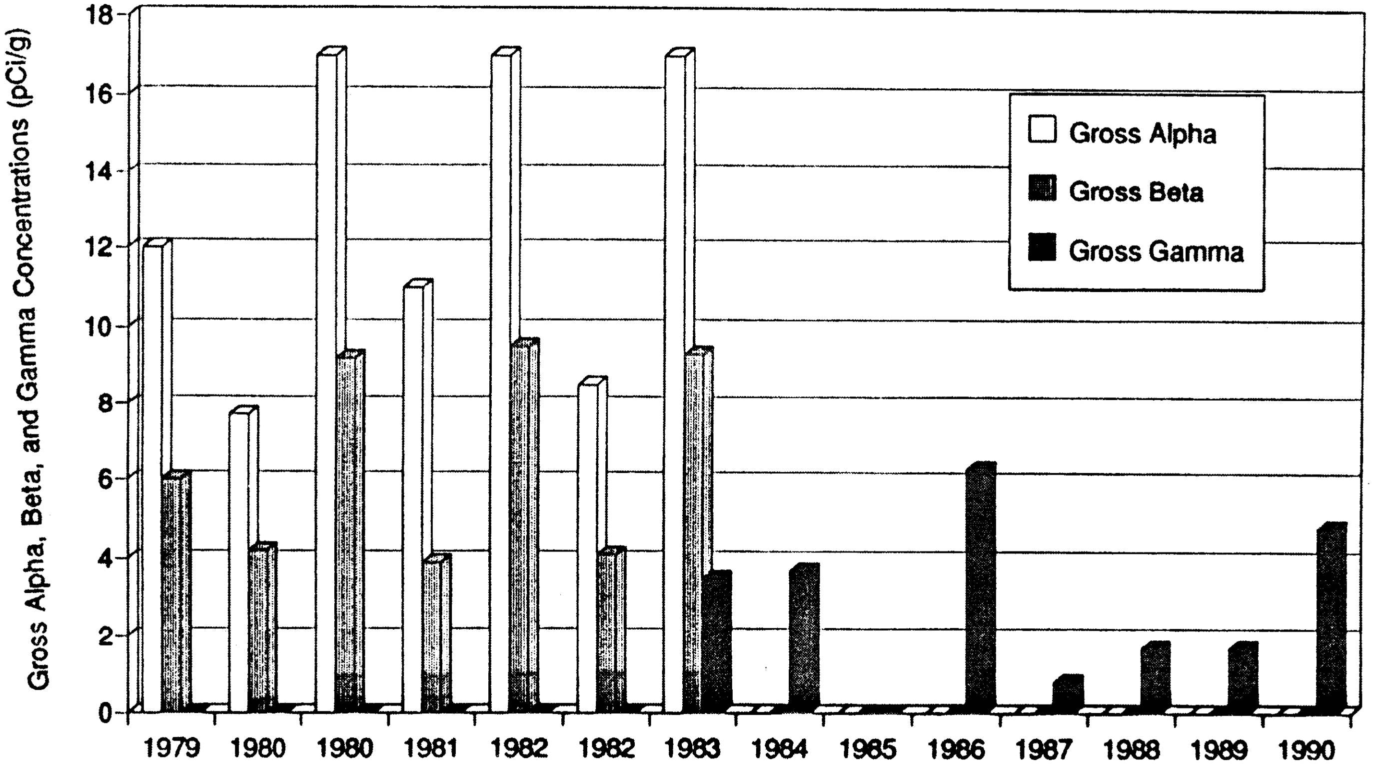

Figure C-11. Gross alpha, gross beta, and gross gamma concentrations in sediment at Acid Weir. Gross alpha and beta concentrations were not measured after 1983; gross gamma was not measured before 1983. Negative radioactivity values indicate that measured concentration was less than average Instrumental background concentration.

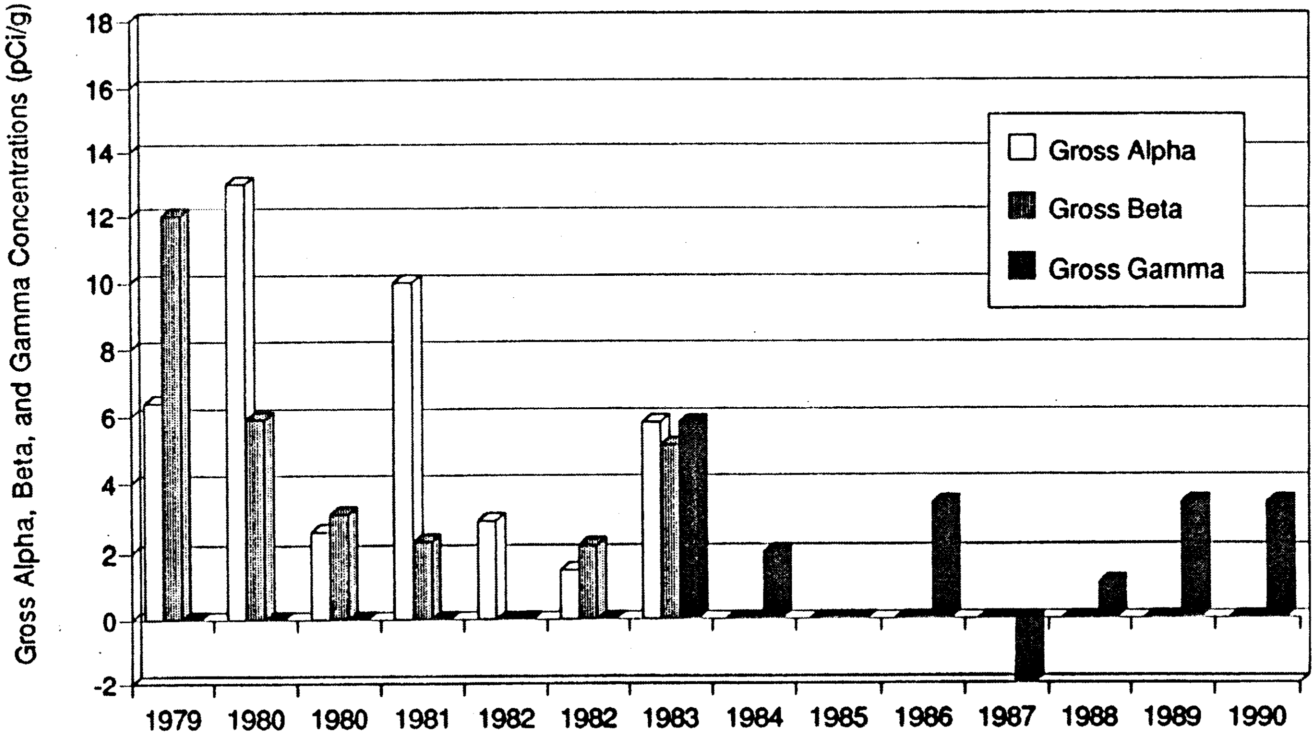

Figure C-12. Gross alpha, gross beta, and gross gamma concentrations in sediment at Pueblo 1. Gross alpha and beta concentrations were not measured after 1983; gross gamma was not measured before 1983. Negative radioactivity values indicate that measured concentration was less than average instrumental background concentration.

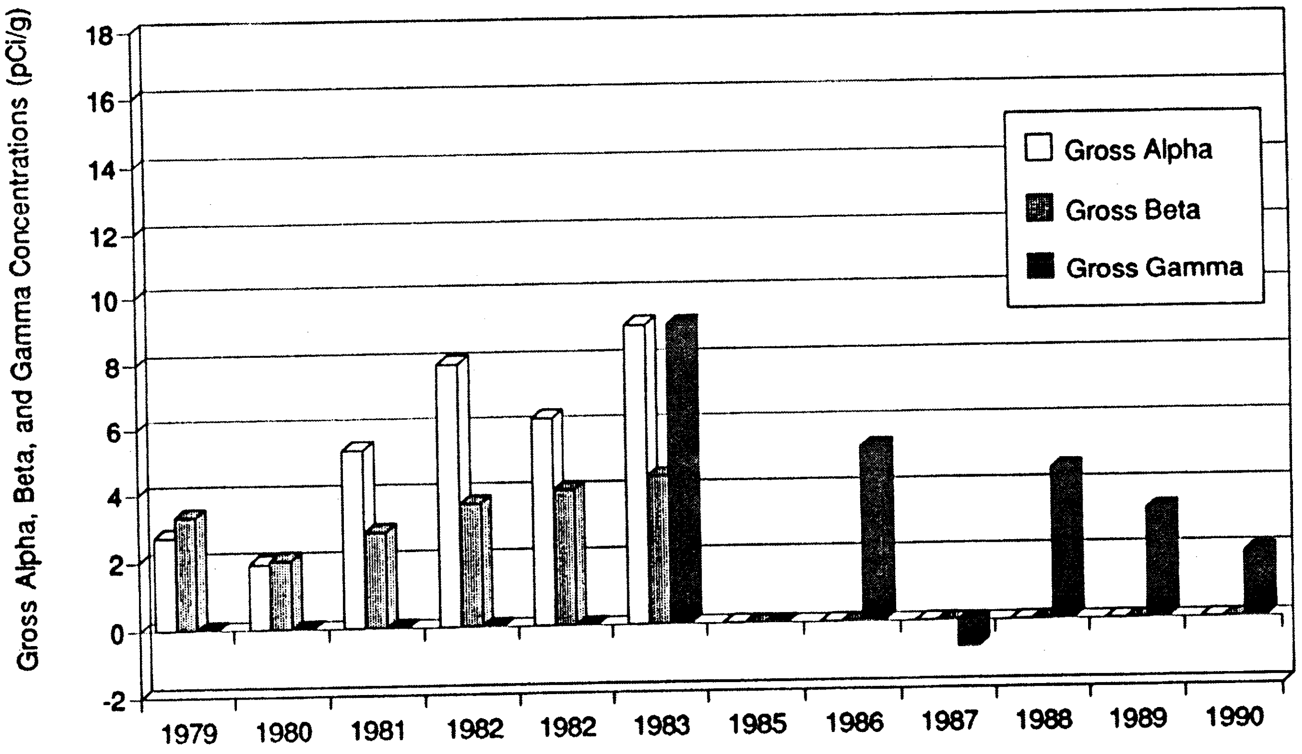

Figure C-13. Gross alpha, gross beta, and gross gamma concentrations in sediment at Pueblo 2. Gross alpha and beta concentrations were not measured after 1983; gross gamma was not measured before 1983. Negative radioactivity values indicate that measured concentration was less than average instrumental background concentration.

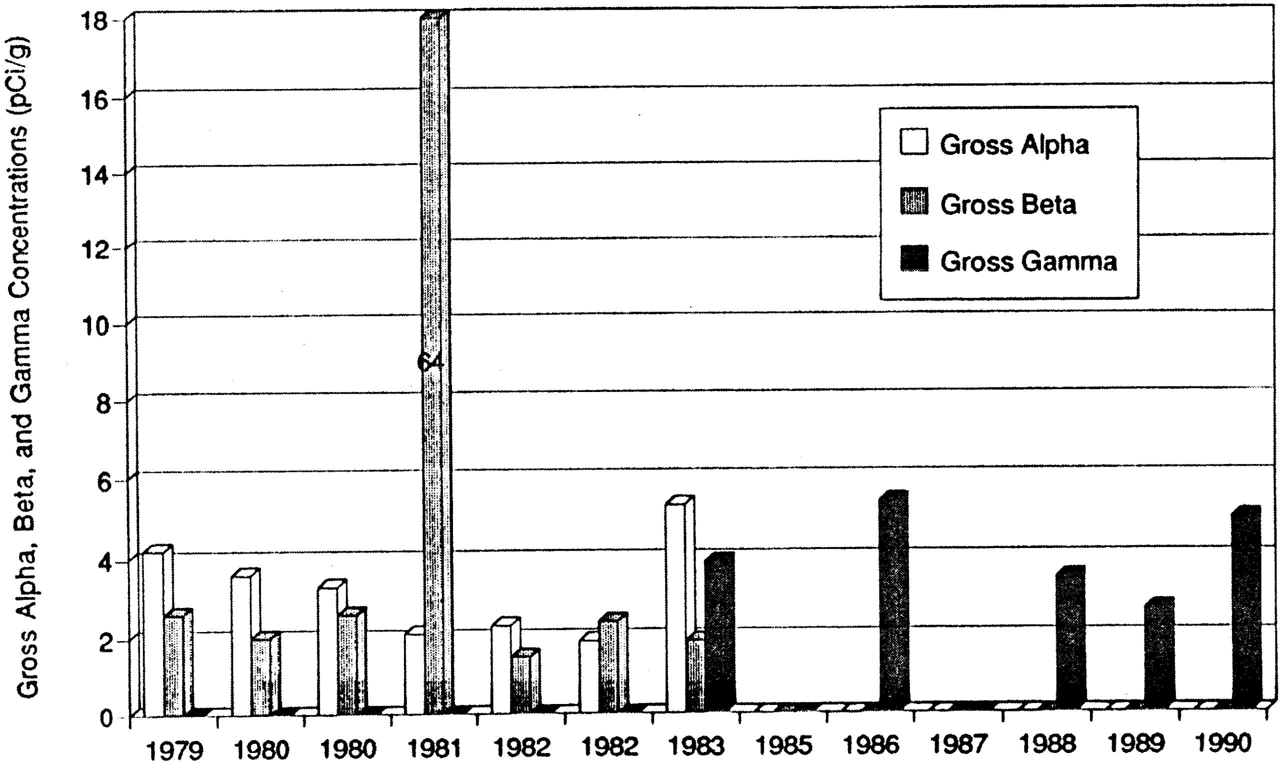

Figure C-14. Gross alpha, gross beta, and gross gamma concentrations in sediment at Hamilton Bend. Gross alpha and beta concentrations were not measured after 1983; gross gamma was not measured before 1983. Negative radioactivity values indicate that measured concentration was less than average instrumental background concentration.

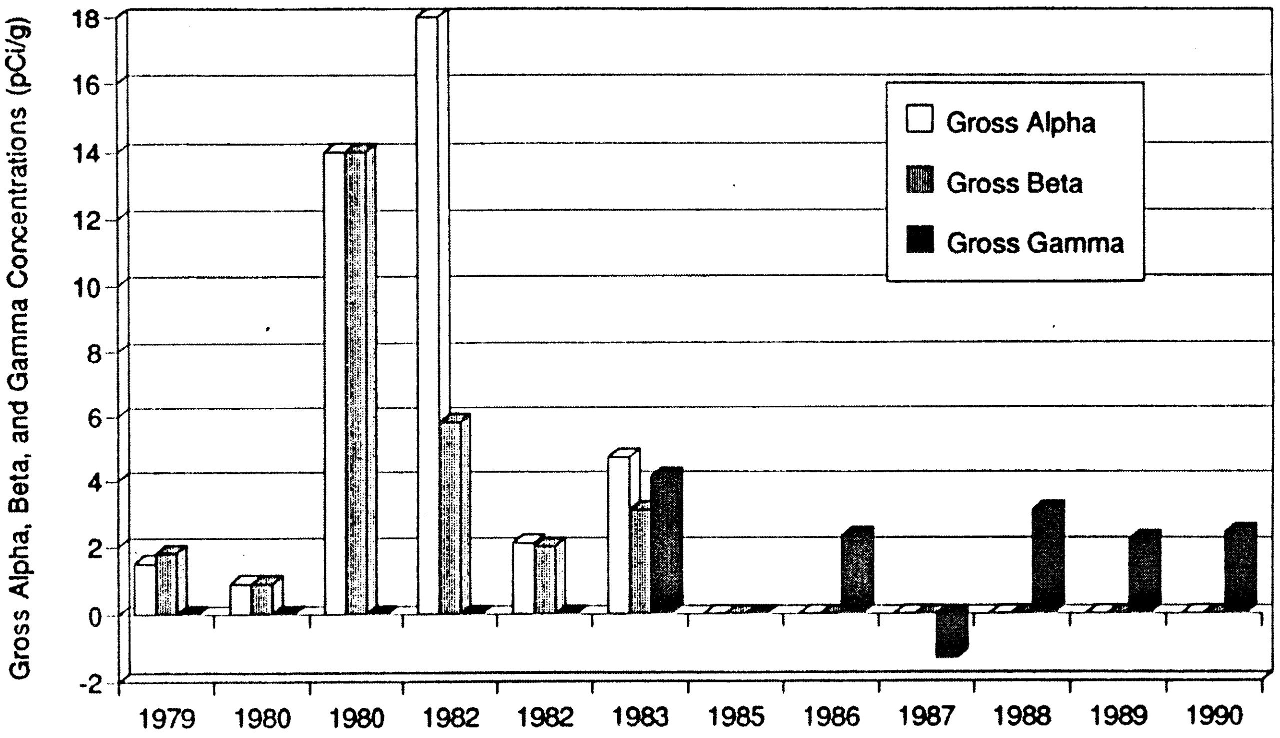

Figure C-15. Gross alpha, gross beta, and gross gamma concentrations in sediment at Pueblo 3. Gross alpha and beta concentrations were not measured after 1983; gross gamma was not measured before 1983. Negative radioactivity values indicate that measured concentration was less than average instrumental background concentration.

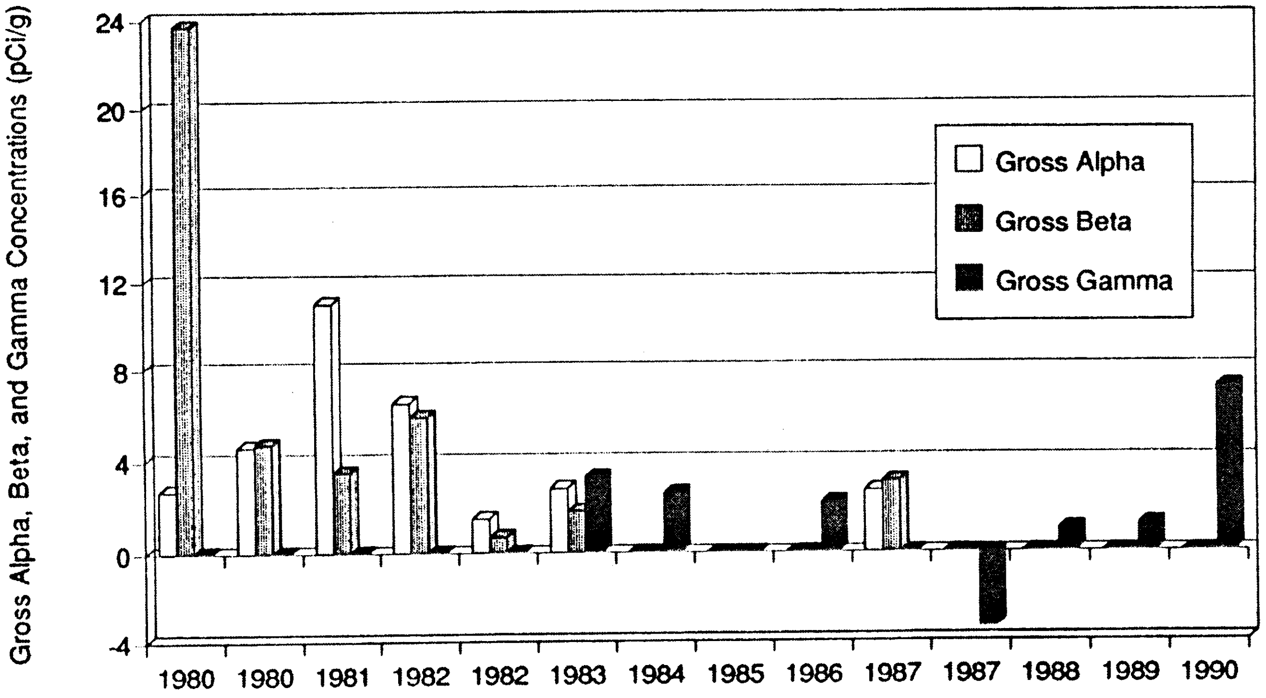

Figure C-16. Gross alpha, gross beta, and gross gamma concentrations in sediment in Pueblo Canyon at State Road 4. Gross alpha and beta concentrations were not measured after 1983; gross gamma was not measured before 1983. Negative radioactivity values indicate that measured concentration was less than average instrumental background concentration.

Remedial Action Program (FUSRAP) cleanup effort conducted in 1982 (Gunderson et al. 1983, 0671).

2. Total uranium concentrations generally do not exceed the average regional background level for natural uranium (Figures C-5 through C-10). Total uranium concentrations at each sampling location are consistently between zero and 4.6 micrograms per gram (μg/g), or within the natural background concentration range for uranium (ESG 1982, 0620).

3. For the period between 1978 and 1990, concentrations of ^{239,240}Pu, ^{241}Am, and gross-alpha, gross-beta, and gross-gamma activity are consistently higher in Acid Canyon (Acid Weir location) than in Pueblo Canyon (compare Figures C-5 and C-11 with the graphs for the Pueblo Canyon sampling locations). Although transport of plutonium and other radionuclides in sediment down Acid and Pueblo Canyons by storm runoff and snowmelt has been documented (e.g. ESG 1983, 0621; Purtymun et al. 1990, 0215), concentrations of most radionuclides and gross radioactivity types remain highest near the former effluent discharge points in Acid Canyon.

4. There is a general decrease in ^{239,240}Pu concentration through time at each sampling location (Figures C-5 through C-10). This trend may reflect gradual transport of radionuclides in suspended sediment and bedload from Acid Canyon into Pueblo Canyon, and further transport from Pueblo Canyon into lower Los Alamos Canyon by storm runoff and snowmelt (ESG 1983, 0621; Purtymun et al. 1990, 0215).

5. The most recent data available (for the year 1990) show no change in the trends discussed above. The ^{239,240}Pu concentration measured in sediment at Acid Weir in 1990 was 5.17 pCi/g, an order of magnitude higher than the ^{239,240}Pu concentrations measured for any of the samples collected in Pueblo Canyon, but lower than the levels recorded at Acid Weir for the two previous years, and well below the level of concern for ^{239,240}Pu (100 pCi/g).

Canyon sediment samples are not analyzed for chemical or metal content as part of the environmental surveillance program, and no data are available on concentrations of chemicals in sediment in Acid and Pueblo Canyons.

5.0 EXPLANATIONS OF PEAKS AND ANOMALIES IN THE DATA

The concentrations of ^{241}Am in sediment are anomalously high (between 1.28 and 2.51 pCi/g) at most sampling locations for the year 1987 (Figures C-5 through C-10), with the exception of the Pueblo 1 location, where the ^{241}Am concentration was conspicuously low (-1.83 pCi/g). As there is no explanation for such a significant and consistent rise in the ^{241}Am levels at all of these sampling locations that year, it is suspected that these values reflect an analytical error. Error is also indicated by the observation that the recorded 1987 ^{241}Am concentrations are one to two orders of magnitude greater than ^{239}Pu concentrations. It is highly unlikely that ^{241}Am levels would exceed ^{239}Pu levels, especially when that is not the case for any other year during the sampling period (IT Corporation 1992, 06-0066).

Another anomaly is the high gross-beta activity value (64 pCi/g) recorded at the Hamilton Bend location in 1981 (Figure C-14). This value is much higher than the gross-beta values at other stations and other years, and is not supported by the recorded concentrations of ^{90}Sr and ^{137}Cs, the most common beta emitters in the canyon. This value might be a statistical outlier (IT Corporation 1992, 06-0066).

Concentrations of ^{239,240}Pu in sediment are particularly high for the year 1982 at the Acid Weir and Pueblo 3 sampling locations. Although no radionuclide-contaminated effluent was released into Acid Canyon that year, there are several possible reasons for this plutonium concentration peak in 1982. In 1982, the area received high precipitation and runoff, which led to increased sediment transport in the canyons (ESG 1983, 0621; IT Corporation 1992, 06-0066). It is likely that some plutonium was transported along with this sediment. Also, the construction of a sanitary sewage line that year by the County of Los Alamos on the floor of Pueblo Canyon may have resulted in the movement of plutonium-contaminated soil and sediment into the stream channel. Finally, the FUSRAP cleanup effort conducted in 1982 at TA-45 and in Acid Canyon may have resulted in additional remobilization of plutonium down the canyon. Any combination of these three factors might have led to higher than usual plutonium values in the samples collected that year.

An additional study of radionuclide content in the sediments of Pueblo Canyon was conducted in 1982 (ESG 1983, 0621). In this study, sediment samples were collected from the trench that was dug in the canyon floor for installation of the sewage line. Samples were collected from three sites located between the Pueblo 1 and Pueblo 2 sampling locations indicated on Figure C-1. The average ^{239}Pu concentrations at these three sites were 0.47 pCi/g at Site 1; 6.5 pCi/g at Site 2; and 150 pCi/g at Site 3 (ESG 1983, 0621). The values of samples from Sites 1 and 2 are within the range of values from other sites sampled in Pueblo Canyon as part of the environmental surveillance program (Figures C-6 through C-10), but the ^{239}Pu concentrations determined for the samples from Site 3 are much higher. The maximum ^{239}Pu concentration determined for Site 3 samples was 615 pCi/g (ESG 1983, 0621).

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APPENDIX D

Field Investigation Approach and Methods

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List of Tables

1.0 GENERAL

This appendix has been prepared to describe the common elements that apply to the conduct of field investigations at all Operable Unit (OU) 1079 Solid Waste Management Units (SWMUs). The purpose of providing this information in a single discussion is to reduce the repetition in each sampling plan of details that are common in most of the plans.

Several general concepts apply to all of the field investigations presented in Chapters 5 through 8 of this work plan. They include the following

- potential radiological contamination is a common characteristic in many OU 1079 SWMUs;
- for most SWMUs, the release of any hazardous constituents would have been associated with the release of radioactive materials; and
- field surveys and field screening of samples can be used to identify gross contamination and assist in sample selection for laboratory analyses.

Field Operations. This discussion identifies several aspects of the Laboratory's implementation of the field sampling process that are not mentioned in the SWMU-specific field sampling plans. Standard activities that will be used to support the following field operations (see Section 2.0, Field Operations) include

- Laboratory-required preliminary activities and support procedures;
- identifying and documenting locations that have been sampled;
- sample handling and laboratory coordination procedures;
- equipment decontamination procedures; and
- management of wastes generated by sampling activities.

Investigation Methods. The primary focus of this appendix is on field investigation methods and it is tiered to the field sampling methods section of the Laboratory's Installation Work Plan (IWP), as presented in Section 3.5.3 of that document (LANL 1991, 0553). The methods presented here are specific examples of the options identified in the IWP. In addition, this appendix references the Laboratory's ER Program Standard Operating Procedures (SOPs) (LANL 1992, 0668). Each of the brief method descriptions given herein refer to the applicable SOPs for detailed methodology.

The methods described in this appendix include (see Sections 4.0-7.0)

- field survey methods to identify contaminants *in situ* (Level I);

- sampling methods;
- field sample screening methods to be used at the point of sample collection (Level I); and
- analytical laboratory methods (Level III).

The method descriptions are simple and brief and provide some information on the application of the method. Specific information such as sampling location or target depth of a borehole is provided by the individual field sampling plan. The method descriptions presented here are not intended to supplant or reduce the importance of the Quality Assurance Project Plan (Annex II) of this work plan and the governing SOPs (LANL 1992, 0668).

2.0 FIELD OPERATIONS

In this section, several aspects of field operations are described that will occur as a part of all field operations.

2.1 Health and Safety

Annex III of this work plan presents the Health and Safety Project Plan for all field activities within OU 1079. The plan gives SWMU-specific information regarding known or suspected contaminants and personnel protection required for different activities. Samples acquired as part of this work plan will be screened at the point of collection to identify the presence of gross contamination or conditions that may pose a threat to the health and safety of field personnel. The techniques listed in Section 6.0 of this appendix will be used.

2.2 Site Control

Access, staging, and sample storage areas will be designated by the Field Team Leader (FTL). In order to maintain sample integrity and sample documentation, all sampling sites will be included in one or several exclusion zones. Exclusion zones will be delineated by the FTL with the concurrence of the Site Safety Officer (SSO). The boundary of an exclusion zone will be defined based on the nature, magnitude, and extent of confirmed or possible contamination; the potential for contaminant migration; and hazards at the site, such as use of mechanical equipment; the presence of electrical lines or other utilities, structures, tanks, pits, or trenches; and the presence of steep banks or cliffs.

Boundaries of exclusion zones may be changed as operations progress. All changes will be designated by the FTL, with the concurrence of the SSO.

In order to assure sample integrity, to maintain control over sampling waste, and to avoid contamination of the site office, decontamination may be required for personnel, equipment, tools, and vehicles moving from one zone to another. Therefore, a contamination reduction zone (CRZ) will be established surrounding the exclusion zone(s). A contamination reduction corridor through the contamination reduction zones will be established, the size of which will depend on the number of stations required for decontamination activities. The corridor should be located in a direction that is generally upwind from the exclusion zone.

If required, decontamination stations will be set up to reduce contamination as personnel move toward the end of the contamination reduction corridor. The system will be set up to wash and rinse at least once all sample containers, waste containers, protective equipment worn, tools, and other equipment. A sequential doffing of protective equipment will be conducted, starting with the most heavily contaminated items at the first station and progressing to the least contaminated items at the final station. The stations will be far enough apart to minimize cross-contamination.

All decontamination materials must be stored in drums with proper labels and identifying information. Efforts will be made to keep the volume of decontamination materials to a minimum. Persons involved in performing the actual decontamination will generally be dressed in protective clothing one level below what the exclusion zone workers are required to wear. All personnel and equipment will be monitored for radioactive contamination prior to leaving an exclusion zone or central decontamination area.

Personnel entering an exclusion zone in which personnel decontamination is required must follow the specified decontamination procedures. Personnel who are not required to wear the maximum level of protective clothing may by-pass the decontamination stations for protective clothing they are not wearing.

2.3 Site Monitoring

Entry to, and egress from, sites will be controlled for monitoring purposes. All personnel entering the sites must use appropriate radiation monitoring badges. Locations for drinking water, rest room facilities, etc., will be identified prior to beginning on site activities. Protective clothing requirements will be determined by the SSO assigned to the project.

Field measurements for wind-borne contaminants shall be made and documented prior to, during, and after surface sampling activities. Qualified health and safety personnel (or designees) are responsible for this monitoring. Results of monitoring will be used to evaluate possible hazards existing at the site in order to evaluate current conditions and specify personal protective equipment. All personnel will visually monitor for extreme weather conditions, lightning, or other physical or environmental hazards which may develop. Personnel will notify the SSO when unanticipated physical or environmental hazards develop. Potential site hazards are discussed in detail in Annex III of this work plan.

2.4 Archaeological, Cultural, and Ecological Evaluations

Prior to initiation of field work and as part of the Laboratory's Environment, Safety, and Health (ES&H) Questionnaire process, archaeological and ecological evaluations will be performed in all areas where the surface is to be disturbed, vegetation removed, or invasive sampling performed. Depending on the results of the archaeological and ecological evaluations, a DOE environmental checklist for either categorical exclusion or an environmental assessment will be completed.

2.5 Support Services

Physical services support during the field investigation will be provided by Laboratory support groups ENG-3, ENG-5, Johnson Controls, or contractors. Existing job ticket procedures will be used. The services these groups will provide include, but are not limited to, back-hoe and front-end loader excavations, moving pallets of drummed auger cuttings and decontamination solutions, and setting up signs and other warning notices around the perimeter of the working area.

2.6 Excavation Permits

As part of the ES&H Questionnaire process, excavation permits are required by the Laboratory prior to any excavation, drilling, or other invasive activity. Acquisition of the permits will be coordinated with the Laboratory's Safety and Risk Assessment Group (HS-3) and Johnson Controls. Acquisition of excavation permits will be scheduled as appropriate for each phase of field work. All areas intended for excavation, drilling, or sampling deeper than 18 in. will be marked in the field for formal clearance prior to the work.

2.7 Sample Control and Documentation

Guidance for sample handling is provided in Section 3.5.5 and Annex IV of the IWP (LANL 1991, 0553). Sample packaging, handling, chain of custody, and documentation procedures are provided in the following ER Program SOPs (LANL 1992, 0668):

- LANL-ER-SOP-01.01, "General Instructions for Field Investigations,"
- LANL-ER-SOP-01.02, "Sample Containers and Preservation,"
- LANL-ER-SOP-01.03, "Handling, Packaging and Shipping of Samples," and
- LANL-ER-SOP-01.04, "Sample Control and Field Documentation."

2.8 Sample Coordination

A sample coordination facility has been established by the ER Program in the Laboratory's Environmental Chemistry Group (EM-9) to provide consistency for all investigations. The system is described in Section 3.5.5 and Appendix O of the IWP (LANL 1991, 0553). The applicable SOP is LANL-ER-SOP-01.04, "Sample Control and Field Documentation" (LANL 1992, 0668).

2.9 Quality Control Samples

Field quality control (QC) samples of several types are collected during the course of a field investigation. The definition for each kind of sample and the purpose it is intended to fulfill are given in Annex II of this work plan, the Quality Assurance Project Plan (QAPjP), and in LANL-ER-SOP-01.05, "Field Quality Control Samples" (LANL 1992, 0668). The frequency with which each type of field QA sample is to be collected is detailed in the sampling plans in Chapters 5 through 8 of this work plan.

2.10 Equipment Decontamination

Decontamination is performed as a quality assurance measure and a safety precaution. It prevents cross contamination among samples and helps maintain a clean working environment for the safety of personnel. Sampling tools are decontaminated by washing, rinsing, and drying. The effectiveness of the decontamination process is documented through rinsate blanks submitted for laboratory analysis. Steam cleaning is used for large machinery, vehicles, auger flights, and coring tools used in borehole sampling. Decontamination fluids, including steam cleaning fluids, are considered wastes and must be collected and contained for proper disposal.

2.11 Waste Management

This discussion is based on the guidance provided in Section 3.5.4 and Appendix B of the IWP (LANL 1991, 0553). Wastes produced during sampling activities may include borehole auger cuttings, excess sample, excavated soil from trenching, decontamination and steam-cleaning fluids, and disposable materials such as wipes, protective clothing, and sample bottles. In different areas of OU 1079, several of the following waste categories may be encountered: hazardous waste, low-level radioactive waste, transuranic waste, and mixed waste (either low-level or transuranic mixed waste). Requirements for segregating, containing, characterizing, treating, and disposing of each type and category of waste are provided in the applicable SOP, LANL-ER-SOP-01.06, "Management of RFI-Generated Waste" (LANL 1992, 0668).

3.0 STANDARD SCREENING METHODS

In all sampling plans of this RFI work plan, a table has been used to identify certain field operations as well as sample analytical requirements. Table D-1 is an example of screening and analytical requirements for a sampling plan at OU 1079.

3.1 Samples and Sampling Methods

The four columns on the left side of Table D-1 identify, by SWMU, the sampling or activity to be conducted; identify the sampling location; identify the depth interval (as appropriate); and provide space for recording the sample identification number. The sampling methods or activities identified in the first column are specifically defined below. Sampling methods are described in detail in Section 5.0 of this appendix.

3.2 Screening, Surveying, and Analysis Methods

Very precise language has been adopted in this work plan to refer to categories of measurements. "Screening", "surveying", and "analysis" are defined as follows:

1. **Field Surveys** (or "surveys"). Direct reading or recording instruments are used to scan the land surface to make measurements of *in situ* conditions. Typically, surveys provide Level I data. Gamma radioactivity is a common target of field surveys. Land surveys and borehole logging are included in this category.

2. **Field Screening** ("field sample screening" or "screening"). The process by which instruments or observations are applied to samples at the point of collection to measure the presence of contaminants or determine other properties of the sample. Screening usually provides Level I data. Alpha radioactivity and organic vapors are common targets of field screening. Lithological logging of core samples is included in this category.

3. **Laboratory Analysis** (or "analytical laboratory analyses"). This category represents the primary analysis for which samples are collected, preserved, and sealed. Level III or IV data are usually expected. Analyses are commonly provided by offsite analytical laboratories.

These categories of measurements are shown in Table D-1. For each category, several measurement techniques are identified by vertical columns. The individual measurement techniques represented by each vertical column are identified in the following sections of this appendix: Section 4.0, "Land Surveys"; Section 6.0, "Field Screening"; and Section 7.0, "Laboratory Analysis."

TABLE D-1 SCREENING AND ANALYSIS FOR TA--45 INVESTIGATION

Sample Type/Location	Sample Number	Sample Depth	Sample Identification	Field Screening						Laboratory Analysis										
				Gross Alpha	Gross Beta	Gross Gamma	Combustible Gas/oxygen	Organic Vapor	Lithological Logging	Gamma Spectrometry, ^{137}Cs	Tritium	Strontium-90	Isotopic Plutonium	Isotopic Uranium	TAL Metals	Semivolatiles (SW 8270)	Metals (SW 6010)	PCB (SW 8080)	VOA (SW 8240)	Explosives
SWMU 1-002 Untreated Outfall																				
Shallow Borehole	1–8	12–18 in.		X	X	X		X	X	X	X	X	X	X	X	X			•	
Near Surface Soil	9–20	15 cm		X	X	X		X		X	X	X	X	X	X	X			•	
Field Duplicate	21	12–18 in.		X	X	X		X	X	X	X	X	X	X	X	X			•	
Field Duplicate	22	15 cm		X	X	X		X		X	X	X	X	X	X	X			•	
Equipment Rinsate	23									X	X	X	X	X	X					
SWMU 45-001 Treatment Plant and Outfalls																				
Shallow Borehole	24-35	Variable	4 samples per borehole	X	X	X		X	X	X	X	X	X	X	X	X			•	
Cliff Face	36-40	0-6 in.	2 samples per site	X	X	X		X		X	X	X	X	X	X				•	
Near Surface Soil	41-46	15 cm		X	X	X		X		X	X	X	X	X	X				•	
Field Duplicate	47	Variable		X	X	X		X	X	X	X	X	X	X	X	X			•	
Field Duplicate	48	Variable		X	X	X		X	X	X	X	X	X	X	X	X			•	
Field Duplicate	49	12–18 in.		X	X	X		X		X	X	X	X	X	X				•	
Field Duplicate	50	15 cm		X	X	X		X		X	X	X	X	X	X				•	
Equipment Rinsate	51									X	X	X	X	X	X	X			•	
SWMU 45-002 Vehicle Decontamination Facility																				
Borehole at Soil/bedrock Interface	52-56	Variable		X	X	X		X	X	X	X	X	X	X	X	X			X	X
Field Duplicate	57			X	X	X		X		X	X	X	X	X	X	X			X	X
Equipment Rinsate	58									X	X	X	X	X	X	X			X	X

X Manditory analysis

• Analyze if positive organic vapor measurements in field screening

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TABLE D-1 SCREENING AND ANALYSIS FOR TA-45 INVESTIGATION (CONTINUED)

				Field Screening						Laboratory Analysis										
Sample Type/Location	Sample Number	Sample Depth	Sample Identification	Gross Alpha	Gross Beta	Gross Gamma	Combustible Gas/oxygen	Organic Vapor	Lithological Logging	Gamma Spectrometry, ^{137}Cs	Tritium	Strontium-90	Isotopic Plutonium	Isotopic Uranium	TAL Metals	Semivolatiles (SW 8270)	Metals (SW 6010)	PCB (SW 8080)	VOA (SW 8240)	Explosives
SWMU 45-003 Industrial Waste (Acid Waste) Lines																				
Borehole	59-62	Variable		X	X	X		X	X	X	X	X	X	X	X	X			●	
Field Duplicate	63			X	X	X		X		X	X	X	X	X	X	X			●	
SWMU 45-004 Sanitary Outfall																				
Shallow Borehole	64	12–18 in.		X	X	X		X	X	X	X	X	X	X	X	X			●	
Near Surface Soil	65-66	15 cm		X	X	X		X		X	X	X	X	X	X				●	

X Manditory analysis

● Analyze if positive organic vapor measurements in field screening

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3.2.1 Use of the Standard Screening and Analysis Table

The screening and analysis tables serve two major purposes. First, they clearly and concisely summarize the details of a sampling plan. They give locations; indicate sampling methods and intervals; identify the screening and analysis measurements for each sample detailed in Chapters 5 through 8 of this work plan; explicitly identify the collection and analysis of field quality assurance samples; and give a representation of certain options and uncertainties in the plan. Second, the table provides the detail needed to estimate the costs of the investigation.

4.0 FIELD SURVEYS

Field surveys were defined in Section 3.0 of this appendix. These are primarily walking scans of the land surface using direct reading or recording instruments. Field survey data such as radioactivity or organic vapor measurements are used to identify the presence of contaminants or structures in the field. While negative results from field surveys are not conclusive evidence of the absence of contaminants, positive results obtained at an early stage can allow timely redirecting of a sampling plan. For convenience, land surveys to identify and mark locations from old drawings are included here.

4.1 Radiological Surveys

4.1.1 Gross Gamma Survey

Several instruments are available that are suitable for these surveys: microR meters, Sodium-Iodide (NaI) detectors of various sizes with ratemeters or scalers, and Geiger-Muller detectors. The preferred instruments are microR meters with the ability to measure to 5 µR/hr, and 2-in. by 2-in. NaI detectors with a ratemeter capable of displaying 100 counts per minute (cpm). Some discrete-measurement or continuous-measurement recording instruments are also available using the same detectors. Surveys are conducted by carrying the instrument at waist height at a slow walking pace and observing and recording the ratemeter response. Measurements may also be made at the ground surface to aid in identifying the presence of localized contamination.

4.1.2 Low-Energy Gamma Survey

Two instruments are commonly used for these surveys, the FIDLER and the PHOSWICH. Both are optimized for the detection of low-energy photons, such as the 60 keV gamma emission from ^{241}Am or the x-rays that accompany the decay of most heavy radionuclides, such as uranium, thorium, plutonium, and other transuranic radionuclides. Either instrument may be used for this work plan. Discrete- or continuous-measurement recording options are available. Surveys are conducted by carrying the instrument close to the ground surface and observing the ratemeter or scaler. Measurements may also be made at the ground surface to aid in identifying the presence of localized contamination.

4.2 Organic Vapor Surveys

Organic vapor detectors will be used to monitor breathing zones for personnel safety in sample collection and handling areas at OU 1079 sites. Two types of detectors, photoionization detector (PID) and flame ionization detector (FID), will be used to survey a wide range of organic vapors as described below:

PID: A Model PI 101 PID, or its equivalent, will be used. It is a general survey instrument capable of detecting real-time concentrations of many complex organic compounds and some inorganic compounds in air. The instrument can be calibrated to a particular compound; however, it cannot distinguish between detectable compounds in a mixture of gases.

FID: A Foxboro Model OVA-128, or its equivalent, will be used. It is a flame ionization detector (FID), which can be used as a general screening instrument to detect the presence of many organic vapors. Its response to an unknown sample is relative to the response to a gas of known composition to which the instrument has been calibrated.

4.3 Land Surveys

Land surveys will be used for two purposes: first, to document all sampling locations, and second, to locate either former or buried structures where needed. In all cases, the documentation requirements for the surveys are the same: plus or minus 1 ft horizontal and plus or minus 0.1 ft vertical. The conventional survey procedures used are documented by Facilities Engineering personnel.

5.0 SAMPLING METHODS

5.1 Introduction

For the field sampling plans used in this work plan, a suite of specific sampling methods has been selected, and the details of their use and application in the field have been carefully defined. For example, a "surface soil sample" in this document is specifically defined as representing a 5 to 10 cm layer of soil collected by a hand scoop (see Subsection 5.2.1), and a "vertical borehole core sample" is specifically defined as a 5 ft core interval taken with a particular length and diameter split-barrel sampler (see Subsection 5.3.2).

Setting these common definitions and using them uniformly in all of the field sampling plans provides several benefits: consistency of field operations, comparability of sample analysis results from location to location in OU 1079, and the ability to have each sampling plan refer to a method definition in this chapter without reproducing the information in each plan. For each method identified below, the specifically defined portion is detailed. However, complete specification of the method requires additional information that is referenced to the applicable SOP or provided in the field sampling plan (e.g., nominal or target depth for a borehole).

5.2 Soil Sampling Methods

5.2.1 Surface Soil Sample

Surface soil samples are defined as samples taken from the upper 5 to 10 cm of soil. This type of soil sample will be gathered using a stainless steel or Teflon scoop. Care will be used to take the sample to a full 10 cm depth and to cut the sides of the hole vertically to ensure equal volumes of soil are taken over the full 10 cm depth. The applicable SOP is LANL-ER-SOP-06.09, "Spade and Scoop Method for Collection of Soil Samples" (LANL 1992, 0668).

5.2.2 Near-Surface Soil Sample

The spade and scoop method will be used to obtain near surface soil samples from depths to 30 in. Sample collection from depths greater than 30 in. can become labor-intensive. Collection of samples is accomplished with spades, shovels, and scoops. Spades and shovels are used to remove surficial material to the required depth. A stainless steel or Teflon scoop is then used to collect the sample. Care will be used to take the sample to a full 10 cm depth and to cut the sides of the hole vertically to ensure equal volumes of soil are taken over the full 10 cm. Unless otherwise specified, the sample interval will be 10 cm. Devices plated with chrome or other materials are not acceptable for sample collection. The applicable SOP is LANL-ER-SOP-06.09, "Spade and Scoop Method for Collection of Soil Samples" (LANL 1992, 0668).

5.2.3 Undisturbed Surface Soil Sample

Undisturbed soil samples will be gathered from the first 10 cm of soil using the ring sampler method. This method involves driving a 4 in.-diameter stainless steel tube (ring sampler) vertically into the area to be sampled. The soil around the ring sampler is then excavated so that the tube can be removed. An undisturbed core sample is obtained by pushing out the soil in the ring sampler. The applicable SOP is LANL-ER-SOP-06.11, "Stainless Steel Surface Soil Sampler" (LANL 1992, 0668).

5.2.4 Deposition-Layer Soil Sample

Deposition-layer soil samples are those samples collected from the first 1 in. of soil. The method is used to collect samples that represent wind- or air-deposited contaminants on the soil surface (i.e., contaminants dispersed and deposited from stack emissions). They will be collected using a stainless steel or Teflon trowel to scrape off the upper 1 in. of soil. The applicable SOP is LANL-ER-SOP-06.09, "Spade and Scoop Method for Collection of Soil Samples" (LANL 1992, 0668).

5.2.5 Manual Shallow Core Sample

Small volume soil samples can be recovered from depths approaching 10 ft with a hand auger or with a thin-wall tube sampler. The thin-wall tube sampler provides a less disturbed sample than that obtained with a hand auger. However, it may not be possible to force the thin-wall tube sampler through some soil or tuff, and sampling with the hand auger may be the more viable alternative. It is usually not practical to use a hand auger or thin-wall sampler at depths below 10 ft. The applicable SOP is LANL-ER-SOP-06.10, "Hand Auger and Thin-Wall Tube Sampler" (LANL 1992, 0668).

5.3 Borehole Core Sampling Methods

Split-barrel core sampling will be accomplished using an auger rig that drives hollow-stem augers. Soil samples will be collected using a 5 ft-long continuous, split-barrel sampler. Auger and split-barrel sampler diameters may vary depending on equipment availability. In each sampling plan, a nominal depth for each borehole is given. The borehole will be sampled until background concentrations are detected in two successive sample intervals, or to the maximum depth. Each sampling plan specifies an analytical plan for cores down to the nominal depth. The pattern set by the analytical plan will be followed for the complete depth of the borehole as determined by the stopping criterion just described.

5.3.1 Shallow Boreholes

A number of the sampling plans call for core samples to be collected from limited depths to investigate subsurface migration of contaminants where little potential for deep migration exists. This shallow borehole method is intended for boreholes of limited depth; 30 ft is a reasonable maximum. Because these boreholes are primarily used for areas where minimal penetration of contaminants into the soil is expected, a major feature of this method is the specification of a 2.5 ft core interval as a sample. For ease of setup and rapid drilling, the use of the light-weight drilling rig may be preferred for all shallow boreholes, regardless of site access. The stopping criterion described in Section 5.3 of this appendix will be used, and the applicable SOP is LANL-ER-SOP-04.01, "Drilling Methods and Drill Site Management" (LANL 1992, 0668).

5.3.2 Vertical Boreholes

This is the standard hollow-stem auger, split-barrel core sampling method. A 5-ft core interval is specified as the standard sample. Drilling equipment is specified in Section 5.3. The stopping criterion described in Section 5.3 of this appendix will also be used. The applicable SOP is LANL-ER-SOP-04.01, "Drilling Methods and Drill Site Management" (LANL 1992, 0668).

5.3.3 Angled Boreholes

Angle drilling is employed to access contaminant locations when placement of the rig directly over the point of interest is not feasible. As for vertical core sampling, a 5-ft core interval is specified as the standard sample. The auger rig used in this type of investigation should have mechanical specifications comparable to a Failing F-10 or CME-85, with angle drilling capability. In setting up for angle drilling, the drill rig will begin a borehole at a location specified in the sampling plan. The drilling angle and direction specified in the sampling plan will direct the auger string beneath the area to be investigated at the desired depth. The stopping criterion described in Section 5.3 of this appendix will be used. The applicable SOP is LANL-ER-SOP-04.01, "Drilling Methods and Drill Site Management" (LANL 1992, 0668).

5.3.4 Deep Core Sampling

For tuff coring deeper than 150-200 ft, a drilling rig is needed with capabilities greater than those used for the hollow-stem auger methods described above. Selection of rig and drilling method are matched to the goals of the investigation, according to the applicable SOP, LANL-ER-SOP-04.01, "Drilling Methods and Drill Site Management" (LANL 1992, 0668).

5.3.5 Rock Coring

Rock samples can be recovered from indurated rock formations with the use of a diamond-studded bit. In this method, the diamond bit cuts a small diameter core of rock 5 or 10 ft in length. As the rock is cut, it is pushed into an inner barrel of the drill string and retrieved by a wire-line apparatus. This method works best in rock that is hard, relatively free of bedding planes, lithology changes, and fractures. The applicable SOP is LANL-ER-SOP-04.01, "Drilling Methods and Drill Site Management" (LANL 1992, 0668).

5.4 Trenching

Trenching will be performed by a back-hoe or track-hoe capable of excavating to a depth of 15 ft. The bucket width and type will be determined by the equipment operator based on the structure to be exposed and the soil conditions. The trench must be wide enough for soil sampling and field surveys and screening to be safely performed. If the trenching is at a depth of 4 ft or greater, Occupation Safety and Health Administration (OSHA) standards for shoring and sloping will be followed [Code of Federal Regulations Title 29 (29 CFR) 1926.650)]. Each trench should be inspected by a competent engineer to ensure that there is no sign of potential cave-ins. The maximum depth of a trench will be 15 ft.

6.0 FIELD SCREENING

Field screening is defined in Section 3.0 of this appendix. Screening measurements are applied at the point of sample collection, in borehole headspace, and in excavations to identify gross contamination and to assess conditions affecting the health or safety of field personnel. Application of screening for personnel health and safety is detailed in Annex III of this work plan, the Health and Safety Project Plan. Individual sampling plans may not explicitly identify the use or role of sample screening measurements; however, the standard analytical table for each investigation will show the methods to be used.

In addition to the role of sample screening in monitoring for gross contamination or situations of concern for health and safety, certain sampling plans use the sample screening information explicitly as Level I data for making decisions on further sampling or for selecting sample analysis options.

6.1 Radiological Screening

6.1.1 Gross-Gamma Radiological Screening

Field screening of samples for gross-gamma radioactivity will be done using a hand-held NaI detector probe and ratemeter. The detector is held close to the sample or core and is capable of identifying elevated concentrations of certain radionuclides as an increased ratemeter reading above instrument background levels. Quantification of the response is difficult and is best interpreted as a gross indicator of potential contamination.

6.1.2 Gross-Alpha Radiological Screening

Field screening of samples for gross-alpha radioactivity is conducted using a hand-held alpha scintillation detector and a ratemeter. The detector is held close to contact with the sample or core and is capable of detecting on the order of approximately 100-200 pCi/g for a damp soil sample. The instrument cannot identify specific radionuclides.

6.1.3 Gross-Beta Radiological Screening

Field screening of samples for gross-beta radioactivity is conducted using a hand-held detector. A typical beta detector consists of a Geiger-Mueller tube with a thin mica window protected by a sturdy wire screen. The mica window thickness may vary from 1.4 to 2 mg/cm^2. The detector is held close to contact with the sample or core and is capable of detecting gross-beta activity down to 40 keV. The gamma sensitivity of such a detector is approximately 3,600 cpm/mR/h. The beta efficiency with screen in place is 45% ^{90}Sr and 10% ^{14}C. Screen removal will increase efficiency by 45%. The efficiencies are determined as percentage of 2π emission rate, from a 1 in. diameter source. This beta detector is alpha sensitive above 3 MeV.

6.2 Nonradioactive Screening

6.2.1 Organic Vapor Detectors

Organic vapor detectors will be used to screen borehole cores and soil samples at the point of collection to identify grossly contaminated samples. Two types of detectors, photoionization detector (PID) and flame ionization detector (FID), will be used to improve the probability of detecting a wide range of vapors and are described in Section 4.2 of this appendix.

6.2.2 Lithological Logging

Lithological logging of drill core will be performed to describe the physical nature of borehole cores. Lithological logging will be performed by a geologist capable of describing subsurface lithologies and differentiating the various strata of the Bandelier Tuff.

7.0 LABORATORY ANALYSIS

Section 3.0 of this appendix provides the definition of laboratory analysis as used in this work plan. Level III is intended to be the highest quality level of data acquired. As described in Section 2.0 of this appendix, samples to be submitted to an analytical laboratory will be coordinated, handled, and tracked by the ER Program Sample Coordination Facility.

The following list provides references for methods and analytical levels for the parameters which appear in the screening and analysis tables.

> **Gamma Spectroscopy**. Quantification of radionuclides by measurement of photon emissions. Quantitation limits are given in LANL-ER-QAPjP, Table V.8 (LANL 1991, 0412).

Explosives (USATHAMA). U.S. Army Toxic and Hazardous Materials Agency standard method for explosive analysis. The standard list of analytes and quantitation limits is given in LANL-ER-QAPjP, Table V.10 (LANL 1991, 0412).

Volatile Organic Compounds (SW-846 Method 8240). EPA standard method for quantification of volatile organic compounds. The standard list of analytes and quantitation limits is given in LANL-ER-QAPjP, Table V.3 (LANL 1991, 0412).

Semivolatile Organic Compounds (SW-846 Method 8270). EPA standard method for quantification of semivolatile organic compounds. The standard list of analytes and quantitation limits is given in LANL-ER-QAPjP, Table V.4 (LANL 1991, 0412).

Strontium-90. Radiochemical separation using multiple selective precipitation and counting of beta activity by gas proportional detectors. Quantitation limits are given in LANL-ER-QAPjP, Table V.8 (LANL 1991, 0412).

Carbon-14. Combustion of sample and counting of beta activity by gas proportional detectors (LANL 1991, 0412).

Americium-241. Radiochemical separation followed by alpha spectrometry. Quantitation limits are given in LANL-ER-QAPjP, Table V.8 (LANL 1991, 0412).

Isotopic Plutonium. Radiochemical separation of plutonium from soil is followed by alpha spectrometry to quantify each isotope of plutonium. Quantitation limits are given in LANL-ER-QAPjP, Table V.8 (LANL 1991, 0412).

Isotopic Uranium. Radiochemical separation of uranium from soil is followed by alpha spectrometry to quantify each isotope of uranium. Quantitation limits are given in LANL-ER-QAPjP, Table V.8 (LANL 1991, 0412).

Tritium. Measurement of tritium in soil moisture. Soil moisture is distilled from soil, and the low energy beta emission from tritium is measured by liquid scintillation techniques. Quantitation limits are given in LANL-ER-QAPjP, Table V.8 (LANL 1991, 0412).

Cesium-137. Quantification of Cesium-137 by gamma spectrometry. Quantitation limits are given in LANL-ER-QAPjP, Table V.8 (LANL 1991, 0412).

Lead, beryllium, barium, and cadmium. EPA standard method for quantification of metals, SW-846, Method 6010. Quantitation limits are given in LANL-ER-QAPjP, Table V.7 (LANL 1991, 0412).

Target Analyte List (TAL) Metals. Quantification of metals defined in EPA Standard Methods SW-846 Method 6010, SW-846 Method 7740, SW-846 Method 7470, and SW-846 Method 7060. The standard list of analytes and quantitation limits for SW-846 Method 6010 is given in LANL-ER-QAPjP, Table V.7 (LANL 1991, 0412). Method 7740 analyzes for selenium by atomic absorption furnace techniques, Method 7470 analyzes for mercury in liquid waste by manual cold-vapor technique, and Method 7060 analyzes for arsenic by atomic absorption furnace technique.

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APPENDIX E

Work Plan Contributors

I. Administrative Management

Name and Affiliation	Education/Expertise	Program Assignment
Bob Vocke, EM-13	Ph.D. Water Resources 15 years experience in hazardous waste site assessment, including waste management, regulatory compliance, and program management.	Program Manager, Group Leader
Paul Aamodt, HSE-13	B.S. Geology 22 years experience in geosciences, including site characterization, radioactive and hazardous waste management and disposal, and project management.	Senior Programmatic Project Leader
Sandra Wagner, EM-13	M.S. Organic/Analytical Chemistry 11 years experience in implementing and managing assessment and remediation activities for hazardous waste sites.	Operable Unit Project Leader
Devon Jercinovic, IT Corporation	M.S. Geology 10 years experience performing assessment and restoration at hazardous and mixed waste sites.	Assistant Operable Unit Project Leader

II. Technical Contributors

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Kathryn Bennett, EM-8	M.S. Environmental Sciences 2 years experience in field biology and ecology. Studies include threatened and endangered species assessments and wetland studies. 3 years experience in water quality and toxics studies.	Chapter 3, Biological Assessment
James Briggs, Contractor, EM-8	M.S. Wildlife Biology 5 years experience in wildlife biology and ecology. Experience in biological surveys and preparation of biological assessments.	Chapter 3, Biological Assessment
Robert Charles, INC-7	Ph.D. Geochemistry 25 years experience in geochemistry, geology, mineralogy, and isotopic studies.	Chapters 5 to 8, Sampling and Analysis Plans
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Elizabeth J. Kelly, A-1	Ph.D. Statistics 25 years experience as a consulting statistician and operations research analyst, including modeling complex physical and biological systems and performing probability risk assessments for nuclear power plants. Research in model-based sampling designs and ecological modeling. 3 years experience using DQOs and decision analysis tools to develop efficient sampling and analysis designs for the Environmental Restoration program at Los Alamos. Project Leader for Environmental Systems Analysis in A-Division (Technical Team Leader for Decision Analysis and DQOs and Statistics for ER Program.	Chapter 2, Technical Approach; Chapters 5 to 8, Sampling and Analysis Plans; Appendix B

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