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RFI Work Plan for Operable Unit 1111

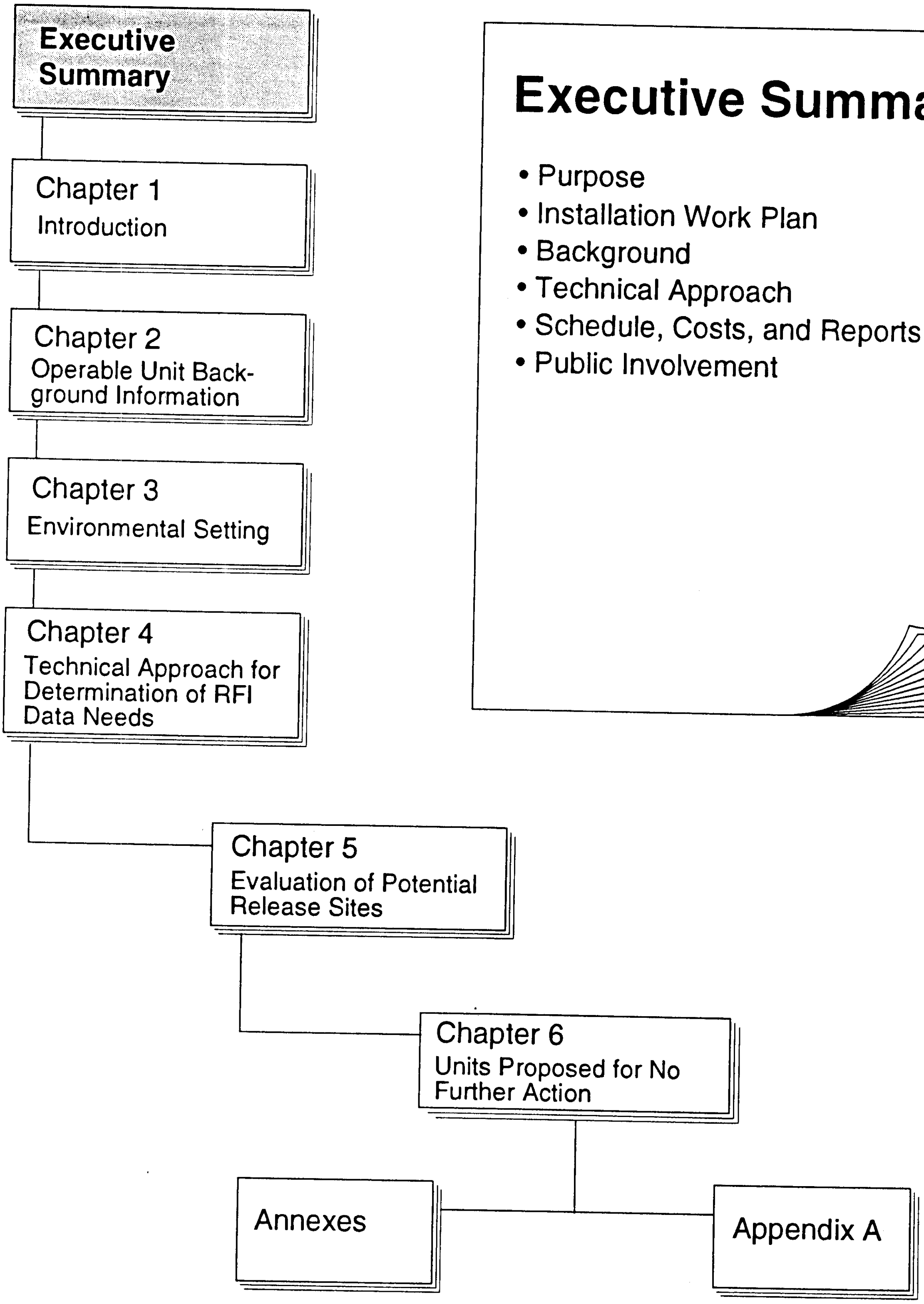
Environmental Restoration Program

August 1993

A Department of Energy
Environmental Cleanup Program

Los Alamos
NATIONAL LABORATORY

LA-UR-93-2166



Executive Summary

- Purpose
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- Background
- Technical Approach
- Schedule, Costs, and Reports
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EXECUTIVE SUMMARY

Purpose

The primary purpose of this Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) is to determine the nature and extent of releases of contaminants from potential release sites (PRSs) in Operable Unit (OU) 1111. From this investigation, the need for corrective measures studies (CMSs) can be determined. This work plan describes the Phase I sampling plans that will be followed to implement the RFI at OU 1111. Results from these Phase I sampling plans will be used to decide whether no further action is justified or a Phase II investigation is needed.

The work plan also satisfies part of the regulatory requirements contained in Los Alamos National Laboratory's (the Laboratory's) permit to operate under RCRA. Module VIII of the permit, known as the Hazardous and Solid Waste Amendments (HSWA) Module, was issued by the Environmental Protection Agency (EPA) to address potential corrective action requirements for solid waste management units (SWMUs). These permit requirements are addressed by the Department of Energy's (DOE's) Environmental Restoration (ER) Program at the Laboratory. This work plan will be submitted, along with nine other work plans, to the EPA in 1993.

Installation Work Plan

The HSWA Module requires the Laboratory to prepare an installation work plan (IWP) to describe the Laboratory-wide system for accomplishing RFIs and CMSs. The IWP is updated annually; the most recent revision was published in November 1992. It identifies the Laboratory's PRSs, describes their aggregation into 24 OUs, and presents the Laboratory's overall management plan and technical approach for meeting the requirements of the HSWA Module. When information relevant to this work plan is already provided in the IWP, the reader is referred to the 1992 version.

Background

OU 1111 includes Technical Areas (TAs) 6, 7, 22, 40, 58, and 62. These TAs are located in Los Alamos County on land owned by the DOE. Within these TAs are 89 PRSs. Sites that potentially contain only non-RCRA materials are called areas of concern (AOCs). Sites that have managed solid waste are called SWMUs. The term PRS is the generic name for both SWMUs and AOCs.

PRSs in OU 1111 include Materials Disposal Area F, outfalls, sump systems, active and inactive firing sites, surface disposal sites, sites that formerly were used for container storage, and the sites of buildings and other structures that were removed prior to 1980. A few of the PRSs have been investigated for the presence of contaminants, but most have never been sampled.

Technical Approach

The work plan includes sites that are not identified in the HSWA Module and are outside the regulatory scope of the permit. These units are included to ensure that all potential environmental problems at each OU are investigated and to present to the public and the regulators a unified plan that addresses all potential environmental problems on site. Inclusion of these sites in the work plan does not confer additional regulatory responsibility or authority for these sites to the regulators and does not bind the Laboratory to additional commitments outside the scope of the permit. The Laboratory will consider all comments received on this work plan.

A phased approach to the RFI is used to ensure that any environmental impacts from past and present activities are investigated in a manner that is cost-effective and complies with the HSWA Module. This phased approach also permits intermediate data evaluation and opportunities for additional sampling, if required. This document presents a Phase I work plan.

This work plan presents a description and an operating history of each PRS and an evaluation of historical evidence and existing data. A preliminary conceptual model and the recommended Phase I action for each PRS are based on this evaluation. For some PRSs, no further action is proposed. For some of the active PRSs (storage areas), this evaluation has determined that investigation and remediation, if required, may be deferred until the PRS is decommissioned. RFI field work, which may include field surveys, field screening, and sampling, and/or voluntary actions are proposed for the remaining PRSs. Phase I field sampling for these PRSs is designed to test the hypothesis that concentrations of contaminants are below conservatively estimated risk-based screening action levels. If evidence is found to disprove this hypothesis for a PRS, a Phase II investigation will refine the conceptual exposure model for a baseline risk assessment and evaluate remedial alternatives.

Data quality objectives were developed for Phase I sampling and analysis plans to ensure that the right type, amount, and quality of data are collected. Samples will be analyzed in field and analytical laboratories.

Schedule, Costs, and Reports

The RFI field work described in this document requires 4 years (Figure ES-1) to complete. A single phase of field work is expected to complete the RFI for most PRSs; however, a second phase will occur if warranted by the results of the first phase.

Cost estimates for baseline activities for OU 1111 are provided in Table ES-1. The estimated cost for implementing the RFI and reporting is $12.9 million. The estimated cost for implementing corrective measures and reporting is $8.6 million. The total estimated cost for the corrective action process is approximately $23.7 million.

The HSWA Module requires the submittal of quarterly technical progress reports. In addition, RFI phase reports will be submitted at the completion of each of the sampling phases. The phase reports will

- summarize the results of initial site characterization activities;
- propose modifications to the sampling plans, as suggested by the initial findings;
- describe the next phase of sampling, when such sampling is required;
- recommend voluntary corrective action or no further action, as warranted by findings; and
- summarize the sampling plans.

At the conclusion of the RFI, a final report will be submitted to the EPA.

Public Involvement

The HSWA Module requires public involvement in the corrective action process. The Laboratory holds regular public meetings to disseminate information, discuss significant milestones, and solicit informal public review of all draft work plans. It also prepares fact sheets, which summarize completed and future activities, and provides public access to plans, reports, and other ER Program documents.

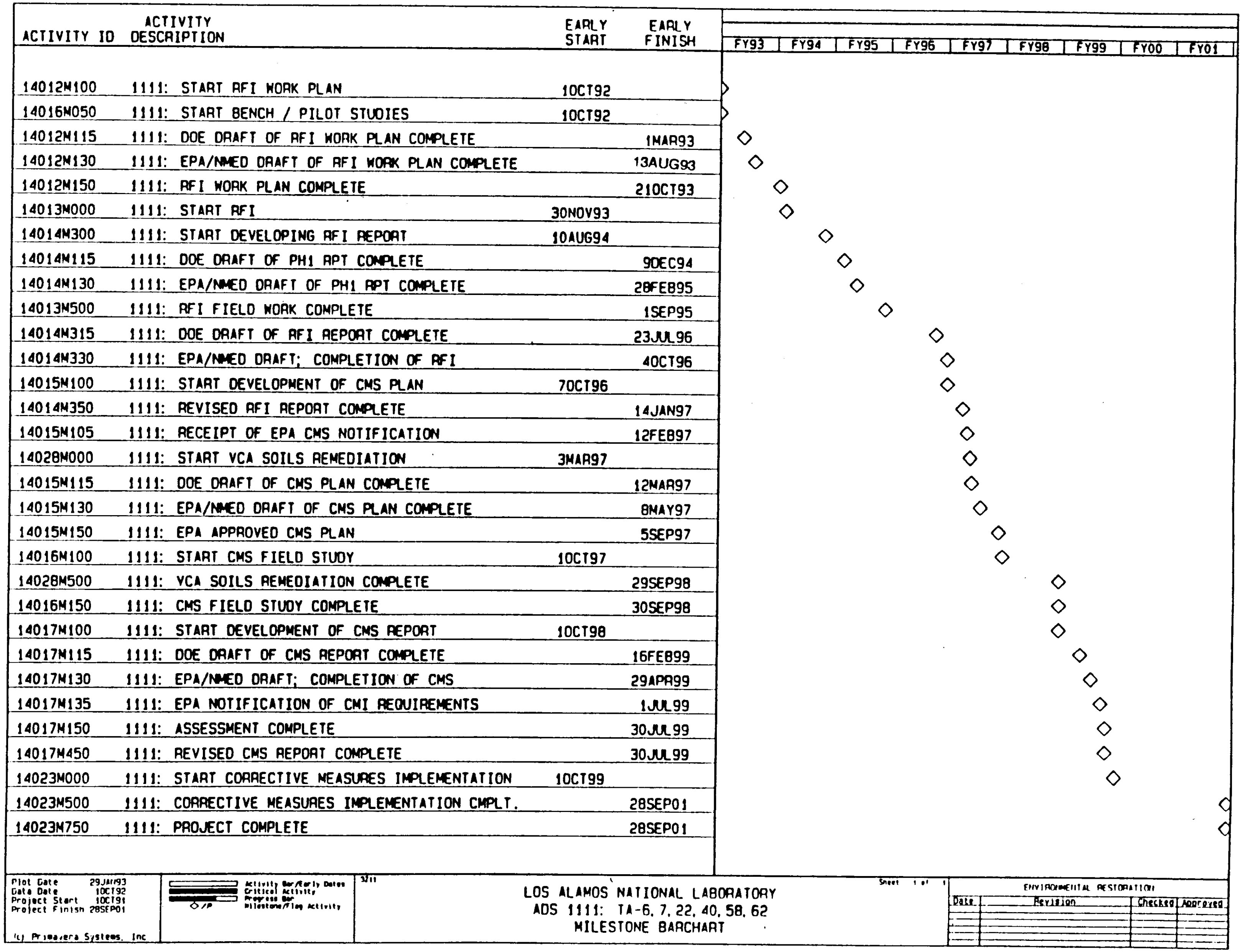
TABLE ES-1

ESTIMATED COSTS OF BASELINE ACTIVITIES AT OU 1111

Task	Budget	Scheduled Start	Scheduled Finish
RFI Work Plan	$1,167,366	October 1, 1992	August 13, 1993
RFI	9,845,386	November 30, 1993	October 4, 1996
RFI Report	1,902,108	August 10, 1994	July 23, 1996
CMS Plan	853,176	October 7, 1996	May 8, 1997
CMS	4,258,037	October 1, 1997	April 29, 1999
CMS Report	586,118	October 1, 1998	February 16, 1999
Corrective Measures Implementation	2,918,520	October 1, 1999	September 28, 2001
ADS* Management	1,139,534	Continuing	Continuing
Voluntary Corrective Action	1,056,851	March 3, 1997	September 29, 1998
Report Total	$23,727,096		

*Activity data sheet

These materials are available for public review between 9:00 a.m. and 4:00 p.m. on Laboratory business days at the ER Program's public reading room at 15th and Central in Los Alamos and at the main branches of the public libraries in Española, Los Alamos, and Santa Fe.



ACTIVITY ID	ACTIVITY DESCRIPTION	EARLY START	EARLY FINISH
14012M100	1111: START RFI WORK PLAN	1OCT92	
14016M050	1111: START BENCH / PILOT STUDIES	1OCT92	
14012M115	1111: DOE DRAFT OF RFI WORK PLAN COMPLETE		1MAR93
14012M130	1111: EPA/NMED DRAFT OF RFI WORK PLAN COMPLETE		13AUG93
14012M150	1111: RFI WORK PLAN COMPLETE		21OCT93
14013M000	1111: START RFI	30NOV93	
14014M300	1111: START DEVELOPING RFI REPORT	10AUG94	
14014M115	1111: DOE DRAFT OF PH1 RPT COMPLETE		9DEC94
14014M130	1111: EPA/NMED DRAFT OF PH1 RPT COMPLETE		28FEB95
14013M500	1111: RFI FIELD WORK COMPLETE		1SEP95
14014M315	1111: DOE DRAFT OF RFI REPORT COMPLETE		23JUL96
14014M330	1111: EPA/NMED DRAFT; COMPLETION OF RFI		4OCT96
14015M100	1111: START DEVELOPMENT OF CMS PLAN	7OCT96	
14014M350	1111: REVISED RFI REPORT COMPLETE		14JAN97
14015M105	1111: RECEIPT OF EPA CMS NOTIFICATION		12FEB97
14028M000	1111: START VCA SOILS REMEDIATION	3MAR97	
14015M115	1111: DOE DRAFT OF CMS PLAN COMPLETE		12MAR97
14015M130	1111: EPA/NMED DRAFT OF CMS PLAN COMPLETE		8MAY97
14015M150	1111: EPA APPROVED CMS PLAN		5SEP97
14016M100	1111: START CMS FIELD STUDY	1OCT97	
14028M500	1111: VCA SOILS REMEDIATION COMPLETE		29SEP98
14016M150	1111: CMS FIELD STUDY COMPLETE		30SEP98
14017M100	1111: START DEVELOPMENT OF CMS REPORT	1OCT98	
14017M115	1111: DOE DRAFT OF CMS REPORT COMPLETE		16FEB99
14017M130	1111: EPA/NMED DRAFT; COMPLETION OF CMS		29APR99
14017M135	1111: EPA NOTIFICATION OF CMI REQUIREMENTS		1JUL99
14017M150	1111: ASSESSMENT COMPLETE		30JUL99
14017M450	1111: REVISED CMS REPORT COMPLETE		30JUL99
14023M000	1111: START CORRECTIVE MEASURES IMPLEMENTATION	1OCT99	
14023M500	1111: CORRECTIVE MEASURES IMPLEMENTATION CMPLT.		28SEP01
14023M750	1111: PROJECT COMPLETE		28SEP01

Plot Date 29JAN93
Data Date 1OCT92
Project Start 1OCT91
Project Finish 28SEP01

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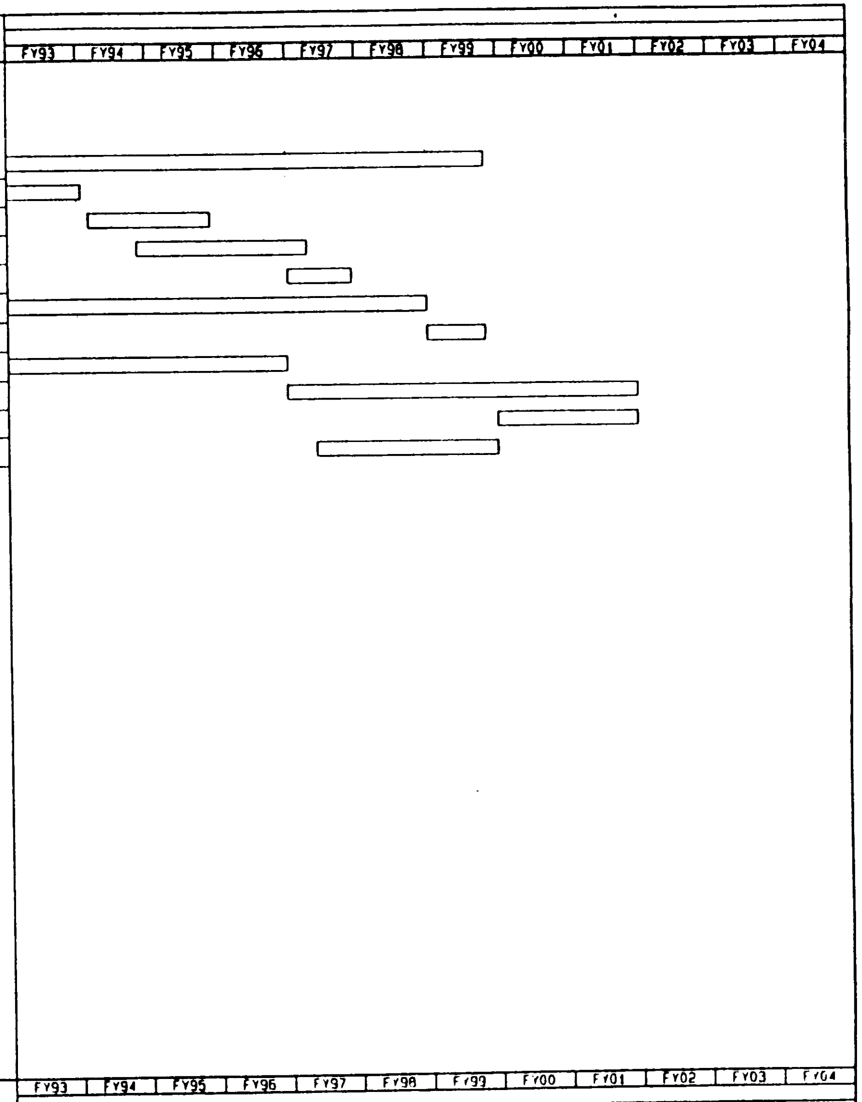
ADS 1111: TA-6, 7, 22, 40, 58, 62
MILESTONE BARCHART

ENVIRONMENTAL RESTORATION

Date	Revision	Checked	Approved

Figure ES-1. RFI/CMS milestone chart for OU 1111.

CODE VALUE	WBS1/WBS2/WBS3/WBS4/WBS5	ORIG DUR	EARLY START	EARLY FINISH
6114011	1111: ADS MANAGEMENT ASSESSMENT	1699	1OCT92	30JUL99
6114012	1111: RFI WORK PLAN	263	1OCT92	21OCT93
6114013	1111: RFI FIELD WORK	440	30NOV93	1SEP95
6114014	1111: RFI REPORT	602	10AUG94	14JAN97
6114015	1111: CMS PLAN	228	7OCT96	5SEP97
6114016	1111: BENCH/PILOT STUDIES AND CMS FIELD STUDY	1493	1OCT92	30SEP98
6114017	1111: CMS REPORT	206	1OCT98	30JUL99
6114018	1111: VOLUNTARY CORRECTIVE ACTION ASSESSMENT	995	1OCT92	30SEP96
6114021	1111: ADS MANAGEMENT REMEDIATION	1244	1OCT96	28SEP01
6114023	1111: CORRECTIVE MEASURES IMPLEMENTATION (CMI)	497	1OCT99	28SEP01
6114028	1111: VOLUNTARY CORRECTIVE ACTION REMEDIATION	449	3MAR97	29SEP99



Plot Date 29JAN93
Data Date 1OCT92
Project Start 1OCT91
Project Finish 28SEP01

▭	Summary Bar/Early Dates
▭	Critical Designator
▬	Progress Bar
◇ /⚑	Milestone/Flag Activity

Sheet 1 of 1

LOS ALAMOS NATIONAL LABORATORY
ADS 1111: TA-6, 7, 22, 40, 58, 62
FY93 BASELINE MOD: SUMMARY BARCHART

ENVIRONMENTAL RESTORATION

Date	Revision	Checked	Approved

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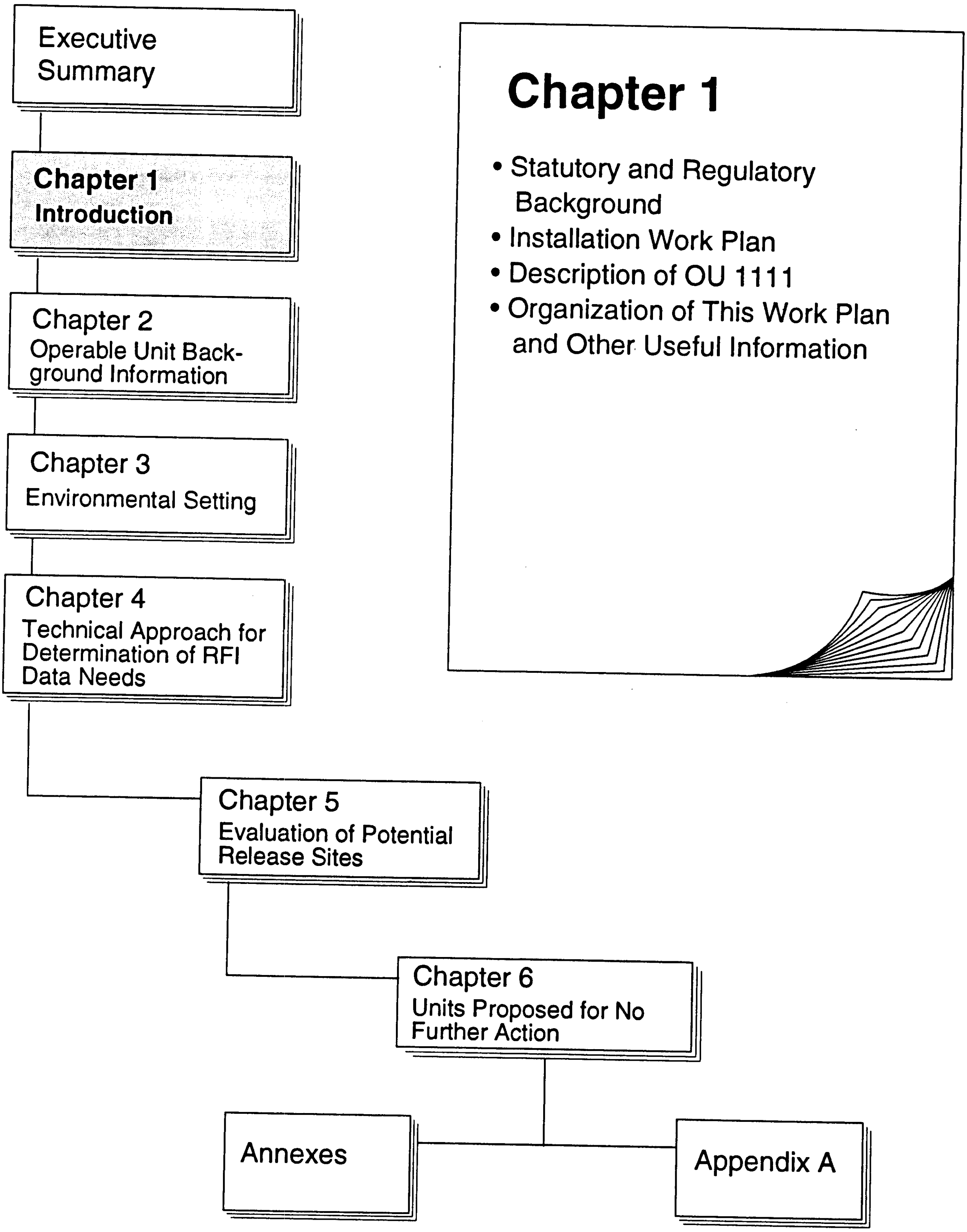
ACRONYMS AND ABBREVIATIONS

AA	Atomic absorption
ACGIH	American Conference of Governmental Industrial Hygienists
ADS	Activity data sheet
ALARA	As low as reasonably achievable
AOC	Area of concern
AR	Administrative requirement
CEARP	Comprehensive Environmental Assessment and Response Program
CFR	Code of Federal Regulations
CMI	Corrective measures implementation
CMS	Corrective measures study
DAC	Derived air concentration
DF	Detonator firing
DOE	US Department of Energy
DQO	Data quality objective
EM	Environmental Management (Division)
EPA	US Environmental Protection Agency
ER	Environmental restoration
ERPG	Emergency response planning guideline
ES&H	Environment, safety, and health
FID	Flame ionization detector
FIDLER	Field instrument for detection of low-energy radiation
GC	Gas chromatograph, Garratt-Callahan
GET	General employee training
GFF	Glass fiber filter
HAZWOP	Hazardous Waste Operations Program
HSE	Health, Safety, and Environment (Division; now EM and HS divisions)
HMX	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
HNS	2,2',4,4',6,6' hexanitro stilbene
HSPL	Health & Safety Project Leader
HSWA	Hazardous and Solid Waste Amendments
ICP	Inductively coupled plasma
IDLH	Immediately dangerous to life and health
IWP	Installation work plan
LANL	Los Alamos National Laboratory
LASL	Los Alamos Scientific Laboratory (LANL before January 1, 1981)
MCEF	Mixed cellulose ester filter
MDA	Material disposal area
NFA	No further action
NIOSH	National Institute of Occupational Health and Safety
NPDES	National pollutant discharge elimination system
OSHA	Occupational Safety and Health Administration
OU	Operable unit
OUPL	Operable unit project leader (ER Program)
PCB	Polychlorinated biphenyl
PEL	Permissible exposure limit
PETN	Pentaerythritol tetranitrate
PID	Photoionization detector
PPE	Personal protective equipment
PRS	Potential release site
PTFE	Polytetrafluoroethylene
QA	Quality assurance

QAPjP	Quality assurance project plan
RCRA	Resource Conservation and Recovery Act
RDX	Hexahydro-1,3,4-trinitro-1,3,5-triazine
RFI	RCRA facility investigation
SAL	Screening action level
SARA	Superfund Amendments and Reauthorization Act
SCBA	Self-contained breathing apparatus
SOP	Standard operating procedure
SSO	Site safety officer
STEL	Short-term exposure limit
SWCS	Sanitary wastewater consolidation system
SWMU	Solid waste management unit
TA	Technical area
TATB	1,3,5 triamino-2,4,6 trinitrobenzene
TD	Trap door
TLD	Thermoluninescent dosimeter
TLV	Threshold limit value
TNT	Trinitrotoluene
TSD	Treatment, storage, disposal
TWA	Time-weighted average
UL	Underwriters Laboratory
VCA	Voluntary corrective action
VOC	Volatile organic compound
XRF	X-ray fluorescence



Chapter 1

- Statutory and Regulatory Background
- Installation Work Plan
- Description of OU 1111
- Organization of This Work Plan and Other Useful Information

1.0 INTRODUCTION

1.1 Statutory and Regulatory Background

The Resource Conservation and Recovery Act (RCRA), enacted by Congress in 1976, governs the operations of hazardous waste treatment, storage, and disposal (TSD) facilities. Section 3004(u), which mandates a cleanup program, and Section (v) of RCRA established a permitting system and set standards for all hazardous-waste-producing operations at a TSD facility. The Laboratory was a TSD by definition when RCRA was activated in 1980. To continue operating in compliance with RCRA, the Laboratory had to submit permit applications to treat, store, and dispose of hazardous waste on site. As part of the permitting process after 1984, the Hazardous and Solid Waste Amendments (HSWA) required that corrective action be included in the permitting process. The Laboratory was issued a RCRA Part B permit by the New Mexico Environmental Department in November 1989 (NMEID 1989, 0595). This permit addresses hazardous waste management units that are currently operational. In May 1990, EPA issued the portion of the permit that addresses corrective action. This portion of the permit is known as Module VIII or the HSWA module. HSWA Module requirements are addressed by the Department of Energy's (DOE's) Environmental Restoration (ER) Program at the Laboratory.

Table A of the HSWA Module identifies 608 solid waste management units (SWMUs) at the Laboratory, and Table B lists those SWMUs that must be investigated first. A SWMU is any discernible unit at which solid wastes have been placed at any time in a routine and systematic way, irrespective of whether the unit was intended for the management of solid or hazardous waste (EPA 1990, 0306). The Laboratory has identified areas of concern (AOCs), which do not meet the HSWA Module's definition of a SWMU. These sites may contain radioactive materials and hazardous substances not regulated under RCRA. SWMUs and AOCs are collectively referred to as potential release sites (PRSs). The primary purpose of the RCRA facility investigation (RFI) is to determine the nature and extent of releases of contaminants from the PRSs.

The Laboratory has aggregated geographically related PRSs in groupings called operable units (OUs). There are 24 OUs; an RFI work plan is prepared for each OU. This work plan for OU 1111 addresses PRSs located in Technical Areas (TAs) 6, 7, 22, and 40. No PRSs are located in TAs 59 and 62. The work plan meets the requirements of the HSWA Module and is also consistent with the scope of the Comprehensive Environmental Response, Compensation, and Liability Act. The HSWA Module requires that the priority SWMUs in Table B be addressed by work plans submitted by August 1993 and the SWMUs listed in Table A be addressed by May 1994. This work plan, together with nine other plans submitted to EPA in 1993 and nine plans submitted in 1991 and 1992, meets the schedule requirements of the HSWA Module.

Table 1-1 indicates the location of HSWA Module requirements in ER Program documents.

TABLE 1-1

LOCATION OF HSWA MODULE REQUIREMENTS IN ER PROGRAM DOCUMENTS

HSWA Module Requirements for RFI Work Plans	Installation Work Plan and Other Program Documents	Documents for OU 1111
Task I: Description of Current Conditions		
A. Facility Background	IWP Section 2.1	RFI Work Plan Chapter 2
B. Nature and Extent of Contamination	IWP Section 2.4 and Appendix F	RFI Work Plan Chapter 5
Task II: RFI Work Plan		
A. Data Collection Quality Assurance Plan	IWP Annex II (Quality Program Plan)*	RFI Work Plan Annex II
B. Data Management Plan	IWP Annex IV (Records Management Program Plan)	RFI Work Plan Annex IV
C. Health and Safety Plan	IWP Annex III (Health and Safety Program Plan)	RFI Work Plan Annex III
D. Community Relations Plan	IWP Annex V (Community Relations Program Plan)	RFI Work Plan Annex V
E. Project Management Plan	IWP Annex I (Program Management Plan)	RFI Work Plan Annex I
Task III: Facility Investigation		
A. Environmental Setting	IWP Chapter 2	RFI Work Plan Chapter 3
B. Source Characterization	IWP Appendix F	RFI Work Plan Chapter 5
C. Contamination Characterization	IWP Appendix F	RFI Work Plan Chapters 4 and 5
D. Potential Receptor Identification	IWP Section 4.2	RFI Work Plan Chapters 4 and 5
Task IV: Investigative Analysis		
A. Data Analysis	IWP Section 4.2	Phase report and RFI report
B. Protection Standards	IWP Section 4.2	RFI report
Task V: Reports		
A. Preliminary and Work Plan	IWP, Rev. 0	Work plan
B. Progress	Monthly reports, quarterly reports, and annual revisions of IWP	Phase reports
C. Draft and Final		Draft and final RFI report

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*Annex II of the IWP addresses these requirements by reference to controlled documents: the Generic Quality Assurance Project Plan (LANL 1991 0843) and the ER Program's standard operating procedures (LANL 1991, 0411).

1.2 Installation Work Plan

According to HSWA Module requirements, the Laboratory has prepared the installation work plan (IWP) to describe the Laboratory-wide system for accomplishing RFIs and corrective measures studies. The IWP is also consistent with EPA's interim final RFI guidance (EPA 1989, 0088) and proposed Subpart S of 40 CFR 264 (EPA 1990, 0432), which will implement the cleanup program. The IWP was first prepared in 1990 and is updated annually. This work plan follows the requirements specified in Revision 2 of the IWP (LANL 1992, 0768).

The IWP presents a facilities description in Chapter 2 and a description of the structure of the Laboratory's ER Program in Chapter 3. Chapter 4 describes the technical approach to corrective action at the Laboratory. Annexes I—V contain the Program Management Plan, Quality Program Plan, Health and Safety Program Plan, Records Management Program Plan, and the Public Involvement Program Plan, respectively. The document also contains a proposal to integrate RCRA closure and corrective action and a strategy for identifying and implementing interim remedial measures. When information relevant to this work plan has already been provided in the IWP, the reader is referred to the 1992 revision.

1.3 Description of OU 1111

OU 1111 is located in Los Alamos County in north-central New Mexico (Figure 1-1) on property owned by the DOE. It includes TAs-6, -7, -22, -40, -58, and -62 and covers about 24 acres. TA-58 (Two-Mile Mesa North Site) and TA-62 (Northwest Site) were established in 1989 from acreage taken from surrounding TAs. They are buffer areas between Laboratory operations and the Forest Service lands to the west and private lands to the north. Figure 1-2, a map inserted at the end of this chapter, shows these areas. TA-6 (Two-Mile Mesa South Site) now includes the former TA-7 (Gomez Ranch Site); both were in use primarily in the 1940s and now are inactive. TA-22 (Trap Door, or TD, Site) and TA-40 (Detonator Firing, or DF, Site) host current Laboratory operations related to detonator development.

TAs-6, -58, and -62 contain minimal Laboratory operations. TA-58 contains a running trail for Laboratory employees, and TA-6 contains experimental receiving antennas and a meteorological monitoring station. TAs-22 and -40 are occupied by Group M-7, the Detonation Systems Group. Detonators are produced at TA-22 and tested at TA-40. The production operations include handling of explosives, particularly PETN, and printed circuit processing. Testing includes a variety of test-firing activities, monitored by sophisticated optical and electronic equipment. In all cases, quantities of materials used are small. A typical detonator contains only a few milligrams of explosives.

All of the 89 identified PRSs are found in TAs-6, -22 (TD Site), and -40 (DF Site). Figure 1-3, a map inserted at the end of this chapter, shows these areas. PRSs in this OU were aggregated primarily on similarity of structures and functions and on proximity.

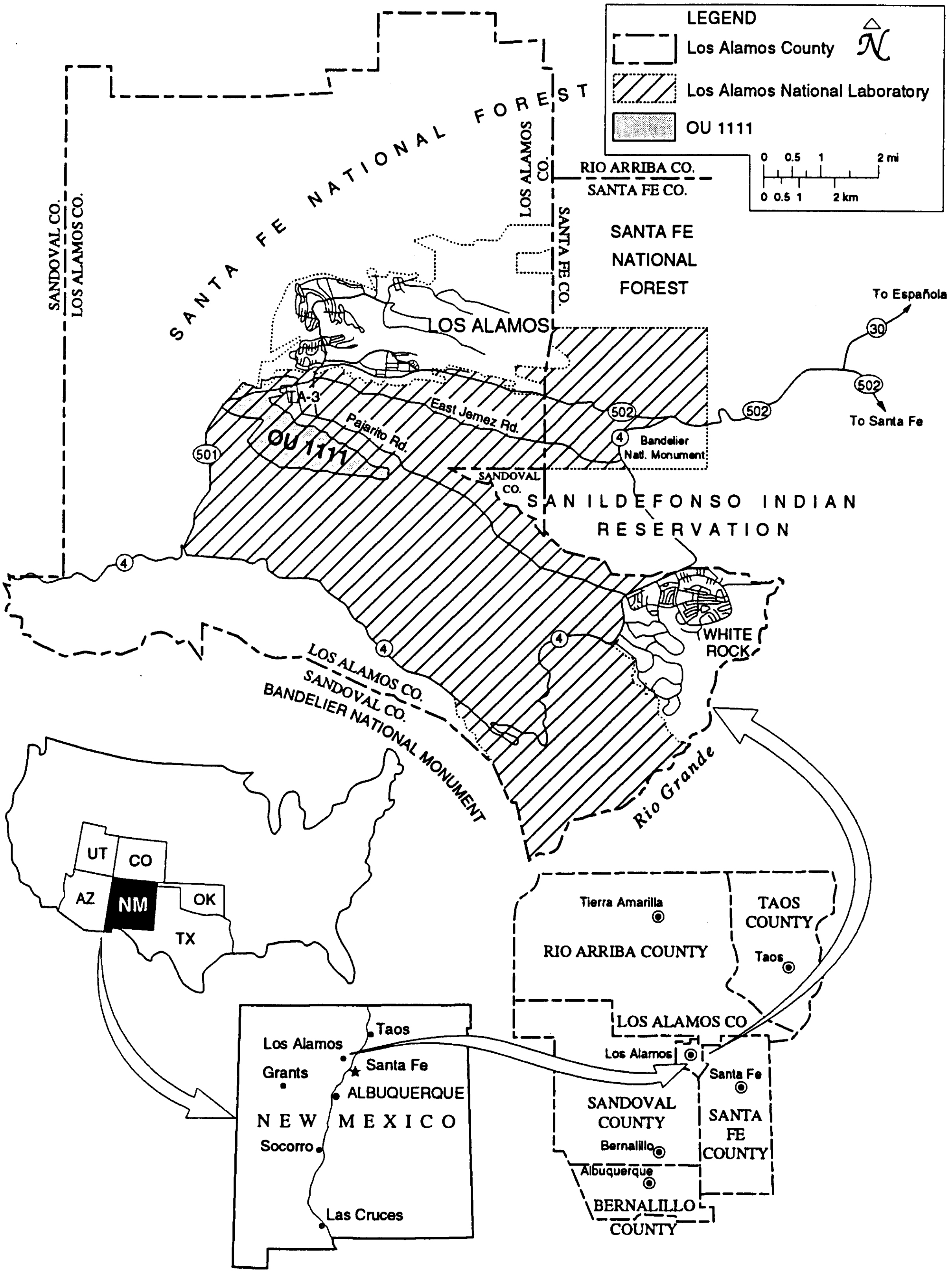

Figure 1-1. Location map of OU 1111.

Table 1-2 gives the SWMUs listed on the HSWA Permit, other PRSs addressed in this work plan, and the sections of this work plan in which they are discussed in detail. Table 1-3 lists the PRSs proposed for no further action.

1.4 Organization of This Work Plan and Other Useful Information

This work plan follows the generic outline provided in Table 3-2 of the IWP (LANL 1992, 0768). Chapter 2 provides background information on OU 1111, which includes a description and history of the OU, a description of past waste management practices, and current conditions at TAs in the OU. Chapter 3 describes the environmental setting, and Chapter 4 presents the technical approach to the field investigation. Chapter 5 contains an evaluation of all the PRSs in OU 1111, which includes a description and history of each PRS, a conceptual exposure model, remediation alternatives and evaluation criteria, data needs and data quality objectives, and a sampling plan. Chapter 6 of this work plan provides a brief description of each PRS proposed for no further action and the basis for that recommendation. References for each chapter appear at the end of that chapter.

Five annexes correspond to the program plans in the IWP: project management, quality assurance, health and safety, records management, and public involvement. Appendix A contains a list of contributors to this work plan.

English and metric units of measurement are used in this document. When information is derived from another published report, the units are consistent with those used in that report.

A list of acronyms precedes this chapter. Glossaries of unfamiliar terms are provided in the IWP (LANL 1992, 0768) and in this document.

TABLE 1-2

PRSs IN OU 1111 AND LOCATIONS OF DISCUSSION

SWMUs in Table A of the HSWA Module	PRS Number in SWMU Report and This Work Plan	PRS Description	Discussed in Section
6-001(a, b)	6-001(a, b)	Septic systems	5.6
6-002	6-002	Decommissioned septic system	5.8
6-003(c)	6-003(c)	Inactive firing site	5.4
6-006	6-006	Storage area	5.9
6-007*	6-007(a–e)	MDA F and other landfills	5.1
6-007*	6-007(f)	Landfill	5.5
7-001(a, b)	7-001(a, b)	Inactive firing sites	5.4
22-004(a, b)	22-014(a)	Sump	5.3
22-005	22-014(b)	Building 34 sumps	5.3
22-006	22-015(a)	Building 91 dry wells	5.3
22-007	22-015(b)	Building 25 sump system	5.3
22-008*	22-015(c)	Building 52 plating and etching bath outfall	5.2
22-009	22-015(d)	Building 1 explosives sump system	5.3
22-010	22-010(a, b), 22-016	Active septic systems	5.6

TABLE 1-2 (concluded)

SWMUs in Table A of the HSWA Module	PRS Number in SWMU Report and This Work Plan	PRS Description	Discussed in Section
22-011	22-011	Disposal pit	6.5
40-001(a)	40-001(a)	Septic system	6.7
40-001(b)	40-001(b)	Septic system	5.6
40-001(c)	40-001(c)	Septic system	5.6
40-003(a)	40-003(a)	Burning area	6.2
40-004	40-004	Decommissioned container storage area	5.9
40-005	40-005	Building 41 sump	5.3
40-006(a–c)	40-006(a–c)	Active firing sites	5.7
40-009	40-009	Landfill	5.7
	6-003(a, d, e, f, g)	Inactive firing sites	5.4
	6-003(b)	Explosion containers	6.3
	6-004	Sump	6.4
	6-005	Pit	5.1
	6-007(g)	Former building location and surface disposal	5.5
	6-008	Decommissioned underground storage tank	5.4
	7-001(c, d)	Inactive firing sites	5.4
	22-001	Explosives waste storage area	6.2
	22-003(a–g)	Satellite waste storage areas	6.1
	22-012	Wash pad	5.3
	22-013	Liquid waste treatment/storage	6.1
	22-014(c)	Active sump and outfall	6.6
	22-015(e)	Sump	5.3
	40-002(a–c)	Container storage areas	6.1
	40-003(b)	Burning area/open detonation	6.2
	40-007 (a–e)	Explosives storage areas	5.10
	40-008	Decommissioned explosives storage	6.2
	40-010	Surface disposal	5.5
	C-6-001, C-6-003, C-6-005 through C-6-018, C-6-021	Areas of concern	5.8
	C-6-019	Area of concern	5.4
	C-6-020	Decommissioned Building Site	6.8
	C-40-001	Area of concern	6.9
	TA-6-8	Inactive Firing Site	5.4
	TA-40-4	Active firing site	5.7
	TA-40-9	Active firing site	5.7
	TA-40-12	Active firing site	5.7
		Explosives lens disposal area	5.1

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*Also in Table B of the HSWA Module

TABLE 1-3

PRSs IN OU 1111 PROPOSED FOR NO FURTHER ACTION

PRS Number	Title	Location of Discussion (Section)
6-003(b)	Explosion containers	6.3
6-004	Sump	6.4
22-001	Explosives waste storage area	6.2
22-003(a)	Satellite waste storage area	6.1
22-003(b)	Satellite waste storage area	6.1
22-003(c)	Satellite waste storage area	6.1
22-003(d)	Satellite waste storage area	6.1
22-003(e)	Satellite waste storage area	6.1
22-003(f)	Satellite waste storage area	6.1
22-003(g)	Satellite waste storage area	6.1
22-011	Disposal pit	6.5
22-014(c)	Active sump and outfall	6.6
40-001(a)	Septic system	6.7
40-001(c)	Septic system	6.8
40-002(a)	Container storage area	6.1
40-002(b)	Container storage area	6.1
40-002(c)	Container storage area	6.1
40-003(a)	Burning area/open detonation	6.2
40-003(b)	Burning area/open detonation	6.2
40-008	Decommissioned explosives storage	6.2
C-6-020	Decommissioned building site	6.8
C-40-001	Herbicide area	6.9

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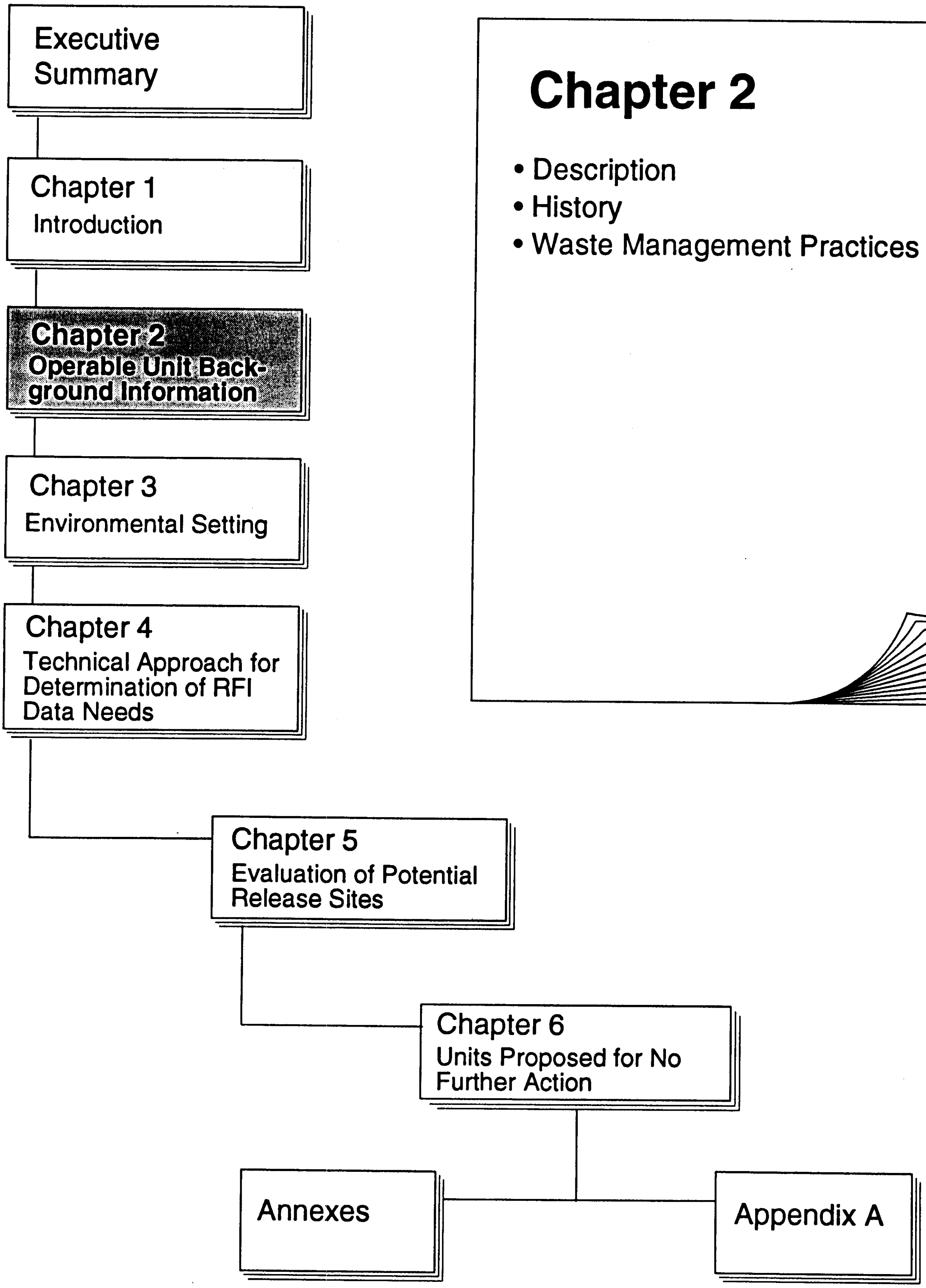
Chapter 2

- Description
- History
- Waste Management Practices



2.0 BACKGROUND INFORMATION FOR OPERABLE UNIT 1111

2.1 Description

Operable Unit (OU) 1111 includes approximately 24 acres in the northwestern portion of the Los Alamos National Laboratory (the Laboratory) site (Figure 1-1). The OU includes Technical Areas (TAs) 6, 7, 22, 40, 58, and 62. TA-6 (Two-Mile Mesa Site South) now includes TA-7 (Gomez Ranch Site); both sites are inactive. TAs-22 (Trap Door Site) and -40 (Detonator Firing Site) are active sites. TA-58 (Two-Mile Mesa Site North) and TA-62 (Northwest Site) were established in 1989 from acreage taken from surrounding TAs and serve as a buffer between Laboratory activities and National Forest lands. Figure 2-1 shows the TAs and geographic features in OU 1111.

The designation "Two-Mile" applies to a mesa, a canyon, and to the TAs above. It is commonly used within the Laboratory and will be used throughout this work plan. Alternative versions are Twomile (used by the United States Geological Survey), Two Mile, and 2 Mile. All of OU 1111, except TA-62, and all solid waste management units are located on Two-Mile Mesa. Two-Mile Canyon is the northern boundary of Two-Mile Mesa and TA-6.

The OU is located on the Pajarito Plateau on the flanks of the Jemez Mountains. It is bounded by Pajarito Canyon and Laboratory land on the south, other Laboratory land on the east, private land on the north, and Forest Service land on the west. Two-Mile Canyon joins Pajarito Canyon at the eastern border of the OU. The Frijoles Canyon Fault, a major tectonic feature in northern New Mexico, almost parallels the western boundary of the OU. The land rises steeply along the fault to a high point for the OU of approximately 7900 feet. The lowest altitude (approximately 6450 feet) is on the eastern edge of the OU.

The Pajarito Plateau is composed of volcanic ash flow and ash fall deposits. The Tshirege Member of the Bandelier Tuff is the predominant cap rock on the mesa. Overlying the Bandelier Tuff on the OU is an extensive Quaternary alluvial deposit. The soils on the OU include Carjo loam, Tocal very fine sandy loam, and Pogna fine sandy loam (Nyhan et al. 1978, 0161).

OU 1111 has a semiarid, temperate mountain climate. The predominant vegetation is ponderosa pine; large grassy areas provide feeding locations for deer and elk. No endangered species have been found within this OU.

Surface drainage from Two-Mile Mesa is into Two-Mile Canyon on the north and Pajarito Canyon on the south. Drainage from mesa top land in TAs-58 and -62 is into Two-Mile and Los Alamos canyons. Los Alamos Canyon contains a perennial stream, Pajarito Canyon contains an intermittent stream, and Two-Mile Canyon and its small tributaries contain ephemeral streams. Depth to the main aquifer from the mesa tops in OU 1111 is more than 1000 feet. A full description of the environmental setting of OU 1111 is included in Chapter 3.

2.2 History

A few Native American sites from the thirteenth and fourteenth centuries, and possibly earlier, have been found on Two-Mile Mesa and in Pajarito Canyon.

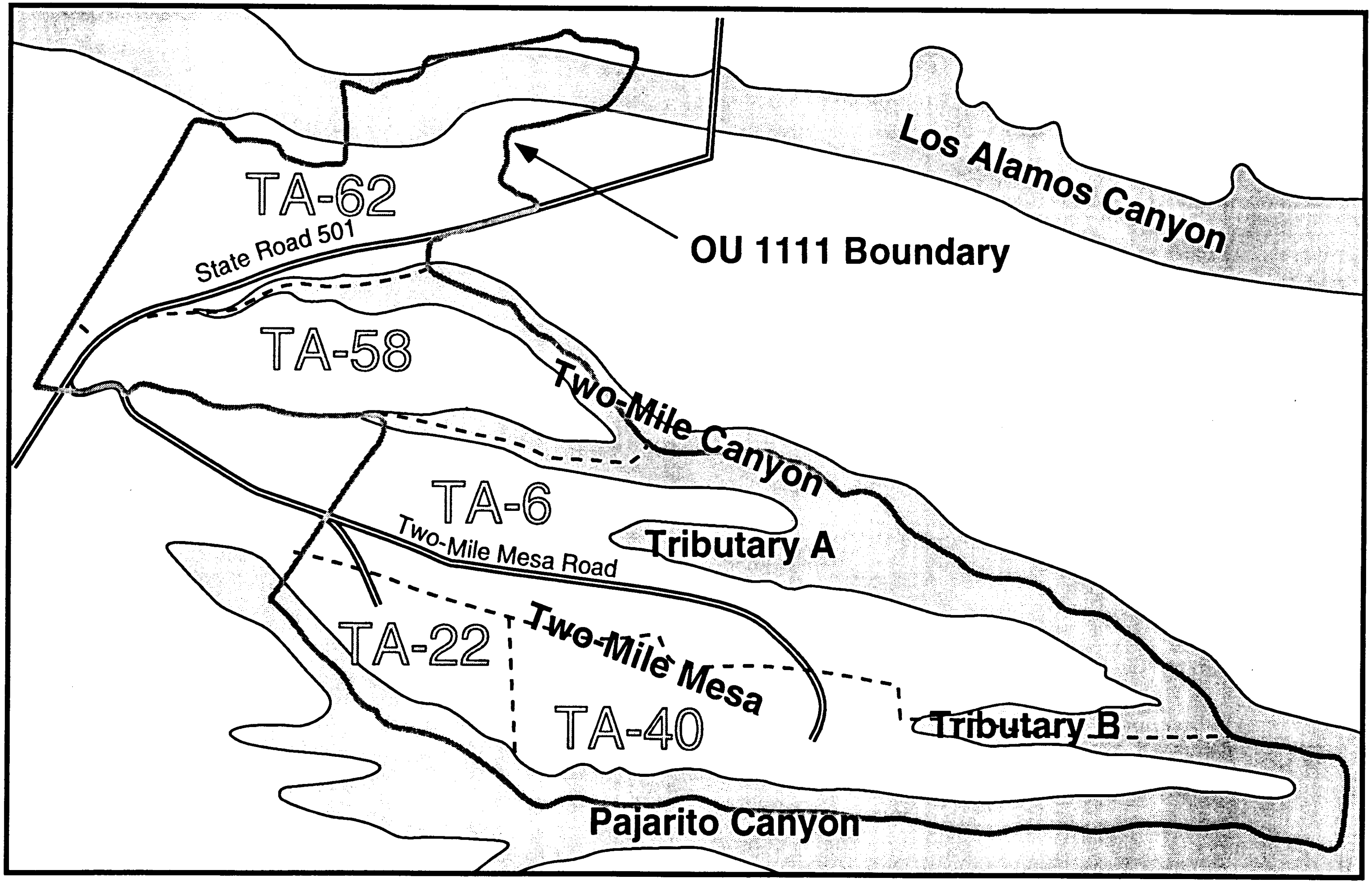


Figure 2-1. Technical areas and geographic features in OU 1111.

There is no evidence of above-ground structures for habitation, but seasonal camps may have been located here. The area was probably used for hunting and gathering. In comparison to Laboratory sites located farther to the east, few archaeological sites have been found.

Two ranches occupied Two-Mile Mesa before the Manhattan Project arrived on the Pajarito Plateau. Aerial photographs from 1935 show extensive farmed areas on the mesa (SCS 1935, 19-0068; SCS 1935, 19-0117). Beans and corn were the principal crops grown on the OU; family vegetable gardens and fruit trees were also cultivated. A grove of apricot trees grew in TA-22 until the early 1980s. A few cattle and sheep may also have grazed in this area. The ranches may have been occupied only during the summer months, with the owners returning to their homes in the valley during the winter. Remnants of ranch buildings still exist.

All Laboratory lands, including the area in OU 1111, were requisitioned for Manhattan Project use in 1943.* Early in the Manhattan Project, two methods for assembling fissionable material to produce a weapon were identified: gun assembly and implosion. For a nuclear explosion to take place, the fissionable material must be brought together (assembled) in a critical mass within an extremely short time. The time is determined by the materials' properties. In a gun assembly, one piece of fissionable material is fired into another; each is less than a critical mass, but both together are greater than a critical mass. In implosion, shaped charges around a spherical mass of fissionable material force the material into a much smaller volume, producing a critical mass.

The principles of ballistics needed to produce a gun assembly were well understood, and a gun assembly was expected to work for uranium-235. However, the nuclear properties of plutonium were not sufficiently understood, and a successful design could not be predicted. Implosion required significant development but theoretically could assemble a critical mass more quickly than the gun design, if that were necessary for plutonium. The project proceeded on both tracks, but early efforts emphasized the development of a gun design.

In July 1944, enough plutonium became available from the reactors at the Hanford Engineer Works in Washington State for Enrico Fermi and his students at Los Alamos to measure its nuclear properties. These measurements showed that reactor-produced plutonium could not produce a nuclear explosion in a gun assembly. During the summer of 1944, Los Alamos was reorganized into a crash effort to produce an implosion weapon.

Most Manhattan Project activities on Two-Mile Mesa were related to the development of the implosion weapon. Because an implosion weapon required extensive development, it would need to be tested to make sure it would work. Fissionable materials were in short supply, and extraordinary measures were taken throughout the Manhattan Project to conserve them. If a test of an implosion weapon failed, the detonation of the conventional explosives could fragment and scatter a large part of the world's supply of plutonium. The Recovery Group, X-2B, tested methods for recovering the plutonium from the test, in case of a nuclear misfire. Successful implosion depended on extremely close timing of

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*Much of the following history is derived from Hoddeson et al. (in preparation, 0851). This reference may be assumed unless another source is cited.

detonations, and the detonators available in 1944 were not capable of such close timing. Thus, new detonators needed to be developed. Detonator testing and then production and development activities were assigned to Two-Mile Mesa (TA-6).

The building numbers used for TA-6 do not reflect the sequence of construction, and the numbering was changed at least once (LANL 1944- , 19-0115). Building numbers used in this work plan are those used most recently. Control buildings for test firing (TA-6-3 and TA-6-11) were probably built first (LASL 1944, 19-0004). Early studies in the recovery effort were designed to determine the dispersion of material from an implosion shot fired above the ground. Tracer metals that simulated the mechanical behavior of the fissionable material were recovered. Building TA-6-1 contained a chemistry laboratory (LASL 1944, 19-0001) and a carpenter shop to support the tests (Creamer 1993, 19-0035).

Three methods of recovery investigated during the tests were (1) water recovery, (2) sand recovery, and (3) Jumbino vessels. During water recovery, shots were detonated in a container of water to slow metal fragments down, and a paved area received the fragments. Shots were also detonated under piles of sand; the sand retained the metal fragments. Steel vessels (Jumbinos) were designed to withstand the force of explosion and contain metal fragments. Methods 1 and 3 were tested at TA-6. Most tests of Method 2 were done in Bayo Canyon, a part of OU 1079.

The Jumbino method was judged to be the most satisfactory for a full-scale test. A cylindrical steel vessel with spherical ends (called Jumbo) was fabricated by Babcock and Wilcox for containment of the Trinity test; the vessel was 28 feet long, almost 13 feet in diameter, and weighed 214 tons. However, by March 1945, plutonium production at the Hanford Engineer Works was steady, and thus the necessity for conserving plutonium decreased. The Trinity test was conducted with Jumbo as a 214-ton object in the path of the blast, rather than as a containment vessel. The remains of Jumbo are now near the Trinity Test Site.

In August 1944, Group X-7 was formed to design and fabricate the electric detonators and firing systems needed for the implosion weapon. Detonator work was consolidated at TA-6 as new buildings were constructed in 1944 and 1945. Pentaerythritol tetranitrate (PETN) was chosen as the explosive to be used in detonator fabrication. Because PETN, as received from the manufacturer, was not sufficiently pure or uniform for the performance required by the implosion detonators, a method of recrystallization was developed and put into operation at TA-6-10 (Meyers 1993, 19-0044). The recrystallization operation continued in TA-6-10 until 1948.

Late in 1944, the Gadget (G) Division constructed four buildings on the south edge of Two-Mile Mesa to assemble the conventional explosives for the Fat Man weapon, which was used against the city of Nagasaki. This area is now called Trap Door Site (TA-22). To shield the operation from the view of people working at TA-6, an 18-ft-high fence was constructed on the north side of the buildings (LASL 1945, 19-0019). After the assembly of the Fat Man, the buildings were abandoned until 1948, when they were remodeled for use by X-7.

In the spring of 1945, shaped explosive charges called lenses were being produced in large numbers at S-Site (TA-16, OU 1082) for the Trinity test and the implosion weapon. The charges were called lenses because they focused the force of the explosives to provide an implosion. About 100 of these lenses were defective and were destroyed by detonation on Two-Mile Mesa, probably in the area now known as Materials Disposal Area F (Van Vessem 1992, 19-0045).

During 1945, 25 new structures were erected on both sides of Two-Mile Mesa Road in TA-6 (LANL 1944- , 19-0115). The new structures included three firing chambers (TA-6-7, -8, and -9), a laboratory (TA-6-6), and one explosives pressing facility (TA-6-5).

In 1946 and 1947, Norris Bradbury, the Laboratory director, ordered that pits be dug on Two-Mile Mesa to bury classified objects (Bradbury 1946, 19-0048; Bradbury 1947, 19-0049). These pits are now part of Materials Disposal Area F and are discussed further in Section 5.1.

By 1948, the abandoned buildings at TA-22 were remodeled into office, laboratory, and fabrication space to replace those activities at TA-6, and new magazines and utility buildings were built. In the early 1980s, a new Detonation Systems Laboratory was constructed north of the old buildings in TA-22. By 1985, the laboratory was occupied and the old buildings were demolished or abandoned (Creamer 1993, 19-0107).

Test firing continued at TA-6 until 1952, when operations were moved to TA-40 (Creamer 1993, 19-0107). Explosives development, laser, chemical laboratory, and photographic operations continued at TA-6 through February 1976 (Schott 1993, 19-0125). Several small operations, including a carpenter shop, a cable fabrication shop, and silk screening, continued at TA-6 until the 1980s (Schott 1993, 19-0125). Several structures are still in place but are no longer used. Ten magazines and other buildings were removed or destroyed by burning (LANL 1944- , 19-0115).

Detonator Firing Site, TA-40, was built in 1950 to replace the detonator firing chambers at TA-6 (Creamer 1993, 19-0107). It contains six firing sites that have been used since 1950 for explosives testing related to research and development of detonators and other small explosives assemblies. TA-40 includes an office building, an inert assembly building, six firing chambers, five shot preparation buildings, eight magazines, and utility buildings. One of the firing chambers, TA-40-9, was upgraded in the 1980s to house a two-stage gas gun. The Laboratory's first contained test-firing facility was completed in 1992 at chamber TA-40-8.

The detonator development group (now M-7) has operated under the names G-7, X-7, GMX-7, and WX-7.

Chapter 5 contains more detailed histories of firing sites, buildings, and other structures that are related to potential release sites.

2.3 Waste Management Practices

Operations at OU 1111 have included chemistry laboratories, machine shops, mechanical assembly, darkrooms, and explosives operations such as storage, loading, and test firing. PETN is the explosive used in the greatest quantity, but total quantities of explosives used have been small. No more than 600 lb. of

PETN is estimated to have been processed at OU 1111 (Meyers 1993, 19-0044). Amounts are discussed in more detail in Section 4.3.1. The disposal of explosive lenses at TA-6 in 1945 may have distributed barium over that area.

Handling of explosives has always been recognized as a dangerous activity. All organizations that handle explosives must exercise stringent safety precautions, which include accountability of materials and exacting housekeeping practices. Quantities of stored explosives are limited, and safe handling requires that explosives not be dropped or broken. Facilities are engineered to prevent the buildup of deposits of explosives from solutions or dusts. When a misfire occurs at a firing site, scattered pieces of explosives are recovered. Explosives waste is normally disposed of by burning at the S-Site incinerator or by detonation, which now takes place at the M-8 open detonation facility. These practices have been followed at the Laboratory since explosives were first handled. Standards have become more stringent over time. Except for airborne dispersion during detonation, the required safety practices also prevent environmental releases of explosives. The only explicit allowance of explosives releases in OU 1111 were some of the early drain arrangements at TA-6 and TA-22 that allowed small quantities of explosives to be released in wastewater. These are discussed further in Section 5.3.

The use of radionuclides in OU 1111 has been confined to short-lived radionuclides (now decayed to negligible concentrations), contained sources, and depleted uranium (Meyers 1993, 19-0112).

Standard Laboratory operating practices have been followed. Chemical waste may have flowed from drains, sumps, and septic systems to outfalls until the 1980s. Although most waste from the plating and etching operations at TA-22-52 was collected, a stream from the rinse tanks was allowed to flow into the environment. Plating and etching wastes are now treated on site and disposed of by the Waste Management Group. Plans exist to connect septic systems at TA-22 to the Sanitary Wastewater Consolidation System during 1993. Plans are being made to eliminate discharges from sumps designed to collect solid explosives from wastewater.

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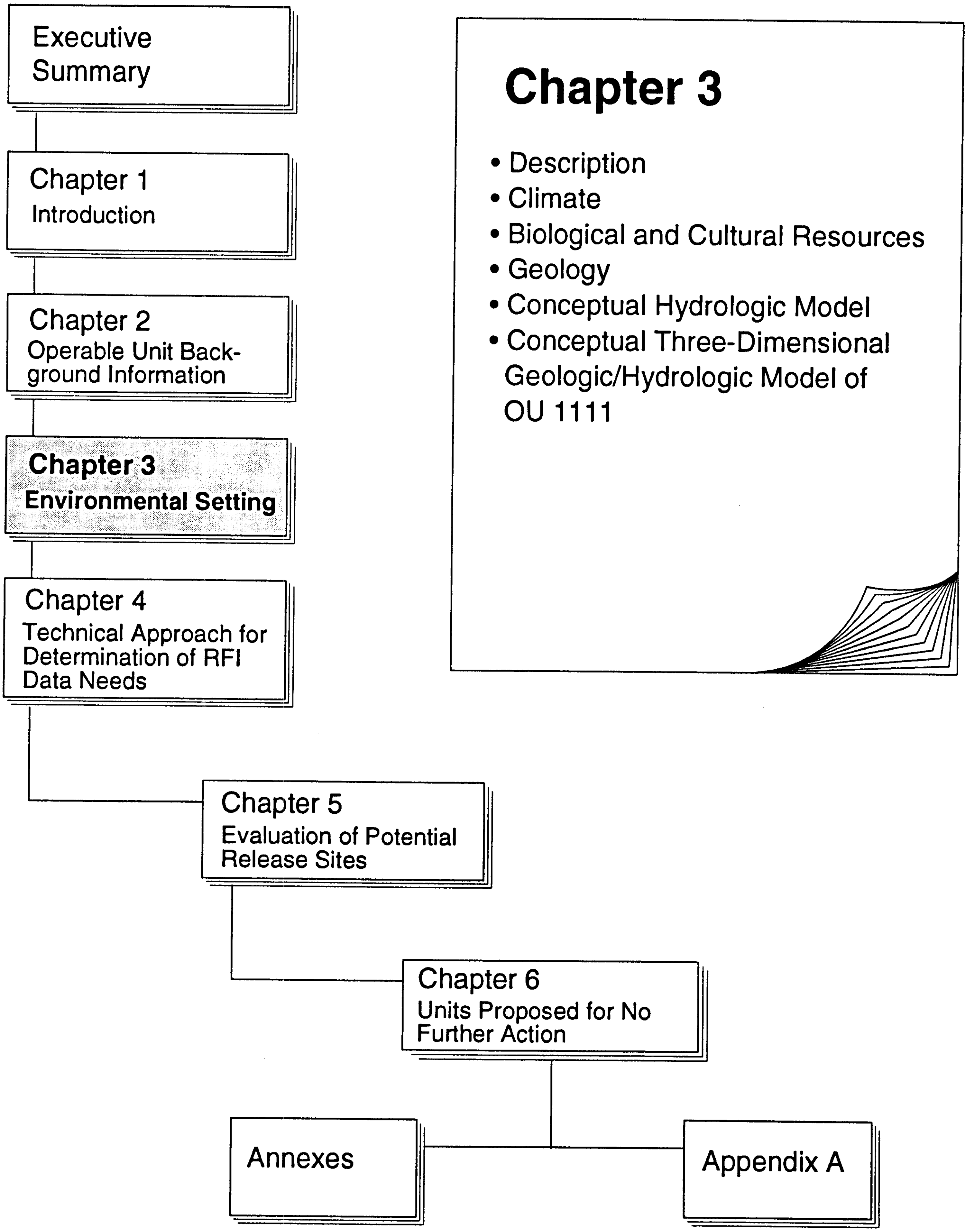


Chapter 3

- Description
- Climate
- Biological and Cultural Resources
- Geology
- Conceptual Hydrologic Model
- Conceptual Three-Dimensional Geologic/Hydrologic Model of OU 1111

3.0 ENVIRONMENTAL SETTING

3.1 Description

An overall physical description of the portion of Pajarito Plateau occupied by Los Alamos National Laboratory (the Laboratory) is given in the installation work plan (IWP) in Sections 2.1, 2.5, and 2.6 (LANL 1992, 0768). Operable Unit (OU) 1111 lies on the western edge of the plateau and extends onto the flanks of the Jemez Mountains; elevation ranges between 6450 ft and 7900 ft. The OU consists dominantly of mesa tops (7060–7250 ft) and canyons that trend east-southeast (6950–7160 ft). The canyons, which are up to 190 ft deep and have steep sides, have formed as the result of water and sediment moving across the area for the last million years. OU 1111 is bounded on the northeast by Two-Mile Canyon and on the south by Pajarito Canyon (Figure 3-1). Run-off from the OU drains into four canyons: Two-Mile Canyon, Pajarito Canyon, and two unnamed canyons (referred to here as Tributaries A and B). Tributaries A and B drain into Two-Mile Canyon, and Two-Mile Canyon drains into Pajarito Canyon at the eastern edge of the OU. Pajarito Canyon eventually drains into the Rio Grande at White Rock Canyon.

Ponderosa pine is the predominant vegetation in the wooded areas of the mesa tops, south-facing canyon walls, and the canyon bottoms. Open grassy areas on the mesa tops are a result of farming done before 1943. North-facing canyon walls are predominantly mixed conifer with diverse grasses. Vegetation typical of wetlands is found in Pajarito Canyon, Two-Mile Canyon, and Tributary B. Although no threatened or endangered species have been observed in the OU, possible habitats for some species exist. A herd of elk is resident on Two-Mile Mesa, and there are signs of bear in parts of the OU. Medium-sized mammals, such as raccoons, coyotes, rabbits, porcupines, and skunks, frequent the area. Further information on the biota of OU 1111 is described in the biological and floodplain/wetland assessment (Salisbury, in preparation, 19-0114).

Most potential releases sites (PRSs) in OU 1111 are on the mesa tops; a few are on canyon walls and bottoms (Figure 3-1). All PRSs occur within an elevation range of 7275–7535 ft. Estimates of the elevation for the main aquifer under OU 1111 suggest that the PRSs on the mesa top are 1025–1285 ft above the main aquifer (Purtymun and Johansen 1974, 0199), although canyon bottoms may be 700 ft above the main aquifer. These estimates are based on extrapolations of data from studies on test wells located several miles from the OU (Purtymun and Johansen 1974, 0199) (Sections 3.4.1 and 3.5.2.4). Recent drilling efforts near OU 1111 suggest, however, that there may be an aquifer at a depth of 800 ft below the mesa top of the OU (Gardner et al. 1993, 0848). Ongoing work at the drilling site will characterize this aquifer. The canyons into which the PRSs drain are listed in Table 3-1; no PRSs drain into Los Alamos Canyon.

3.2 Climate

Section 2.5.3 of the IWP (LANL 1992, 0768) and Bowen (1990, 0033) present a detailed discussion of the climate for the county. Nyhan et al. (1989, 0417) present a detailed discussion of southwestern climate as it might influence long-term waste sites.

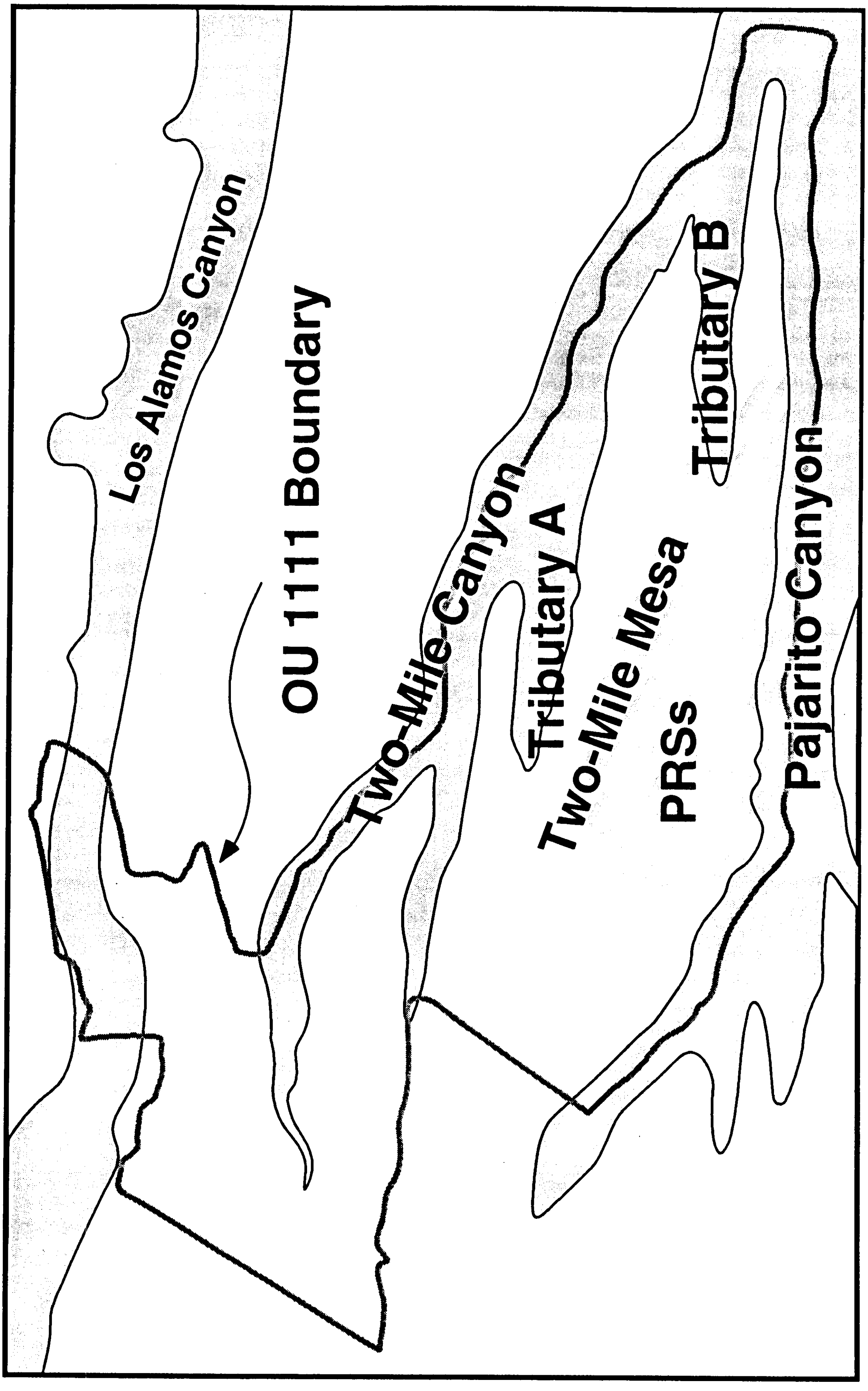


Figure 3-1. OU 1111 boundary, canyons, and Two-Mile Mesa. Hatched area includes PRSs.

TABLE 3-1

DRAINAGE CANYONS FOR SOLID WASTE MANAGEMENT UNITS IN OU 1111

Canyon	**SWMU Number**
Two-Mile Canyon, Tributary A	6-001(a), 6-001(b), 6-003(a),* 6-003(d), 6-003(e), 6-005, 6-006, 6-007(a), 6-007(c),* 6-007(d),* 6-007(e),* 6-007(f), 6-008*
Two-Mile Canyon, Tributary B	6-002, 6-003(a), 6-003(c), 6-004, 6-007(b), 6-007(c), 6-007(d), 6-007(e), 6-008, 7-001(a), 7-001(b), 22-003(a), 22-003(b), 22-003(c), 22-003(d), 22-003(e), 22-003(f), 22-010, 22-014(a), 22-014(b), 22-015(a), 22-015(b), 40-001(a), 40-001(b), 40-002(a), 40-005, 40-007(e)
Pajarito Canyon	22-001, 22-003(a),* 22-003(g), 22-010(b), 22-011, 22-012, 22-015(c), 22-015(e), 40-001(c), 40-003(a), 40-003(b), 40-004, 40-006(a), 40-006(b), 40-006(c), 40-007(a), 40-007(b), 40-007(c), 40-007(d), 40-008, 40-009

* Uncertain whether drainage is into designated canyon.

OU 1111 has a semiarid mountain climate, as does all of Los Alamos County. Climatic data from numerous weather stations have been collected in the county since 1910. One weather station has been located in OU 1111 since 1990; several other weather stations have been and are located within 10 mi of the OU.

Winter temperatures typically range between 15°F (night) and 50°F (day), with minimum temperatures near 0°F (Bowen 1990, 0033). Between November and March, Los Alamos generally experiences 20–30 freeze and thaw days (Bowen 1990, 0033). Summer temperatures typically range between 50°F and 86°F, with maximum temperatures near 90°F (Bowen 1990, 0033). Figure 3-2 shows monthly temperatures recorded in Technical Area (TA) 6.

Average annual rainfall in the OU is approximately 18 in., with about half of that occurring during summer thunderstorms (Bowen 1990, 0033). In TA-59 (<0.5 mi from the eastern edge of OU 1111), monthly precipitation during July and August averages 3–4 in., with maximums during 1911–1986 of about 10 in. (Nyhan et al. 1989, 0417). Between November and April, Los Alamos typically receives 5–11 in. of snow monthly. Figure 3-3 shows monthly precipitation for the OU. Recorded extremes in annual precipitation range between 7 and 30 in. (Bowen 1990, 0033). The estimated 100-yr maximum monthly rainfall for August is 13 in. (Nyhan et al. 1989, 0417). The estimated 100- and 200-yr maximum annual rainfalls are 33 in. and 35 in., respectively (Nyhan et al. 1989, 0417). These statistically based estimates agree with tree-ring data (Abeele 1980, 0637), which indicate that the 100-, 200-, and 500-yr maximum rainfalls in the Los Alamos area were 30 in., 34 in., and 40 in., respectively.

Surface winds over the Pajarito Plateau average 7 mph (Bowen 1990, 0033). Gusts typically reach 50 mph; the strongest recorded gust in recent history (March 1986 in TA-59) was 69 mph (Bowen 1990, 0033). Generally, surface winds over the plateau are from the south-southeast. However, nighttime winds can have a strong westerly component, and winter winds can have a strong

Source: Bowen 1990, 0033
EM-8, in preparation, 19-0126

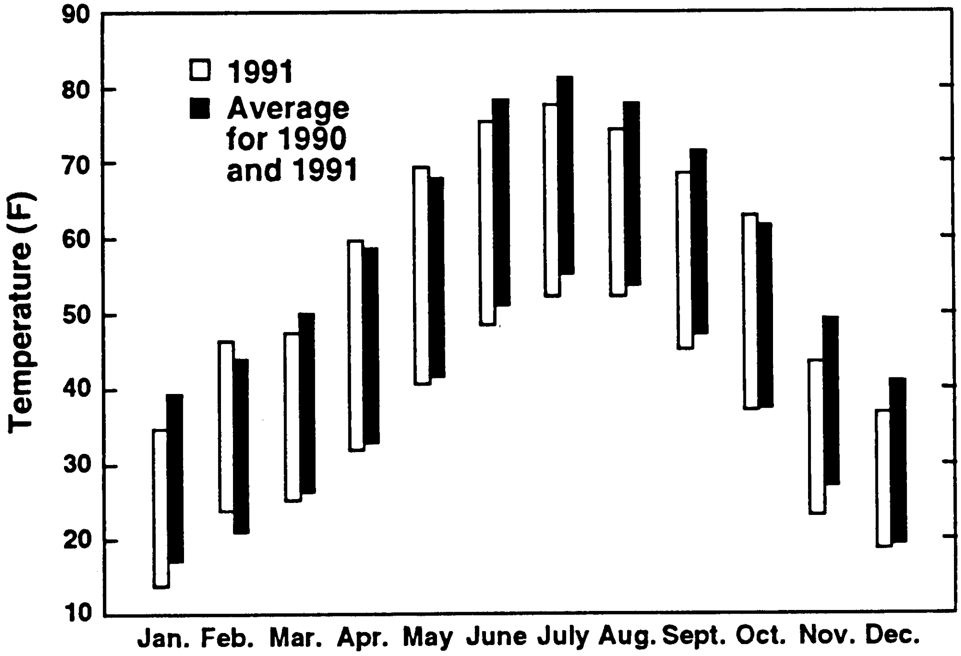


Figure 3-2. Monthly temperatures recorded in TA-6.

Source: Bowen 1990, 0033
EM-8, in preparation, 19-0126

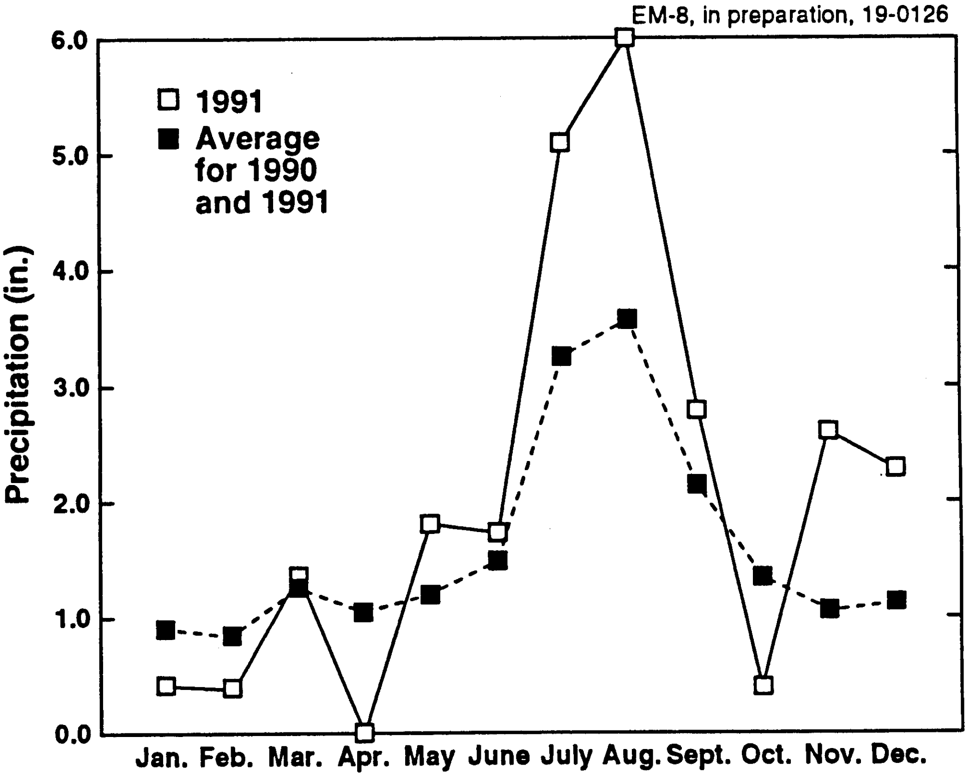
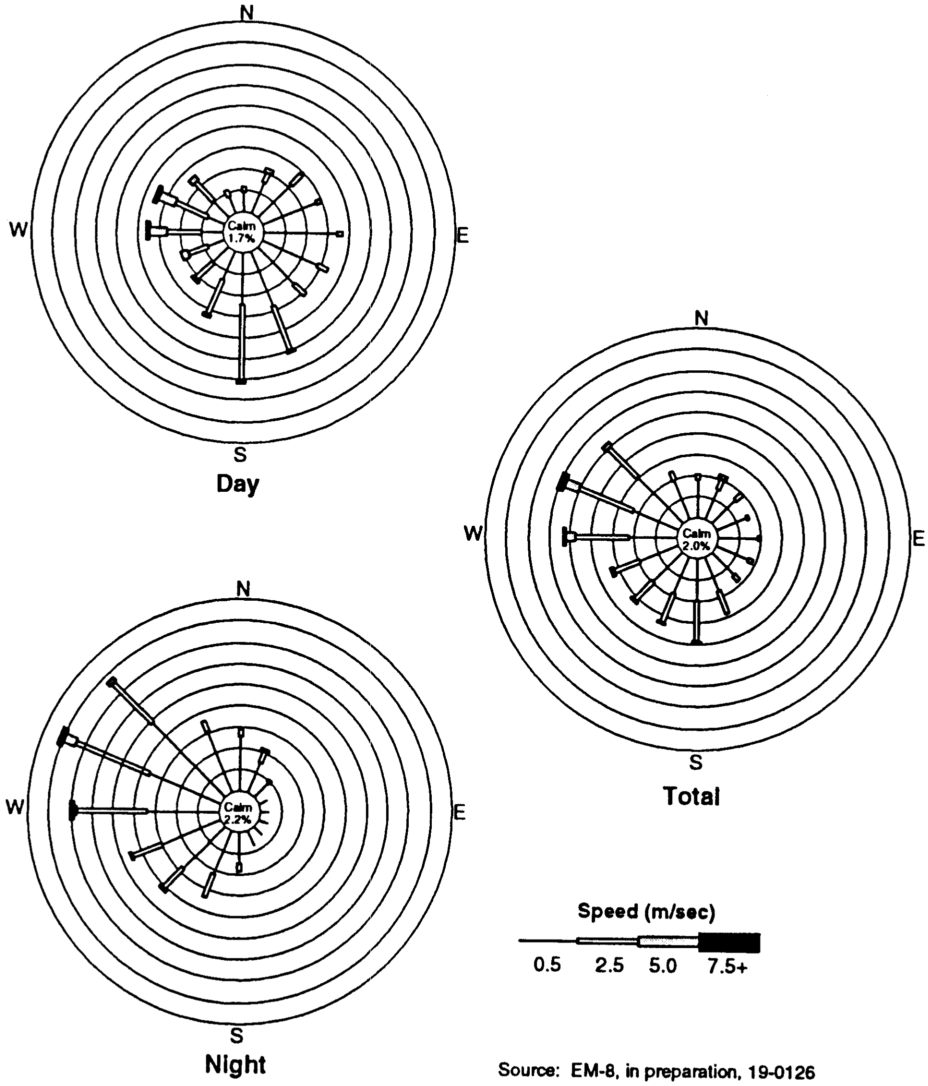


Figure 3-3. Monthly precipitation recorded in TA-6.

northerly component (Bowen 1990, 0033). Additionally, areas closer to the Jemez Mountains (western regions of OU 1111) have a westerly component (down slope) during the night and an easterly component (up slope) during the day (Figure 3-4).

3.3 Biological and Cultural Resources

During 1992, field surveys of OU 1111 were performed by the Biological and Cultural Resource Evaluations Teams of the Environmental Protection Group (EM-8). The purpose of the field surveys was to determine whether habitats for endangered species or the species themselves were present and whether sites needed to be protected as cultural resources.



Day

Total

Night

Source: EM-8, in preparation, 19-0126

Figure 3-4. Wind roses recorded in TA-6 during 1991. Data were collected at a height of 12 m.

Habitat information gathered during the biological survey was compared with habitat requirements for species of concern. Table 3-2 lists the species of concern for this OU. Several of these species may occur in or near OU 1111. Table 3-3 lists these species, their habitats, and how to avoid adverse impact to the species during proposed environmental restoration (ER) operations.

Thirty archaeological or historical sites are located in OU 1111 (Table 3-4). Five of these sites are eligible for inclusion on the National Register of Historical

TABLE 3-2

SPECIES OF CONCERN IN OU 1111

Species	**Endangered (State)**	**Sensitive (State)**	**Candidate (Federal)**	**Proposed (Federal)**
Northern goshawk (Accipiter gentilis)			X	
Mexican spotted owl (Strix occidentalis lucida)				X
Spotted bat (Euderma maculatum)	X		X	
Meadow jumping mouse (Zapus hudsonius)	X		X	
Jemez Mountains salamander (Plethodon neomexicanus)	X		X	
Say's pond snail (Lymnaea captera)	X			
Wood lily (Lilium philadelphicum)	X			
Checker lily (Fritillaria atropurpurea)		X		
Sandia alumroot (Heuchera pulchella)		X		

State Endangered Animal: Category includes any species listed under New Mexico's Wildlife Conservation Act whose prospects of survival or recruitment within the state are in jeopardy or are likely to become jeopardized in the foreseeable future.

State Endangered Plant: Category includes any species listed under New Mexico's Endangered Plant Species Act that is rare across its entire range with limited distribution and population size or widespread across the state but its numbers are being reduced to such a degree that its survival within the state is jeopardized.

State Sensitive Plant: Category includes species that the scientific community believes are vulnerable to human impacts (e.g., disturbance). These species are not legally protected, but could be quickly listed as endangered or threatened.

Threatened Species (Federal): Category includes any species likely to become endangered within the foreseeable future throughout all or a significant portion of its range and has been listed by the US Fish and Wildlife Service as threatened under the Endangered Species Act.

Endangered Species (Federal): Category includes any species in danger of extinction throughout all or a significant portion of its range and has been listed by the US Fish and Wildlife Service as endangered under the Endangered Species Act.

Federal Candidate: Category includes any species for which the US Fish and Wildlife Service has enough information on biological vulnerability to list them as endangered or threatened species, but the proposed rules have not been issued. Also included are species for which available information indicates that proposing to list as endangered or threatened species is possible appropriate, but conclusive data on biological vulnerability are not currently available.

Federal Proposed Species: Category includes any species that has been formally and legally proposed to be listed as threatened or endangered under the Endangered Species Act. The proposed species are given the protection of the Endangered Species Act during the proposal process.

TABLE 3-3

REQUIRED MEASURES FOR SPECIES OF CONCERN

Species	Habitat	Required Measures
Spotted bat (Euderma maculatum)	Pinon-juniper, ponderosa, mixed conifer, and riparian habitats; requires open surface water and caves in cliffs or rock crevices for roosting	No adverse impact expected if roosting sites and water sources are not disturbed
Northern goshawk (Accipiter gentilis)	Mature ponderosa pine forest, nest sites may occur in this OU	Between May and October, contact Biological Resource Evaluations Team 60 days before sampling; contact evaluations team for presampling survey if over one-tenth acre will be disturbed; contact evaluations team for approval if live or snag trees will be removed
Mexican spotted owl (Strix occidentalis lucida)	Uneven-aged, multistory mixed conifer forest with closed canopies	Contact evaluations team 60 days before sampling in Pajarito Canyon
Meadow jumping mouse (Zapus hudsonius)	Riparian or zones with permanent water sources	Contact evaluations team to evaluate need for survey 60 days before sampling along stream-side areas; survey must be performed during the rainy season (preferably in July)
Jemez Mountains salamander (Plethodon neomexicanus)	Mixed conifer to spruce fir habitats; most often found in areas of closed canopies, north-facing slopes, or near streams and seeps	Contact evaluations team to evaluate need for survey 60 before sampling (survey must be performed during summer months after several days of heavy rain); additional measures are dependent on the results of the survey
Wood lily (Lilium philadelphicum)	Moist shaded area	Contact evaluations team before sampling in riparian areas and before taking heavy equipment or vehicles off established roads
Checker lily (Fritillaria atropurpurea)	Moist shaded area	Contact evaluations team before sampling in riparian areas and before taking heavy equipment or vehicles off established roads

Places based on their research potential. The attributes that make these sites eligible for inclusion will not be affected by any ER activities now proposed for OU 1111. One structure, TA-22-1, the Fat Man Assembly Building, has been determined to be eligible for inclusion. Fifteen Manhattan Project and early Atomic Energy Commission era structures (circa 1942 to 1948) will be evaluated for eligibility before they are decommissioned.

Reports on biological and cultural resources will be prepared and submitted to the appropriate authorities, as required under the National Environmental Policy Act and other relevant laws.

3.4 Geology

A detailed discussion of the geology of the Los Alamos area can be found in Section 2.6.1 of the IWP. No detailed geological study has been conducted in OU 1111, but numerous studies have investigated geologic features surrounding the OU.

TABLE 3-4

ARCHAEOLOGICAL/HISTORICAL SITES IN OU 1111

Site Number	Site Type[a]	Cultural Affiliation	Time Period[b]	Eligible[c]
LA 21331	IR (rock piles)	Hispanic	Homesteading	No
LA 21334	HS	Hispanic	Homesteading	Yes
LA 21382	IR	Unknown	Recent	No
LA 21383	LS	Anasazi	Unknown	No
LA 22767 A & B	RR	Anasazi	Unknown	Not relocated
LA 86641	CP	Anasazi	Coalition	PE
LA 86642	SH	Unknown	Unknown	PE
LA 86643	HS	Hispanic	Homesteading	Yes
E-1, -3, -5	WC	Hispanic	Homesteading	No
E-2/E-4	RD	Hispanic	Homesteading	No
L-55	SS	Anasazi	Unknown	PE
M-54	AS	Hispanic	Homesteading	No
LA 25284 A	OR (cement pond)	Euro-American	Manhattan Project	TBE
LA 25284 B (1)	OR (bomb cover)	Euro-American	Manhattan Project	TBE
LA 25284 B (2)	OR (bomb cover)	Euro-American	Manhattan Project	TBE
LA 25284 C (1)	OR (firing site)	Euro-American	Manhattan Project	TBE
LA 25284 C (2)	OR (firing site)	Euro-American	Manhattan Project	TBE
LA 25284 C (3)	OR (firing site)	Euro-American	Manhattan Project	TBE
TA-6-1, -2, -3	RB	Euro-American	Manhattan Project	TBE
TA-6-5, -6, -7	RB	Euro-American	Manhattan Project	TBE
TA-6-8, -9, -10	RB	Euro-American	Manhattan Project	TBE
TA-22-1	RB	Euro-American	Manhattan Project	Yes

[a] Site Type Codes: AS = Artifact Scatter, CP = Cavate(s) or Cavate Pueblo, HS = Homestead, IR = Indeterminate Rubble, LS = Lithic Scatter, OR = Other Recent Site Type, RB = Recent Building, RD = Roadway, RR = Rock Ring, SH = Rock Shelter, SS = Small Rock Structure, WC = Water or Soil Control Device

[b] Time Period Codes: Coalition = A.D. 1100—A.D. 1325, Homesteading = A.D. 1890—A.D. 1943, Manhattan Project = circa A.D. 1942—A.D. 1948, Recent = A.D. 1944 to present

[c] Eligibility Codes: PE = Potentially Eligible, TBE = To Be Evaluated

3.4.1 Stratigraphy

Section 2.6.1.2 of the IWP details the generalized stratigraphy for the Los Alamos area.

Although no test wells are located in OU 1111, several nearby wells may provide an adequate assessment of the stratigraphy under the OU (Figure 3-5). Data from three of these are discussed below. The wells are

- **PM-4** (Purtymun et al. 1983, 0712), located on Mesita del Buey about 2.0 mi east of the eastern tip of OU 1111;

- **PM-2** (Cooper et al. 1965, 0495), situated in Pajarito Canyon about 0.5 mi south of PM-4 and 2.1 mi east-southeast of the eastern tip of OU 1111;
- **DT-10** (Weir and Purtymun 1962, 0228), located on Frijoles Mesa, about 2.2 mi south-southeast of the eastern tip of OU 1111; and
- **SHB-1** (Gardner et al. 1993, 0848), located just east of OU 1111.

Well SHB-1 provides the best information on the stratigraphy underlying OU 1111; however, this well penetrates only 700 ft. Consequently, additional wells (PM-2, PM-4, and DT-10) were used to estimate the deep stratigraphy under OU 1111.

Data from studies of PM-2 provide an approximation of the stratigraphy underlying the canyons in OU 1111; data from studies of PM-4 and DT-10 provide an approximation of the stratigraphy underlying the mesas. However, the stratigraphy observed in these wells differs from that under OU 1111 in at least two ways. Each of these wells starts below the uppermost rock units in the stratigraphic section under OU 1111, and all are farther from the Jemez Mountains, the volcanic source of many of the rock units of the Pajarito Plateau. Because most of the units underlying the OU are known to vary with proximity to source, the detailed lithologies observed in the wells are expected to differ from those under OU 1111. Consequently, there is some uncertainty about the stratigraphy under OU 1111, and Figure 3-6 must be regarded as an approximation until more data are obtained.

Source: Gardner et al. 1993, 0848
Purtymun 1984, 0196

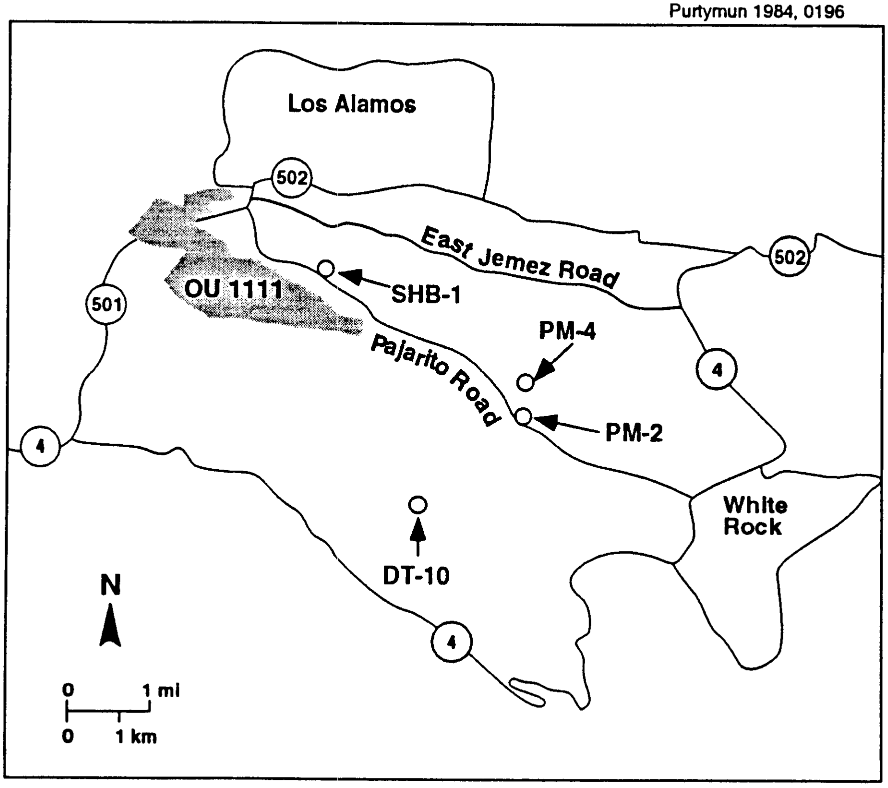


Figure 3-5. Locations of wells SHB-1, PM-2, PM-4, and DT-10.

Source: Purtymun et al. 1983, 0712
Cooper et al. 1965, 0495
Weir and Purtymun 1962, 0228
Gardner et al. 1993, 0848

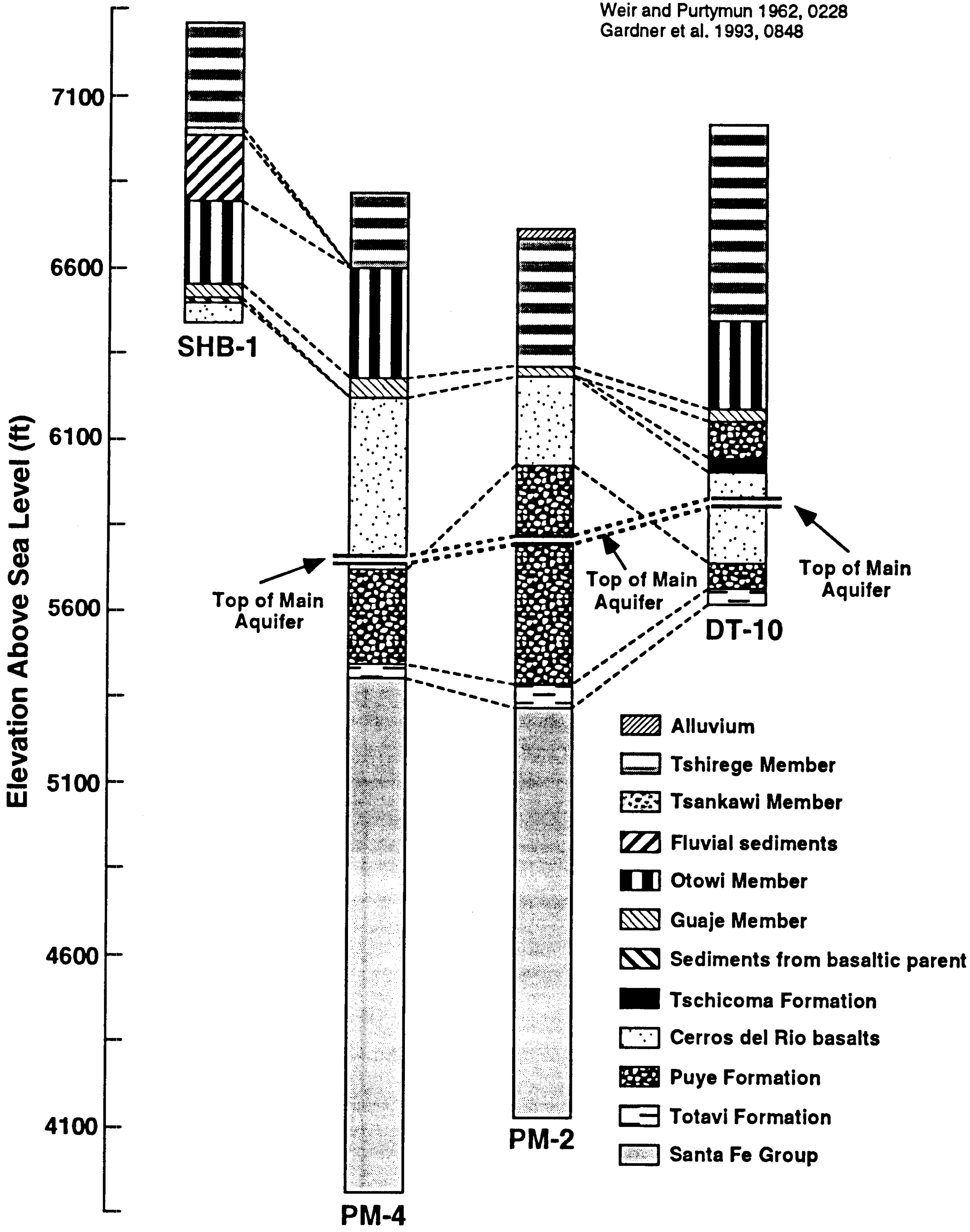


Figure 3-6. Stratigraphy in the vicinity of OU 1111.

The stratigraphic columns in Figure 3-6 show the major rock units that probably underlie OU 1111. Beginning with the oldest, units important to the OU are discussed below.

Santa Fe Group. The Santa Fe Group dates from about 21 to 4.5 million years ago. The maximum total thickness is probably about 7710 ft. It is believed to be completely saturated by the main aquifer under OU 1111 (albeit the top of the main aquifer probably occurs above the Santa Fe Group in the Puye Formation).

In PM-2, the Santa Fe Group consists of sand, gravel, and conglomerates interfingered with basalts (Cooper et al. 1965, 0495). At PM-4, the Santa Fe Group consists of silt, clay, and sand interfingered with basalts (Purtymun et al. 1983, 0712). The total thickness of the group cannot be estimated from PM-2, PM-4, or DT-10 because these wells did not extend through the Santa Fe Group.

Totavi Formation. This formation interfingers with the lower and middle parts of the Puye Formation. In PM-2 and PM-4, the Totavi Formation is described as a conglomerate consisting mostly of sands and gravels (Purtymun et al. 1983, 0712; Cooper et al. 1965, 0495). Its total thickness is 40 ft in PM-4 (Purtymun et al. 1983, 0712), 70 ft in PM-2 (Cooper et al. 1965, 0495), and 46 ft in DT-10 (Weir and Purtymun 1962, 0228).

Puye Formation. This formation dates from about 7 to 1.5 million years ago. It was deposited in an alluvial fan building eastward from the Jemez volcanic field. The detailed lithology of the formation depends on proximity to the source.

In PM-2 and PM-4, the Puye Formation is described as a conglomerate with interfingered basalts (Purtymun et al. 1983, 0712; Cooper et al. 1965, 0495). Its total thickness is 280 ft in PM-4 (Purtymun et al. 1983, 0712) and 640 ft in PM-2 (Cooper et al. 1965, 0495). In DT-10, the Puye Formation occurs above the Tschicoma Formation and, in part, below the Cerros del Rio basalts. It has a total thickness of 183 ft (Weir and Purtymun 1962, 0228).

Cerros del Rio Basalts. The Cerros del Rio volcanic field is 3.0 to 1.4 million years old. In SHB-1, PM-2, and PM-4, these units are described as basalts with traces of olivine and vugs lined with calcite (Gardner et al. 1993, 0848; Purtymun et al. 1983, 0712; Cooper et al. 1965, 0495). Interflow breccias containing silts, clays, and gravels are interfingered with the basalts at PM-4 (Purtymun et al. 1983, 0712). This unit is 500 ft thick in PM-4 (Purtymun et al. 1983, 0712), 263 ft thick in PM-2 (Cooper et al. 1965, 0495), and 269 ft thick in DT-10 (Weir and Purtymun 1962, 0228).

Purtymun et al. (1983, 0712) report encountering the top of the main aquifer at 1060 ft in PM-4; this places the aquifer in the Cerros del Rio basalts. Weir and Purtymun (1962, 0228) also encountered the top of the main aquifer within these basalts (at 5934 ft). However, the aquifer was not reported in this unit in PM-2 (Cooper et al. 1965, 0495).

Sediments from Basaltic Parent. Gardner et al. (1993, 0848) report 13 ft of sediment above the Cerros del Rio basalts at SHB-1; they apparently derived from a basaltic parent rock.

Tschicoma Formation. The Tschicoma Formation consists of porphyritic dacites, rhyodacites, and quartz latites (Bailey et al. 1969, 0019). This formation dates from 3 to 7 million years ago. It interfingers with the Santa Fe Group and Puye Formations in DT-10; part of the Puye Formation occurs above the Tschicoma Formation (Weir and Purtymun 1962, 0228). Weir and Purtymun (1962, 0228) report a thickness of 40 ft for the Tschicoma Formation at DT-10. This formation pinches out before reaching PM-2 or PM-4. The thickness of the Tschicoma Formation and the stratigraphic relationship between the Tschicoma Formation, the Cerros del Rio basalts, and the Puye Formation under OU 1111 are unknown.

Bandelier Tuff: Otowi Member. The Otowi Member was deposited during a volcanic event dated at 1.5 million years ago. Some parts of the Otowi Member have been altered by vapor-phase crystallization. The Otowi Member is 184 ft thick in SHB-1 (Gardner et al. 1993, 0848), 320 ft thick in PM-4 (Purtymun et al. 1983, 0712), 375 ft thick in PM-2 (Cooper et al. 1965, 0495), and 257 ft thick in DT-10 (Weir and Purtymun 1962, 0228).

The Guaje Pumice Bed is a fallout unit that forms the base of the Otowi Member. It is 41 ft thick in SHB-1 (Gardner et al. 1993, 0848), 60 ft thick in PM-4 (Purtymun et al. 1983, 0712), 27 ft thick in PM-2 (Cooper et al. 1965, 0495), and 35 ft thick in DT-10 (Weir and Purtymun 1962, 0228).

Cerro Toledo Rhyolite. The Cerro Toledo was erupted about 1.5 to 1.2 million years ago. It occurs between the Otowi and Tshirege members in some locations in Los Alamos County. Most reported occurrences are north of OU 1111. The rhyolite is not present in PM-4 (Purtymun et al. 1983, 0712) or DT-10 (Weir and Purtymun 1962, 0228), and PM-2 starts below the horizon at which the rhyolite would occur (Cooper et al. 1965, 0495). Gardner et al. (1993, 0848) report fallout material from the Cerro Toledo in SHB-1.

Fluvial Sediments. Gardner et al. (1993, 0848) found a 137-ft thick package of sediments overlying the Otowi Member. These sediments are fluvial in origin and consist of sands to gravels, with cobbles up to greater than 30 cm. Interbedded with these sediments are fallout ash and pumice from the Cerro Toledo.

Bandelier Tuff: Tshirege Member. The Tshirege Member of the Bandelier Tuff is the uppermost rock unit that underlies the mesa tops and canyon bottoms over most of OU 1111. It was deposited during a volcanic event dated at 1.1 million years ago.

The Tshirege Member is 310 ft thick in SHB-1 (Gardner et al. 1993, 0848), 220 ft thick in PM-4 (Purtymun et al. 1983, 0712) and 434 ft thick in DT-10 (Weir and Purtymun 1962, 0228). The Tshirege Member under OU 1111 must be thicker than it is in PM-4 because the mesa tops are higher in the stratigraphic section and closer to the source of the ash flow. PM-2 starts below the Tshirege Member (Cooper et al. 1965, 0495).

In some localities, the basal unit of the Tshirege Member is the Tsankawi Pumice Bed, which is a fallout unit. In SHB-1, Gardner et al. (1993, 0848) report an 8-ft-thick pumice unit that they correlate with the Tsankawi Pumice Bed. However, the Tsankawi Pumice Bed is not present in PM-2 (Purtymun et al. 1983, 0712) or DT-10 (Weir and Purtymun 1962, 0228). The distribution of Tsankawi pumice under OU 1111 is unknown.

3.4.2 Faults and Fractures

Faults and fractures can retard or enhance contaminant migration. In some cases, faults and fractures can serve as conduits that transport contaminants rapidly to an aquifer. However, it is difficult to estimate the effect fractures and faults have on hydrologic properties because no data exists for OU 1111 on fluid flow across fractures or on secondary minerals that may fill and seal the fracture.

Faults in the Los Alamos area are associated with the Pajarito fault system, which includes the Frijoles Canyon, Rendija Canyon, and Guaje Mountain faults (Figure 3-7). The Frijoles Canyon Fault lies within TAs-58 and -62, the buffer zones of OU 1111. With respect to the currently accepted direction of flow of the main aquifer, the Frijoles Canyon Fault is upgradient of the PRSs in OU 1111. Consequently, the Frijoles Canyon Fault should not affect contaminant transport at OU 1111. The Rendija Canyon and Guaje Mountain faults may occur in the eastern portions of the OU, but no detailed mapping has been done. The Water Canyon Fault, if it exists, may pass directly through OU 1111; however, no faults have been reported to date. Many of the faults branch into subsidiary faults, as can be seen in Figure 3-7, and there may be such faults in OU 1111. Inspection of the canyon walls continues, but no unambiguous faults have been observed. Such faults, however, are extremely difficult to locate unless new, well-exposed

Source: Dransfield and Gardner 1985, 0082
Gardner and House 1987, 0110

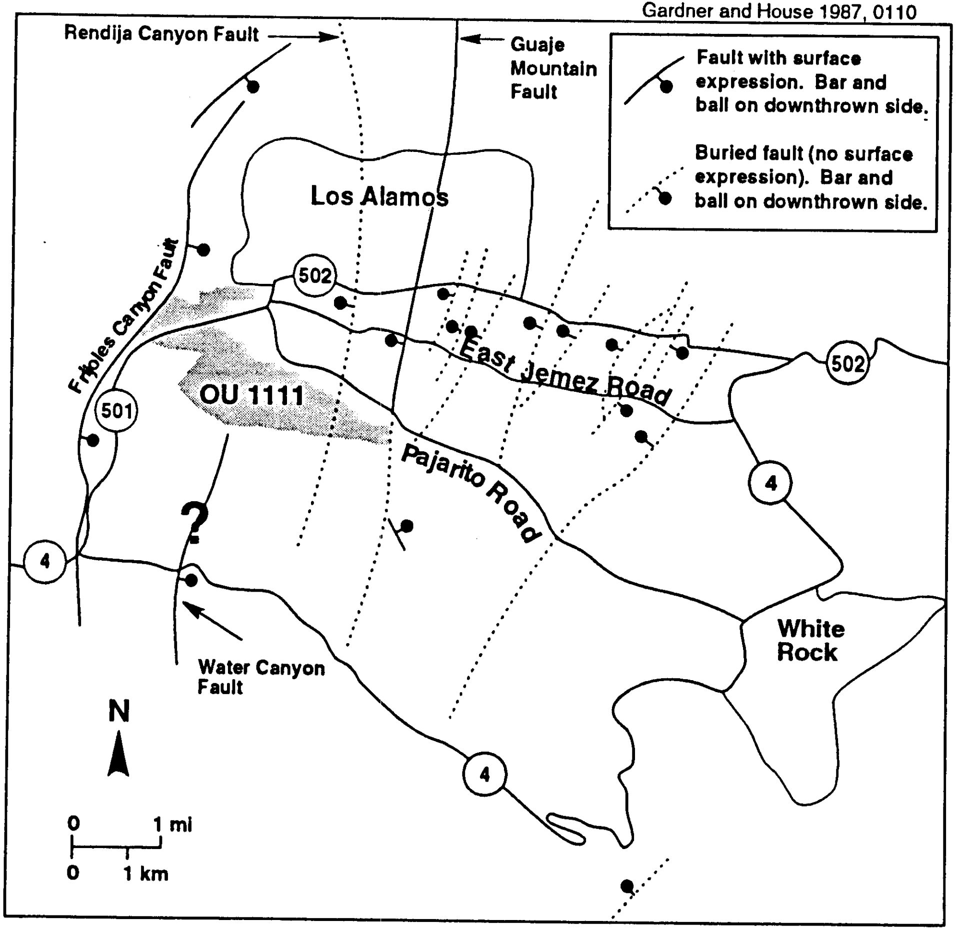


Figure 3-7. Map showing the faults in the Los Alamos area. The Water Canyon Fault (marked with a ?) may not exist.

cuts are available (Vaniman and Wohletz 1990, 0541). Thus, the detailed nature of faulting in OU 1111 is unknown.

During preliminary reconnaissance numerous possible fractures were observed on canyon walls in OU 1111. Two features are of particular interest. First, south of TA-40, the stream channel in Pajarito Canyon has an abrupt offset to the north (Guthrie 1993, 19-0073). Such abrupt offsets of stream channels may occur in association with a pre-existing fault or fracture. Second, drainage streams on one side of the canyon may be associated with fractures on the opposite side of the canyon. Because streams and fractures may align on both sides of the canyon, it is possible that some of these features represent faults or fractures that developed over a large region before formation of the canyon. In either case, these fractures may have more effect on the hydrology than more localized fractures.

Fractures in the tuff are a possible conduit for contaminant transport. Fracture development in Bandelier Tuff is related to degree of welding; more fractures are found in highly welded units, such as those in OU 1111. Deposition or precipitation from water that moves through fractures and the washings of detritus into open fractures are the processes commonly responsible for the fill in fractures. There have been few studies on these filled fractures. The role of fractures in water movement through the vadose zone of the Bandelier Tuff has been the focus of much debate but few quantitative studies. Purtymun and Kennedy (1971, 0200) described fractures in the welded tuff of Mesita del Buey. To a depth of at least 35 ft, these fractures are filled with weathered material that is coated with translocated clays and calcium carbonates, suggesting that water has moved along the fractures through the tuff. Kearl et al. (1991, 0652) recommend that, at a small scale, the role of fractures as transport pathways will need to be addressed at each site. The role of fractures and faults in contaminant transport in OU 1111 has not been investigated.

If risk assessment requires modeling of contaminant transport, additional mapping in the OU 1111 area will be needed to identify potential faults and fractures.

3.4.3 Surficial Deposits

3.4.3.1 Alluvium and Colluvium

Alluvium and colluvium deposits overlie the Bandelier Tuff on canyon bottoms, canyon sides, and mesa tops. These deposits are generally less than 35 ft thick and consist of volcaniclastic sediments and clay-rich to sandy deposits. Cooper et al. (1965, 0495) describe 30 ft of alluvium in Pajarito Canyon; the upper 7 ft consists of clay and boulders (as large as 1 ft) and the lower 23 ft consists of sand and gravel. No alluvium was described in PM-4 (Purtymun et al. 1983, 0712) or DT-10 (Weir and Purtymun 1962, 0228). Because alluvium is formed by fluvial processes, it can be absent on mesa tops.

3.4.3.2 Soils

Pajarito Plateau soils are discussed in Section 2.6.1.3 of the IWP. Because few soils studies have been done, information on soils and soil characteristics that influence contaminant transport is limited. If risk assessment requires modeling of contaminant transport, additional studies of soil properties will be needed.

Soils at OU 1111 can be divided into two major categories according to topographic position: mesa top and canyon wall soils. A map of OU 1111 soils is included at the end of this chapter.

Mesa Top Soils. Primary mesa top soils in OU 1111, as described by Nyhan et al. (1978, 0161), are the Carjo, Tocal, and Pogna soils series. The Carjo and Tocal soils are similar, but the Carjo soils are deeper. The upper horizon (8–10 in.) of these two soils is typically a loam or a fine sandy loam; at about 10 in., soil texture abruptly changes to a clay-rich horizon. The presence of a clay-rich horizon indicates a high degree of soil stability. Soils near the center of the mesa are more likely to show such a horizon and are deeper indicating less erosion than soils near the edges of the mesa. Natural erosion rates increase with proximity to canyon walls, as indicated by decreasing depth of soils. Thus, transport of contaminants may be less for PRSs located farther from the edges of the mesa. The Pogna soils series has a thin upper horizon overlying tuff parent material and erodes most easily.

Canyon Wall Soils. Canyon walls consist of about 90% bedrock outcrop and patches of shallow, undeveloped soils. North-facing canyon walls are steeper and often have areas of very dark-colored soils (e.g., small amounts of Pogna or Tocal soils) (Nyhan et al. 1978, 0161). These could catch contaminants transported off the mesa tops.

3.4.3.3 Erosional Processes

Many contaminants adhere to soils and sediments; hence, contaminant migration is often tied to erosional processes. Erosion at OU 1111 can occur by water and wind. Wind erosion is important if contaminated soils are exposed. This may be the situation at firing sites, outfalls, and other potentially contaminated areas. Water erosion is an important contaminant transport mechanism at disturbed sites when soils are exposed, infiltration is low, and, therefore, run-off is high. Potentially contaminated soils on steep slopes, such as at the plating facility outflow [22-015(c)], are especially susceptible to erosion.

3.5 Conceptual Hydrologic Model

Most contaminants are transported by water. Therefore, an understanding of water movement on the Pajarito Plateau is essential for understanding contaminant transport. Hydrologic studies of the Pajarito Plateau began in 1947 and continue today. No hydrologic studies have been specific to OU 1111, but inferences about water movement at OU 1111 can be made from studies on other parts of the plateau. These studies are discussed in Sections 2.6.3–2.6.8 of the IWP.

3.5.1 Surface Water Hydrology

Surface water in OU 1111 is generated by four major mechanisms: discharge from springs, snowmelt, thunderstorm run-off, and industrial and municipal effluent.

Surface waters from OU 1111 are drained by two major canyons: Pajarito Canyon and Two-Mile Canyon. Pajarito Canyon drains an area of about 4 mi^2, and Two-Mile Canyon drains an area of about 3 mi^2. Pajarito Canyon watershed experiences prolonged snowmelt run-off in the spring as well as run-off from summer thunderstorms. Springs and seeps originating from an alluvial fan southwest of TA-22 generate flow in Pajarito Canyon from just upstream of the inactive plating facility outflow [22-015(c)] to the eastern edge of the OU, with no apparent drop in flow along the OU border (Guthrie 1993, 19-0073). Stream flow in the upper portion of Pajarito Canyon may continue for most of the year but probably stops in drier years. Stream flow in Two-Mile Canyon is ephemeral. The watershed experiences relatively little snowmelt run-off because only a small portion of the watershed lies above 8,000 ft. Most run-off from this watershed is from summer thunderstorms, although intermittent springs also feed into this canyon. A spring in Two-Mile Canyon originates in alluvium and colluvium deposits on the northeastern edge of the OU [~0.5 mi northeast of 6-003(a)]. This spring is thought to discharge perched groundwater originating from infiltrating snowmelt and rain water deposited directly on the alluvium. Effluent discharges from TA-22 drain into Tributary B of Two-Mile Canyon. Stream flow is active at the confluence of Two-Mile and Pajarito canyons during the summer (Guthrie 1993, 19-0073); by November, flow may no longer occur (Guthrie 1993, 19-0074).

Areas of sustained saturation are associated with effluent, storm water run-off, seeps, and springs in OU 1111. Maps of wetland areas and a discussion of wetlands are included in Appendix C of the IWP (LANL 1992, 0768).

Measurements of thunderstorm run-off have been made in DP, Los Alamos, Potrillo, and Mortandad canyons (Purtymun 1974, 0193; Hakonson et al. 1976, 0097; Becker 1991, 0699). Hakonson et al. (1976, 0097) made detailed measurements of one run-off event in Mortandad Canyon. They found that most of the sediments and contaminants were transported during the first part of the event. Becker (1991, 0699) found that thunderstorm run-off in Potrillo Canyon was discontinuous. Run-off from the upper part of Potrillo Canyon never reached the outlet of the watershed because of high transmission losses. High transmission losses occur in all canyons with thick layers of alluvial deposits. Most of the run-off from summer thunderstorms rarely reaches the Rio Grande; winter run-off is more likely to reach the Rio Grande (Purtymun et al. 1990, 0215).

3.5.2 Hydrogeology

3.5.2.1 Vadose Zone

The unsaturated zone between the surface soil (root zone) and the groundwater table is usually called the vadose zone (Nielsen and Biggar 1982, 0885). Hydrology of the vadose zone of the Pajarito Plateau is described in Sections 2.6.2 and 2.6.3 of the IWP. The vadose zone may be up to 800 ft thick in OU 1111 but varies from mesa top to canyon bottoms. It may provide a barrier to contaminant migration through the tuff. Although much has been written about water movement through the tuff (e.g., Abrahams et al. 1961, 0015; Nyhan et al. 1985, 0168; Rush and Dexter 1985, 0397; Purtymun et al. 1989, 0214), few of these studies have addressed the problem quantitatively. Most of these studies have focused on water movement through the top 100 ft of the vadose zone. Studies suggest that water movement through the tuff to the main aquifer is limited or nonexistent.

Factors inhibiting extensive water movement are a high ratio of evapotranspiration to precipitation, a thick vadose zone, and low *in situ* moisture content of the vadose zone.

The hydrologic properties of the Bandelier Tuff have been described by Abeele et al. (1981, 0009). Porosity of the tuff varies from 20 to 60%; below about 35 ft, moisture content of the tuff is consistently less than 10%. Abeele et al. (1981, 0009) noted that weathering and plant roots were absent below 35 ft in the tuff, suggesting that water movement below this depth is very slow and unusual. Abrahams et al. (1961, 0015) reported limited water movement into the tuff from a small soil pit that held a constant head of water for a period of 99 days. They concluded that most of the water moved laterally through the soil. Abrahams et al. (1961, 0015) also monitored soil moisture in a variety of locations and found no evidence of rapid water movement from the soil to the tuff. Other soil moisture measurements (Abeele et al. 1981, 0009) are consistent with those made by Abrahams et al. (1961, 0015). Rush and Dexter (1985, 0397) concluded that aqueous transport of contaminants through the Bandelier Tuff is not a viable mechanism for contaminant migration at Material Disposal Areas (MDAs) G and L. This conclusion was based on empirical observation and low calculated flux rates.

The movement of water and contaminants deeper within the tuff has been studied by Purtymun et al. (1989, 0214) and Nyhan et al. (1985, 0168). Purtymun et al. performed injection well experiments into the Bandelier Tuff; 335,000 gal. of water were pumped into the tuff at a depth of 65 ft over a period of 89 days. After 200 days, the water plume extended to a depth of 200 ft. The authors concluded that, unless large quantities of water are provided continuously, there was little chance of water movement from the surface to the main aquifer. Nyhan et al. (1985, 0168) found that, in a 17-year period, plutonium and americium moved to a depth of at least 100 ft below a waste seepage pond at MDA T in TA-21. Measurements were made only to 100 ft. The conditions of the study represent a "worst case" scenario and are not representative of conditions for any of the PRSs at OU 1111. In 1961, an additional 66 ft of water was applied to the storage ponds at Area T in an aggressive effort to cause redistribution of contaminants. Results of this study indicate that contaminants and water will move through the tuff if there is a constant head of water at the surface.

Water content has not been measured for the vadose zone of OU 1111. Vadose zone water has been monitored in TA-16, south of OU 1111 (Brown et al. 1988, 0034), but no evidence was found of a saturated zone close to the surface. Water content of the tuff averaged about 6%.

3.5.2.2 Saturated Alluvium and Colluvium

Alluvial aquifers occur in canyons that originate in the Sierra de los Valles or that have industrial effluents discharged into them; these include Pajarito, Pueblo, Los Alamos, and Mortandad canyons. Surface water run-off infiltrates into the highly permeable alluvium and rarely reaches the Rio Grande (Purtymun et al. 1990, 0215). Water in alluvium is stored, lost to evapotranspiration, or seeps into the underlying tuff. The underlying tuff is thought to prevent water movement from the alluvial aquifers to the main aquifer (Purtymun 1974, 0192; Devaurs and Purtymun 1985, 0049; Baltz et al. 1963, 0024), but Kearl et al. (1991, 0652) suggest that more information is needed to confirm this conclusion. There have been no studies designed explicitly to evaluate a connection between alluvial aquifers and the main aquifer (Kearl et al. 1991, 0652). Stoker et al. (1991, 0715) found traces of tritium and nitrates from Laboratory operations in tuff below the alluvial aquifer in Mortandad Canyon, indicating water movement into the underlying tuff. Hydrogeologic characteristics (source of water, geometry, water-level fluctuations, nature of perching layer, hydraulic conductivity, effective porosity, hydraulic gradient, leakage to underlying units, and evaporative losses) of the alluvial aquifers are not well known (Kearl et al. 1991, 0652).

The alluvial aquifer underlying Mortandad Canyon has been the most extensively studied on the plateau (Purtymun 1974, 0192; Purtymun et al. 1977, 0206; Devaurs and Purtymun 1985, 0049). This aquifer is recharged mainly by industrial effluents released into the canyon. Purtymun (1974, 0192) used tritium releases in this effluent to estimate the rate of water movement and to determine how water exited the system. He concluded that about 50% of the water was lost to evapotranspiration and about 40% dispersed into the underlying tuff. The fate of the remaining 10% was not discussed. The significance of evapotranspiration loss from these alluvial aquifers is disputed (Kearl et al. 1991, 0652).

There is no indication of an alluvial aquifer in Pajarito Canyon within OU 1111 (Guthrie 1993, 19-0073); however, an alluvial aquifer is present in the lower reaches of Pajarito Canyon (Devaurs and Purtymun 1985, 0049) near Mesita del Buey. It is not known whether an alluvial aquifer exists in Two-Mile Canyon or any of its tributaries. If risk assessment requires modeling of contaminant transport to aquifers, additional characterization of aquifers under OU 1111 will be needed.

3.5.2.3 Perched Aquifers

A perched aquifer is an isolated body of groundwater that is separated from the main aquifer by unsaturated formations. On the Pajarito Plateau, perched aquifers have been found at about 130 ft below the surface in Pueblo and Los Alamos canyons. These aquifers are hydrologically connected to the stream flow in the canyons (Purtymun 1973, 0191) and are located in basalts and conglomerates overlying the main aquifer.

There has been no deep drilling in OU 1111. However, drilling has been conducted at points east of the OU in canyons transecting the mesas. The perched zone in those canyons has been monitored, and no perched aquifers have been identified (LANL 1991, 0553). By inference, no perched aquifers are expected to be present on OU 1111.

3.5.2.4 Main Aquifer

Because it serves as the water supply for Los Alamos County, the main aquifer has been the subject of many hydrologic studies on the Pajarito Plateau. Three well fields with 16 supply wells, 10 test wells, and 2 stock wells have been developed (Appendix C, IWP). Characterization of the aquifer is based on information from these wells and from springs discharging into the Rio Grande at White Rock Canyon. Purtymun (1984, 0196) provides a detailed description of the data gathered during studies.

The main aquifer is found in the Santa Fe Group and the Puye Formation at depths of less than 330 ft in canyon bottoms at the eastern end of the Pajarito Plateau and over 1200 ft on the mesa tops on the western end of the OU. Sediments of the Santa Fe Group and the Puye Formation are much more permeable than the overlying Bandelier Tuff. Permeability of the Santa Fe Group is low where fine-grained sediments (silts and clays) predominate but is high where coarse volcanic debris is common. The Puye Formation overlies the Santa Fe Group and is highly permeable. Chino Mesa basalts interfinger the Santa Fe Group and Puye Formation and are thickest in White Rock Canyon. Purtymun (1984, 0196) states that these thick basalts form a hydrologic barrier to water movement, resulting in the artesian conditions found at the eastern end of the plateau. The thickness of the aquifer is unknown, but permeable sediments below the plateau are about 15,000 ft thick (Purtymun 1984, 0196). The Rio Grande is the major discharge zone for the main aquifer.

The most commonly accepted conceptual model for recharge of the main aquifer was suggested by Purtymun (1984, 0196). In this model, the Valles Caldera in the Sierra de los Valles serves as the main recharge area, and a small amount of recharge occurs on the Pajarito Plateau. Water moves from the highly permeable sediments underlying the Valles Caldera into the Tesuque Formation. Kearl et al. (1991, 0652) have proposed a different conceptual model for recharge of the main aquifer. They suggest that significant recharge occurs on the Pajarito Plateau through canyon bottoms and major fault zones and that the aquifer underlying the plateau is hydrologically connected to the regional aquifer in the Española Basin. The Sangre de Cristo Mountains east of the basin serve as the main recharge area for the regional aquifer. No studies have explicitly examined the amount of recharge to the main aquifer from the mesa tops (Kearl et al. 1991, 0652).

At OU 1111, the main aquifer is estimated to range between 6200 and 6000 ft above sea level, which is about 1200 ft below the surface of Two-Mile Mesa (Purtymun 1984, 0196). No measurements of the depth of the main aquifer have been made in OU 1111.

3.6 Conceptual Three-Dimensional Geologic/Hydrologic Model of OU 1111

A conceptual model of the hydrologic and geologic setting of OU 1111 is presented in Figure 3-8. Major potential pathways for contaminant migration are depicted. The primary release mechanisms and migration pathways of concern are surface run-off and associated erosion and atmospheric dispersion. These pathways are believed to provide the greatest potential for release of contaminants. Pathways of lesser concern are infiltration and transport into the vadose zone, alluvial aquifers, springs, and seeps.

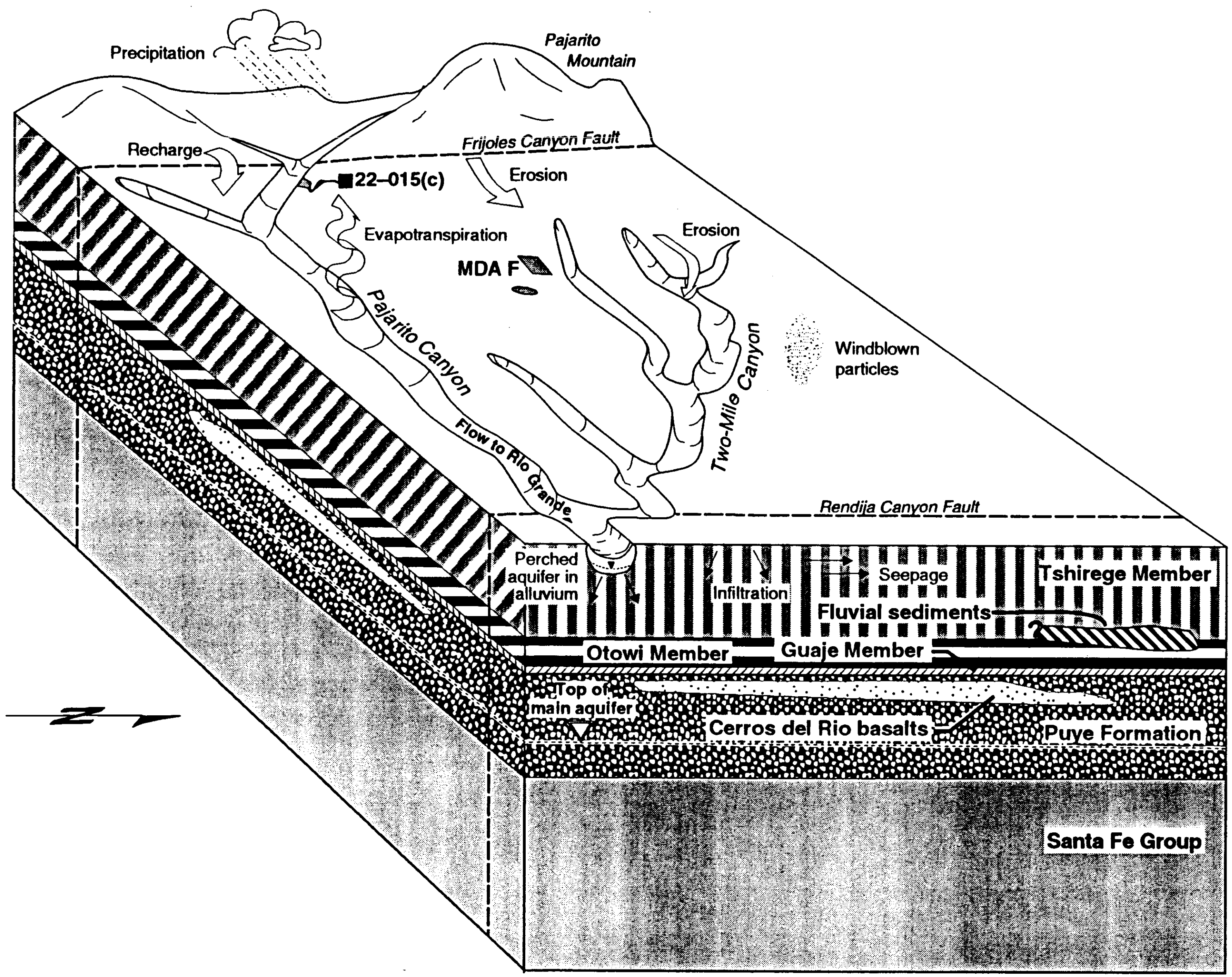


Figure 3-8. Conceptual hydrogeologic model of OU 1111.

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Executive Summary

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Chapter 3
Environmental Setting

Chapter 4
Technical Approach for Determination of RFI Data Needs

Chapter 5
Evaluation of Potential Release Sites

Chapter 6
Units Proposed for No Further Action

Annexes

Appendix A

Chapter 4

- Aggregation of PRSs
- Approach to Site Characterization
- Conceptual Exposure Model
- Potential Response Actions and Evaluation Criteria
- Sampling Strategies and Sampling Methods
- Analytical Methods

4.0 TECHNICAL APPROACH FOR DETERMINATION OF RFI DATA NEEDS

The technical approach to designing the Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) for Operable Unit (OU) 1111 focuses on meeting site characterization requirements cost effectively. This approach incorporates a decision-making process that is consistent with the installation work plan (IWP) and proposed RCRA Subpart S to 40 CFR 264 for recommending potential release sites (PRSs) for no further action or for further study. A streamlined approach and a phased site-characterization methodology, which follow Environmental Protection Agency (EPA) and IWP guidelines, are integral parts of this technical approach. The approach used in developing this work plan is outlined in Chapter 4 of the IWP.

The basic elements of this technical approach follow.

- Existing information provides a basis for understanding the processes and events that produced each PRS and any contaminant(s) of concern,* for identifying PRSs that may be proposed for no further action because no potential hazard exists, and for determining the extent of the Phase I investigation.
- Phase I investigations will be carried out for each PRS that could contain contaminants of concern. The Phase I investigation will verify the presence or absence of contaminants of concern and supplement the existing data on site conditions.
- Data obtained during Phase I will be used to decide which PRSs can be recommended for no further action and which need further study (Phase II). Phase I data will help guide the design of the Phase II investigations. Interim reports will be submitted as work proceeds.
- Phase II studies can include risk analysis, additional sampling, and analysis of data that can contribute to evaluation of the risks posed by the PRS. If sufficient information is available from Phase I, Phase II studies may also include voluntary corrective actions (VCAs) or analysis of possible remediation alternatives under a corrective measures study (CMS).
- The results of the field investigations and the recommendations for PRSs (arrived at using the decision analysis process described below) will be presented in detail in a final RFI report.

4.1 Aggregation of PRSs

In this work plan, PRSs are aggregated on the basis of similarity of structures, uses, history, and geographic proximity. The aggregates and their PRSs are summarized in Table 4-1.

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* The phrase "contaminants of concern" is used throughout this report, as it is in the IWP. It indicates potentially hazardous constituents that are present above the screening action levels (SALs) defined in Chapter 4 of the IWP.

TABLE 4-1

PRS AGGREGATES

Aggregate Number	Aggregate Title	SWMU Number on HSWA Permit	SWMU Number in SWMU Report
1	Materials Disposal Area F and adjacent pit		6-005
		6-007	6-007(a-e)
2	Plating and etching outfall	22-008	22-015(c)
3	Sump and dry well systems and adjacent wash pad		22-012 22-014(a)
		22-005	22-014(b)
		22-006	22-015(a)
		22-007	22-015(b)
		22-009	22-015(d)
			22-015(e)
		40-005	40-005
4	Inactive firing sites		6-003(a, c, d, e, f,* g*) 6-008
		7-001(a, b)	7-001(a, b) 7-001(c,* d*)
5	Disposal areas		6-007(f, g*)
		40-009	40-009 40-010*
6	Septic systems	6-001(a, b)	6-001(a, b)
		22-010(a, b)	22-010(a, b)
		22-010(c)	22-016
		40-001(b, c)	40-001(b, c)
7	Active firing sites	40-006(a-c)	40-006(a-c)
8	Former structure sites	6-002	6-002 C-6-001 C-6-003 C-6-005—C-6-021
9	Former container storage areas	6-006	6-006
		40-004	40-004
10	Storage areas		40-007(a-e)

*Designations assigned since publication of SWMU Report (LANL 1990, 0145).

4.2 Approach to Site Characterization

In general, the approach to characterizing PRSs in OU 1111 follows the approach given in Chapter 4 of the IWP (LANL 1992, 0768). The data quality objectives (DQO) process ensures that proposed data collection activities are carefully developed from and tied back to decision criteria and strategies. The proposed investigation is planned in phases so that data needs can be re-evaluated after each phase to develop the site conceptual exposure model. In this work plan, the Phase I investigation of each PRS for which a sampling plan is provided will attempt to fill in missing information. This phased approach is intended to produce a streamlined investigation that is biased for action and in agreement with the philosophy underlying proposed RCRA Subpart S.

The observational approach provides guidelines for determining the level of detail appropriate for site characterization before engineering a corrective measure (Appendix G, IWP) (LANL 1992, 0768). For the RFI, the goal is to establish the most probable site conditions with sufficient precision to allow the remaining uncertainties to be handled by contingency plans in the remedial design and implementation phases. Site characterization beyond a certain level of detail is more efficiently continued in parallel with corrective measures implementation (CMI), provided that appropriate observational programs are incorporated in this phase.

Existing information on the history of Technical Areas (TAs) 6, 7, 22, 40, 58, and 62 was obtained from Los Alamos National Laboratory (the Laboratory) archives and other records, including reports, memorandums, engineering drawings, aerial photographs, and formal and informal interviews with Laboratory personnel. This information was used to determine the processes that may have contributed to the PRSs. Additionally, field observations were undertaken for the purpose of confirming geologic and hydrologic information and for identifying PRSs and potential migration pathways. These data are the basis for decisions made in this work plan.

The available information suggests that the presence of contaminants of concern is unlikely at most of the PRSs in OU 1111, but most PRSs in OU 1111 have not been sampled or monitored. Sampling plans were developed to test whether contaminants of concern are present or absent. Reconnaissance sampling, described in Appendix H of the IWP (LANL 1992, 0768), is proposed in most sampling plans in Chapter 5. The areas sampled are those judged most likely to contain contaminants of concern on the basis of the archival information, the professional judgment of the OU 1111 work plan team, and the professional judgment of the sampling teams in the field. By sampling those areas, the probability of finding contaminants of concern will be higher than stated for reconnaissance sampling. All PRSs that may contain contaminants of concern will be investigated during Phase I. Enough data will be collected to determine whether the PRS can be recommended for no further action or a Phase II investigation is necessary.

Phase I of the sampling plan consists of sampling two types of areas: those that may have received hazardous constituents directly from the source and those that may later have received the constituents, such as channels carrying surface run-off away from the site. If Phase I data show that contaminants of concern are present, Phase II studies will be proposed. Phase II studies will assess the risk presented by contaminants of concern in the PRS. If additional data are required, further sampling and other studies may be necessary. If sufficient information is available, a CMS may be undertaken in place of a Phase II investigation.

Phase I is the first step in a streamlined approach to characterizing OU 1111 and the potential need for remediation. Reconnaissance sampling is expected to screen out those PRSs containing no constituents above SALs so that they can be recommended for no further action. Resources can then be focused on Phase II investigations of the remaining PRSs and, if necessary, CMSs and CMIs.

4.2.1 Decision Analysis

The decision strategy outlined in Section 4.1 of the IWP (LANL 1992, 0768) was used to develop the sampling and analysis plans presented in Chapter 5. Section 4.2.2 and this section summarize the decision strategy in Section 4.1 of the IWP and how it has been used in this work plan.

The principal decisions required during the RCRA process concern potential corrective actions. Two decisions are required by the conclusion of the RFI: whether corrective action is required for the site and whether a CMS is required to select and design an appropriate corrective action. Other options available at the end of the RFI include (1) proposing no further action; (2) deferring action, and often deferring investigation as well, until an active site becomes inactive; or (3) a VCA. If a CMS is required to evaluate remedial alternatives, it includes additional decisions, such as determining cleanup standards for contaminated environmental media and selecting and designing a corrective measure to meet these standards. The principal decisions during the CMI concern verifying the completion and effectiveness of the remedy.

The sampling and analysis plans in Chapter 5 constitute the first step in addressing whether corrective action is required. Additionally, the information gathered during Phase I investigations will contribute to determining whether a CMS is required, determining cleanup standards, and selecting and designing a corrective measure, if one is necessary.

The Department of Energy's streamlined approach for environmental restoration (ER) provides a starting point for a technical approach to support the decisions outlined above. The streamlined approach combines elements of the observational approach (Appendix G, IWP) (LANL 1992, 0768) and EPA's DQO process for designing data collection to support environmental decision making.

The approach implements a program of phased site characterization that continues beyond the RFI into the corrective action stages of the process. The phased approach expedites corrective action by progressing to the later steps of the RCRA process as soon as possible. Although understanding of the site may change as more site detail is acquired, reasonable deviations can be accommodated by careful contingency planning during the CMS and site monitoring during the CMI. The goal of the RFI is to characterize the site sufficiently to design a corrective measure with contingencies that can effectively accommodate reasonably likely deviations. More detailed characterization may be carried out during the CMI.

The organization of Chapter 5 in this work plan is based on the DQO process. Each step in the DQO process is treated implicitly in subsections. The steps of the DQO process and the subsections in which they are contained are included in Table 4-2. Section 5.x.4 presents the sampling and analysis plan, which consists of instructions for sample collection that result from the DQO process.

Although details of the process differed for PRS aggregates, the organization of Chapter 5 presents the results of the DQO process in a consistent way for all PRS aggregates.

TABLE 4-2

DQO PROCESS STEPS AND CORRESPONDING SECTIONS

DQO Step	Chapter 5 Sections
1. Problem statement	5.x.2. Remediation Decisions and Investigation Objectives
2. Remediation alternatives	5.x.2. Remediation Decisions and Investigation Objectives
3. Decision input	Available information is found in 5.x.1. Additional data and background needed for decisions are discussed in 5.x.3, Data Needs and Data Quality Objectives
4. Decision domain	5.x.3. Data Needs and Data Quality Objectives
5. Evaluation logic	4.2.2. Evaluation Logic 5.x.3. Data Needs and Data Quality Objectives
6. Acceptable uncertainty limits	5.x.3.1.1 Source Characterization
7. Data Needs	5.x.3. Data Needs and Data Quality Objectives

4.2.2. Evaluation Logic

The decision strategy is diagrammed in Figure 4-1 of the IWP (LANL 1992, 0768); it is reproduced here as Figure 4-1.

In this work plan, the existing information about PRSs is reviewed, preliminary conceptual exposure models have been developed, and recommendations for further action are made. These actions include no further action, VCA, deferral of investigation until closure, and Phase II RFI investigation. These options are discussed in detail later in Chapter 4.

The first phase of RFI field work, which is described in this work plan, is designed to provide a basis for the following decisions from Figure 4-1.

- Are current risks above acceptable levels?
- Are there any contaminants of concern?

In a few cases, additional data or studies are recommended to support the decision on whether a CMS is necessary.

The conceptual exposure model and the distribution of any contaminants of concern will be more fully addressed in the Phase II investigations that are judged necessary. The Phase II sampling plans will be based on the amount and type of data available from any previous work. New technologies for remediation may also affect Phase II sampling plans.

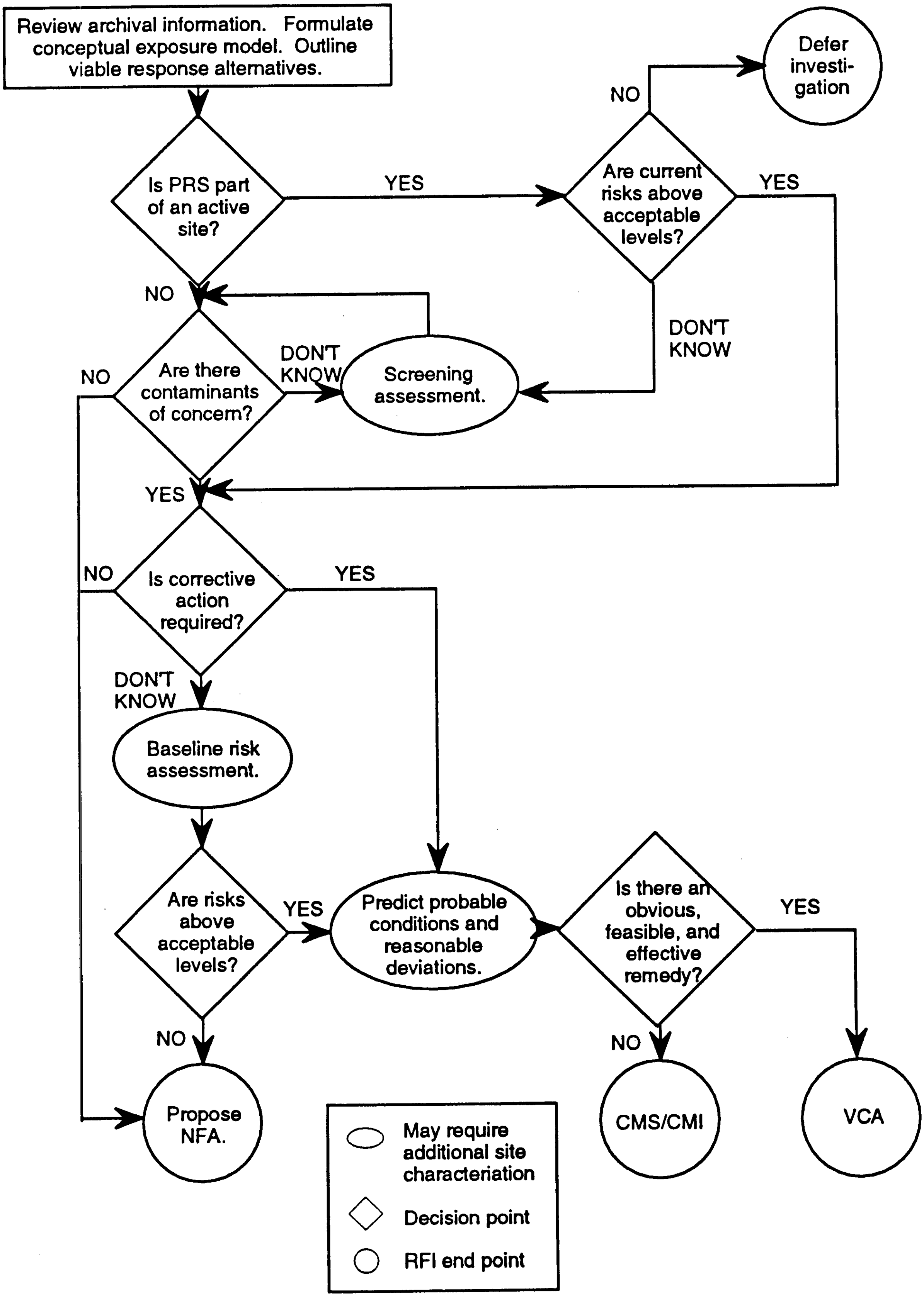

Figure 4-1. Decision flow during the RFI.

4.2.3 Screening Action Levels

SALs are media-specific concentration levels for constituents that can be compared with concentration levels measured during the RFI. The use of SALs and derivation of SALs in the Los Alamos ER Program are discussed in Section 4.2.2 of the IWP (LANL 1992, 0768). SAL values are presented in Appendix J of the IWP. These values or their updated equivalents will be used in the decisions described in this work plan.

Preliminary or final decisions about the site will be made on the basis of the comparison of concentration levels measured during the RFI. For example, a PRS will be recommended for no further action because results of sample analysis are below SALs or may be recommended for a Phase II investigation because results of sample analysis are above SALs. For all such decisions, the measured concentration levels must be validated at a level of quality assurance (QA) appropriate for the decision to be made. QA levels are discussed in Section 4.6.4, and QA procedures are listed in Annex II.

Sample concentration values will be subjected to a screening assessment, the basis for which is comparison to SALs. SALs for many potential contaminants have been derived for soil and water and will be included in the 1993 and subsequent versions of the IWP. For sediment samples taken as part of this RFI, soil SALs will be used. These comparisons will follow protocols to be determined for the ER Program as a whole.

Background concentration levels are being determined for the ER Program as a whole. As part of this determination, samples will be collected from locations within OU 1111 that correspond to sampling locations but are expected not to contain contaminants.

SALs are not cleanup levels; cleanup levels will be based on site-specific risk evaluations and as low as reasonably achievable criteria. In most cases, cleanup levels will be higher than SALs. For example, if the site will never be used for residential use, the site-specific land-use scenario (e.g., recreational use) could allow higher levels of soil contamination than the conservative residential use scenario used to calculate SALs.

4.2.4 Voluntary Corrective Action

A VCA is initiated by the Laboratory if archival information, site observations, or sampling and analysis results indicate that immediate action is required; the corrective action is obvious and does not require study; and the action can be accomplished in an efficient and cost-effective manner. A VCA will involve cleanup or stabilization measures adequate to reduce risk to an acceptable level. The VCA may consist of an interim action, which could include covering or removal of selected wastes, installation of a barrier fence or warning signs, and improving storm water management. An interim action may include plans for monitoring and implies that the PRS continues through the RFI/CMS process.

VCAs, including interim actions, are recommended for some sumps and septic systems (Sections 5.3 and 5.6) and for some surface disposal sites (Section 5.5). VCAs recommended in this work plan are listed in Table 4-3.

TABLE 4-3

PROPOSED VOLUNTARY CORRECTIVE ACTIONS

HSWA Permit SWMU Numbers	Current SWMU Numbers	SWMU Title	Action Recommended
6-001(a)	6-001(a)	Septic system	Concurrent removal and sampling of tank
6-001(b)	6-001(b)	Septic system	Concurrent removal and sampling of tank
	6-007(f)	Surface disposal	Removal of surface debris
	6-007(g)	Surface disposal and former building site	Removal of surface debris
22-007	22-015(b)	Sump and outfall	Concurrent removal and sampling of sump
22-009 and 22-011	22-015(d)	Sump and seepage pit	Concurrent removal and sampling of sump
22-009	22-015(e)	Sump and outfall	Concurrent removal and sampling with Wash Pad 22-012
	22-012	Wash pad	Concurrent removal and sampling with Sump 22-015(e)
22-010(a)	22-010(a)	Septic system	Concurrent removal and sampling of tank
22-010(b)	22-010(b)	Septic system	Concurrent removal and sampling of tank
22-010(c)	22-016	Septic system	Concurrent removal and sampling of tank

4.2.5 Active Sites

A number of PRSs in OU 1111 are currently being used for Laboratory functions (e.g., some of the septic systems and firing sites). These sites will be characterized to determine whether they present a risk to site workers or have a potential for off-site migration and resulting risk to off-site personnel. If a site does not present a risk to site workers or have a potential for off-site migration, a more complete characterization will be deferred until the site is decommissioned.

The Laboratory plans no decommissioning of active sites in OU 1111, with the exception of two septic systems; plans exist to connect these systems to the Sanitary Wastewater Consolidation System in 1994. Sump systems for explosives wastewater may be decommissioned later. Sampling plans are presented for these solid waste management units as if they were inactive (Section 5.6). Active sites are listed in Table 4-4.

4.3. Conceptual Exposure Model

A general approach to conceptual exposure models is provided in Section 4.3.3 of the IWP (LANL 1992, 0768). Possible primary sources of contaminants in OU 1111 include septic systems, sump systems, the plating and etching outfall and run-off area, firing sites, Materials Disposal Area (MDA) F, storage areas, and smaller surface disposal sites. Possible secondary sources of contaminants

TABLE 4-4

ACTIVE SITES

SWMU Number in HSWA Permit	SWMU Number in 1990 SWMU Report	SWMU Title	Characterization Schedule
22-005	22-014(b)	Sump and outfall	Preliminary characterization during RFI
22-010(a)	22-010(a)	Septic system	To be connected to SWCS (as inactive)
22-010(b)	22-010(b)	Septic system	To be connected to SWCS (as inactive)
	22-013	Liquid waste treatment/storage	No further action
	22-014(a)	Sump and seepage well	Preliminary characterization during RFI
40-001(b)	40-001(b)	Septic system	Preliminary characterization during RFI
40-001(c)	40-001(c)	Septic system	Preliminary characterization during RFI
40-005	40-005	Sump	Preliminary characterization during RFI
40-006(a)	40-006(a)	Firing pads	Characterize for possible migration
40-006(b)	40-006(b)	Firing pad	Characterize for possible migration
40-006(c)	40-006(c)	Firing pad	Characterize for possible migration

include surface soils and sediments, subsurface soil and rock, groundwater, surface waters, and biota; these sources may contain contaminants as a result of releases from the primary sources. Primary release mechanisms include leakage, infiltration, leaching, erosion, spills, and discharges. Transport mechanisms include wind and water erosion, subsurface water percolation and vapor diffusion, and food chains. Exposure routes to receptors include direct contact, inhalation, ingestion, and external radiation. The primary human receptors of contaminants are workers on site and possibly on adjacent sites. It is unlikely that visitors would come into contact with contaminated media because access to the areas containing the PRSs is restricted. Nonhuman receptors, native fauna and flora, may be exposed to contaminants from the site.

Current Laboratory plans are to continue the present uses of OU 1111. If the Laboratory were to release the land in OU 1111, the most likely future use appears to be as a part of Bandelier National Monument or the Santa Fe National Forest. In these cases, a recreational scenario would be appropriate for the conceptual exposure model.

4.3.1 Generic Source Information

Explosives and their residues may be found in many PRSs in OU 1111. Most explosives and their decomposition products have some effect on physiological functions, and some are toxic or carcinogenic. In addition, explosives can pose a safety hazard to operations if they are present in detonable quantities. Although we believe that detonable quantities of explosives are not present in the environment in OU 1111, this possibility must be considered for safety purposes. PETN, RDX, HMX, and TNT are the explosives most likely to be found in significant quantities in OU 1111.

In areas where detonators were processed (TAs-6 and -22), pentaerythritol tetranitrate (PETN) was predominantly used; other explosives were tetryl, RDX, HMX, and plastic-bonded RDX and HMX. Because it was recrystallized from solution in several buildings in OU 1111, PETN may be found in the outfalls, septic systems, and outflow areas from those buildings. The total amount of PETN used in detonator processing at all locations in OU 1111 has been estimated to be no more than 585 lb., with total losses estimated at no more than 1.5 lb. (Meyers 1993, 19-0044) (Table 4-5). A 20-year study showed that its decomposition rate in soils is slow (DuBois and Baytos 1991, 0718), and therefore, few decomposition products are expected. The decomposition rate for PETN, expressed as its half-life, is 92 years. For RDX, HMX, and TNT, half-lives are 36 years, 39 years, and 1 year, respectively (DuBois and Baytos 1991, 0718).

TABLE 4-5

PETN RECRYSTALLIZATION IN OU 1111

Location	Operation	Estimated Total PETN	Estimated Maximum PETN Losses to Drains	Potentially Affected SWMUs
TA-6-6	Laboratory	Very small	Very small	6-001(b)
TA-6-10	Production	27 lb.	0.03 lb.	6-002
TA-22-34	Laboratory	16 lb.	0.02 lb.	22-010(a) 22-014(b)
TA-22-1, Room 109	Production	18 lb.	0.02 lb.	22-010(b) 22-015(d) 22-016
TA-22-25	Production	540 lb.	Less than 1 lb.	22-015(b)

All estimates from Meyers (1993, 19-0044). "Very small" is listed for the TA-6-6 laboratory because it was used for less than a year.

In areas where explosives were fired (TA-6 and -40), other explosives were used in addition to those listed for detonators. These included TNT, Composition B, Composition C, Cyclotol, TATB, and all of the plastic-bonded compositions, which contain RDX, HMX, and TATB, made by the Laboratory. Test-firing activities typically result in complete destruction of the explosive component, but failed tests may scatter explosives. TATB, an insensitive explosive used since about 1970, may have been scattered around the TA-40 firing sites. For reasons of worker safety, the practice at the firing sites in OU 1111 has been to recover pieces of scattered explosives when a misfire occurs. However, release of explosives as small particulates to the environment may occur during such incidents. Other residues of explosives include polycyclic aromatic hydrocarbons and other semivolatile organic compounds.

The destruction of defective explosive components during 1944 and 1945 may have resulted in the release of contaminants. These components contained Composition B (TNT and RDX) and Baratol (TNT and barium nitrate) (Creamer

1993, 19-0078). This operation was carried out near the present MDA F. Barium and TNT in soils are the primary contaminants to be expected from this operation. Sampling is discussed in Section 5.1.

The explosives used in OU 1111 are solids at ambient temperatures and are very insoluble in water. They are chemically unreactive with water and air at ambient conditions, but TNT and the nitramine explosives (RDX and HMX) are known to be degraded by soil organisms (Walsh 1990, 0853; Walsh and Jenkins 1992, 0854). Relatively little is known about their migration or the migration of their decomposition products in the environment. Their physical properties suggest that transport is more likely as colloids or small particles than as solutes in water.

Metals are likely to be present in outflows and at firing sites. The predominant metals known to have been used are copper, cobalt, uranium, iron, nickel, lead, and chromium.

As discussed in Chapter 2, very few radionuclides have been used in OU 1111. The only radionuclides known to have been used in significant quantities are short-lived radionuclides (now decayed to negligible concentrations), natural and depleted uranium, and cesium-137 contained in spark gaps (Meyers 1993, 19-0112). In 1944, a few explosives tests used radioactive copper as a tracer material. The copper was prepared by neutron irradiation. Of several isotopes that may have been produced, copper-64, which has a half-life of about 12 hours, was probably predominant. Material from weapons effects tests conducted at the Nevada Test Site was examined at TA-22 on probably less than five occasions. This material may have carried very small amounts of fission and activation products, but it was not retained or disposed of at OU 1111. Finally, a small amount of radioactive gold isotopes were processed at the plating facility in TA-22-52 (Section 5.2.1). The longest-lived radioactive gold isotope has a half-life of 186 days. Uranium was managed at a number of solid waste management units, and the disposal of cesium-137 spark gaps in MDA F is discussed in Section 5.1. These are the only known uses of radionuclides in OU 1111.

Common organic solvents, such as acetone, carbon tetrachloride, and alcohols, have been used in processing and assembly operations. The most commonly used solvent in the PETN recrystallization process was acetone; carbon tetrachloride was used only experimentally. The basic recipe called for 1100 g of acetone for a 240-g batch of PETN. Ethyl alcohol was used in combination with acetone in later years. Most of these solvents have probably evaporated since deposition, but sampling is planned for areas where they may have been present. No surface samples will be analyzed for volatile organic compounds (VOCs), but subsurface samples will be analyzed for VOCs.

Table 4-6 summarizes potential contaminants, their SALs, and the PRSs at which they occur.

4.3.2 Potential Environmental Pathways

Water Transport. Transport of contaminants is closely tied to sediment transport. Most heavy metals bind tightly with soil particles, particularly the fine-grained silts and clays, which can be carried by water to considerable distances downstream. Transport of soluble constituents and sediment by surface run-off will be high around disturbed areas, such as firing sites and outfalls. Receptors in and near

TABLE 4-6

POTENTIAL CONTAMINANTS, OU 1111

Potential Contaminants[a]	Soil SAL (mg/kg)[b]	PRSs That May Contain the Potential Contaminant
Explosives		
HMX	4000	6-003(a, c-f), 6-007(a-g), 6-005, 6-008, 7-001(a, b, d), 22-010(a, b), 22-012, 22-014(a, b), 22-015(d, e), 22-016, 40-001(b, c), 40-005, 40-006(a-c), 40-007(a-e), 40-009, 40-010, C-6-001, C-6-003, C-6-005, C-6-006, C-6-007, C-6-008, C-6-009, C-6-010, C-6-011, C-6-012, C-6-013, C-6-014, C-6-015, C-6-016, C-6-017, C-6-018, C-6-019, C-6-020, C-6-021; Buildings TA-40-4, -9, -12
HNS		40-006(a-c), 40-007(a-e), 40-009; Buildings TA-40-4, -9, -12
Nitroguanidine		40-006(a-c), 40-007(a-e), 40-009; Buildings TA-40-4, -9, -12
PETN	1600	6-002, 6-003(a, c-g), 6-007(a-g), 6-005, 6-008, 7-001(a, b, d), 22-010(a, b), 22-012, 22-014(a, b), 22-015(b, d, e), 22-016, 40-001(b, c), 40-005, 40-006(a-c), 40-007(a-e), 40-009, 40-010, C-6-001, C-6-003, C-6-005, C-6-006, C-6-007, C-6-008, C-6-009, C-6-010, C-6-011, C-6-012, C-6-013, C-6-014, C-6-015, C-6-016, C-6-017, C-6-018, C-6-019, C-6-020, C-6-021; Buildings TA-40-4, -9, -12
RDX	64	6-003(a, c-f), 6-007(a-g), 6-005, 6-008, 7-001(a, b, d), 22-010(a, b), 22-012, 22-014(a, b), 22-015(d, e), 22-016, 40-001(b, c), 40-005, 40-006(a-c), 40-007(a-e), 40-009, 40-010, C-6-001, C-6-003, C-6-005, C-6-006, C-6-007, C-6-008, C-6-009, C-6-010, C-6-011, C-6-012, C-6-013, C-6-014, C-6-015, C-6-016, C-6-017, C-6-018, C-6-019, C-6-020, C-6-021; Buildings TA-40-4, -9, -12
TATB		40-006(a-c), 40-007(a-e), 40-009; buildings TA-40-4, 9, -12
TNT	40	6-003(a, c-f), 6-007(a-g), 6-005, 6-008, 7-001(a, b, d), 22-010(a, b), 22-012, 22-014(a, b), 22-015(d, e), 22-016, 40-001(b, c), 40-005, 40-006(a-c), 40-007(a-e), 40-009, 40-010, C-6-001, C-6-003, C-6-005, C-6-006, C-6-007, C-6-008, C-6-009, C-6-010, C-6-011, C-6-012, C-6-013, C-6-014, C-6-015, C-6-016, C-6-017, C-6-018, C-6-019, C-6-020, C-6-021; Buildings TA-40-4, -9, -12
Semivolatile Organics		
Polychlorinated biphenyls		6-006
Volatile Organics		
Acetone	8000	6-001(a), 6-003(g), 22-010(a, b), 22-012, 22-015(e), 22-016, 40-005
Alcohol		6-001(a), 22-010(a, b), 22-016, 40-005
Benzene	0.67	22-015(c)
Carbon tetrachloride	0.21	6-001(a, b), 6-003(g)
Perchloroethylene	5.9	22-015(c)
Trichloroethylene	3.2	22-015(a, c)
Metals		
Aluminum		22-015(a)
Barium	5600	6-003(a, c-f), 6-007(a-g), 6-005, 6-008, 7-001(a, b, d), 22-010(a, b), 22-012, 22-014(a, b), 22-015(d, e), 22-016, 40-001(b, c), 40-005, 40-006(a-c), 40-007(a-e), 40-009, 40-010, C-6-001, C-6-003, C-6-005, C-6-006, C-6-007, C-6-008, C-6-009, C-6-010, C-6-011, C-6-012, C-6-013, C-6-014, C-6-015, C-6-016, C-6-017, C-6-018, C-6-019, C-6-020, C-6-021; Buildings TA-40-4, -9, -12,
Calcium		22-015(a)
Chromium VI	400	22-015(a), 22-015(c)

Table 4-6 (concluded)

Potential Contaminants	Soil SAL (mg/kg)	PRSs That May Contain the Potential Contaminant
Cobalt		6-003(c), 6-003(f)
Copper	3000	6-003(f), 22-015(a), 22-015(c), 40-006(a-c), 40-009; Buildings TA-40-4, -9, -12
Iron		6-001(a), 22-015(a)
Lead	500	7-001(c), 40-006(a-c), 40-009; Buildings TA-40-4, -9, -12
Magnesium		22-010(b), 22-015(a), 22-016
Nickel	1,600	22-015(c)
Silver	400	6-001(a), 22-015(c)
Thallium	6.4	40-006(a-c), 40-009; Buildings TA-40-4, -9, -12
Uranium	240	6-003(c), 6-007(a-e), 6-005, 40-006(a-c), 40-009; Buildings TA-40-4, -9, -12
Zinc	24,000	22-015(c), 40-006(a-c), 40-009; Buildings TA-40-4, -9, -12
Anions		
Cyanide	1600	22-015(a, c)
Fluoride		6-001(a), 22-010(b), 22-014(b), 22-015(a, c), 22-016, 40-001(b)
Nitrate and nitrite		6-001(a), 22-010(b), 22-014(b), 22-015(a, c), 22-016, 40-001(b)
Phosphate		6-001(a), 22-010(b), 22-014(b), 22-015(a, c), 22-016, 40-001(b)
Sulfate		6-001(a), 22-010(b), 22-014(b), 22-015(a, c), 22-016, 40-001(b)
Miscellaneous Chemicals		
Sodium carbonate		22-015(a, c)
Sodium hydroxide		22-015(a, c)
Sodium thiosulfate		22-015(c)
Radionuclides	**(pCi/g)**	
Cesium-137	4	6-003(c), 6-007(a-e), 6-005
Strontium-90	8.9	6-007(a-e), 6-005

Additional entries will be made in this table as they become available.

[a] Potential contaminants include all chemicals specifically listed in Chapter 5.

[b] SALs for substances on the Target Compound List (EPA 1991, 0971) and Target Analyte List (EPA 1991, 0814) are from Appendix J, IWP. High explosives SALs were calculated using the method described in Appendix J, IWP. Radionuclide SALs were calculated using RESRAD and assuming a 10 mrem/yr. exposure limit.

the site and at considerable distances from the site could be exposed to the contaminants. Depending on the characteristics of the watershed, concentrations can be higher in the downstream depositional areas than on the watershed containing the contaminant source (Muller et al. 1978, 0866).

Atmospheric Transport. This dispersal mechanism is limited to contaminants near the surface and vapors from soil pore gas. Because of the small amount of volatile organics present in OU 1111, dispersal of organic vapors is not a concern. Wind erosion is likely to transport contaminants from disturbed surface areas, such as firing sites. Wind entrainment of contaminated soil particles is a potentially significant pathway for atmospheric transport of contaminants and may lead to inhalation of contaminants by receptors. The hazard, however, typically decreases with distance downwind. Entrainment of soil particles is controlled by soil properties, surface roughness, vegetative cover, terrain, and atmospheric conditions. Direct dispersal can take place from explosion plumes at firing sites. Particles from an explosion plume can be transported by the wind.

Direct Exposure. Workers at OU 1111 and surrounding sites could be exposed to contaminants through ingestion, inhalation, external radiation, or physical contact with contaminants on the soil surface. Surface disturbance could resuspend contaminants, allowing them to be inhaled by workers. Test firing at the active sites and remediation activities are examples of such surface disturbance.

Food-chain Transport. Plants and animals living on contaminated areas may be exposed to surface and subsurface contaminant sources. Studies of small mammals implanted with dosimeters (Miera and Hakonson 1978, 0855) show that doses from radioactive contaminants can be several orders of magnitude above background. Such exposure can also lead to ingestion of nonradioactive contaminants.

The importance of biological uptake of contaminants by plants relative to other transport pathways is largely unknown. Plants are known to incorporate waste-site radionuclides, but most radionuclides in vegetation are in the form of contaminated soil deposited on vegetation surfaces (Hakonson and Nyhan 1980, 0117). Nonradioactive contaminants may behave similarly. Modeling studies (McKenzie et al. 1984, 0970) suggest that food-chain transport can be an important contributor to human exposure. One potential means of transport is game animals ingesting contamination on site, moving off site, and being killed and eaten by hunters. Human exposure through consumption would be limited primarily to those contaminants that accumulate in the muscles of animals. The consumption of meat from game animals that have grazed in contaminated areas is expected to be very limited. Very little is known about the environmental transport of chemicals through the food chains at Los Alamos; therefore, no definite conclusions can be drawn.

Infiltration and Transport in the Vadose Zone and Vapor Diffusion. Infiltration into surface soils and tuff depends on the rate of snowmelt, the rate and amount of precipitation, the amount of ponding, antecedent moisture conditions, and hydraulic properties of the soils or tuff. Joints and faults may provide pathways for infiltration. Movement of liquids in soil and tuff is predominantly by unsaturated flow. The movement of contaminants by liquids in the unsaturated zone can occur in solution or as adsorbates on suspended colloids. Contaminant retardation may occur as the result of adsorption on immobile tuff, soil, or alluvium. Lateral flow (perched water) may occur at unit contacts, between layers whose hydraulic properties differ, and in alluvial aquifers. Lateral flow may discharge as springs or seeps on canyon walls or in canyon bottoms. Based on the current state of knowledge, transport of contaminants into the main aquifer within OU 1111 is considered unlikely.

4.3.3 Potential Impacts

Current Laboratory plans are to continue operations at OU 1111. Baseline risk assessments will utilize the land use scenario deemed most probable at the time they are done.

Very little is known about the biological components of the OU 1111 environs as receptors of contaminants.

4.4 Potential Response Actions and Evaluation Criteria

Potential response actions include no further action or, if corrective measures are required, excavation with disposal or treatment, *in situ* remediation, and conditional remedies (stabilization in place with monitoring and restricting access). Firing sites and outfalls found to contain contaminants of concern may require excavation of contaminated soil and disposal in an appropriate landfill, stabilization in place, or *in situ* remediation. MDA F may be excavated or stabilized in place with monitoring; *in situ* remediation may also be possible.

Pilot studies are now under way to develop stabilization remedies for MDA F (Appendix D, IWP) (LANL 1992, 0768) and to determine whether the TA-22-52 plating and etching outfall [22-015(c)] deposits are now stable or can be stabilized in place.

The selection of the appropriate potential response actions will be based on how well those actions satisfy evaluation criteria. Evaluation factors and criteria for Phase I investigations are discussed in Section 4.2 of the IWP (LANL 1992, 0768). Evaluation factors listed in Section 4.2.1 of the IWP are human health and safety, ecological impact, impacts on Laboratory operations, socioeconomic concerns of the community and the general public, and monetary costs. Cleanup criteria will be developed during CMSs as necessary.

Environmental criteria, as required by the National Environmental Policy Act, the Endangered Species Act, wetland executive orders, or historic preservation, will be evaluated before sampling or any other significant site activity. The purpose of these evaluations will be to determine the impact of sample collection on components of the environment protected by these specific regulations. These regulatory drivers may be important in future ecological risk assessments and include

- state or federal sensitive, threatened, or endangered plant or animal species that potentially occur in the OU;
- sensitive area (e.g., floodplains or wetlands); and
- plant and wildlife of cultural importance.

4.4.1 Criteria for Recommending No Further Action

The criteria for recommending no further action on a PRS in this work plan are as follows.

- The PRS was misidentified, and sampling will proceed under the correct PRS.

- The PRS was never constructed, never installed, or never used.
- The PRS was never the location of solid or radioactive waste generation, treatment, storage, or disposal.
- No release has been observed or documented at the PRS, and the design, construction, and/or institutional controls of the PRS are such that a release to the environment and transport to off-site receptors are highly unlikely.
- The PRS is operating and has always operated under other regulations, such as the RCRA generator requirements or the National Pollutant Discharge Elimination System or is a treatment unit exempt from RCRA requirements for permits.
- The PRS has undergone or is scheduled to undergo remediation.
- Existing data indicate that contaminants at the PRS are not present in concentrations that exceed SALs.

Ecological risk assessment methodology is currently under development, and guidance on the measurement endpoints and spatial scales for determining significant ecological effects will be available in the next IWP. No further action for individual PRSs will be proposed based on a comparison to SALs or a baseline risk assessment, but an ecological risk assessment will be conducted at the appropriate spatial scale to identify ecological effects. If unacceptable ecological effects are identified, then the no further action decisions will be revisited. The contribution of all PRSs, including those proposed for no further action, to unacceptable ecological risk will be assessed so that an effective mitigation strategy can be developed.

PRSs in OU 1111 recommended for no further action on the basis of the available information are discussed in Chapter 6. Others are expected to be candidates for no further action after Phases I and II.

4.4.2 Disposal and Treatment Options

If contaminants of concern are found and assessments confirm that they pose a risk, several disposal and treatment options are possible. For most PRSs in OU 1111, soil, asphalt, surface debris, and structures such as septic tanks, sumps, and drain lines are the media most likely to contain contaminants. MDA F may also contain buried sources of contaminants. Options for all sites include (1) excavation of contaminated media and reburying or storage; (2) excavation of contaminated media for treatment, such as soil washing; (3) *in situ* treatment, such as bioremediation; and (4) stabilization of contaminants in place to prevent their mobilization and monitoring of the stabilized area.

Excavation of contaminated media with reburying or storage is a proven and generally available method. Its use may be limited by the availability of appropriate disposal or storage capacity, particularly if mixed waste is generated by remediation. Excavated areas may need to be filled with clean material and revegetated.

Treatment of contaminated media falls into two categories: treatment requiring excavation and *in situ* treatment. *In situ* treatment potentially is much less expensive and much less disruptive to the environment, but it is not as well developed as treatments requiring excavation of contaminated material. The treatment must also be adapted to the types of contaminants present. For most of OU 1111, metals and explosives appear to be the most likely contaminants present. Soil washing is currently available for removal of certain types of metals, but may be less effective for explosives. Soil incineration is available for destruction of explosives in soils. Bioremediation techniques are being developed for removal of explosives from soils. Excavation, treatment, and replacement of treated soil will probably require revegetation of the treated area.

A conditional remedy would include stabilization of the surface to prevent erosion, emplacement of monitoring devices, and continued institutional control of the site. Capping technologies, described in Appendix D of the IWP (LANL 1992, 0768), are being developed in a pilot study. An engineered cap consists of barriers of gravel mulch, soil, sand or gravel, and compacted clay. The surfaces of the layers are sloped to control the water movement within the capped area, and the surface of the cap is vegetated to control erosion and water balance (Nyhan and Lane 1986, 0159; Barnes and Rodgers 1988, 0025; Lopez et al. 1989, 0146; Hakonson et al. 1992, 0969; Hakonson et al. 1986, 0126; Nyhan et al. 1990, 0173; Nyhan and Barnes 1989, 0156; Nyhan et al. 1984, 0167).

Many innovative contaminant removal technologies are being developed that may have application to PRSs in OU 1111, if corrective measures are required. Applicable new technologies will be evaluated as part of the CMS.

4.5 Sampling Strategies and Sampling Methods

The primary question for each PRS in this OU is whether contaminants are present above acceptable risk levels at the PRS. Sampling plans are designed to answer this question. Historical information, knowledge and expert opinion on depositional, geological, and biological processes is used to develop a conceptual model of where contaminants might be located and how much might be there. This conceptual model then becomes the basis for developing a sampling plan to answer the primary question.

To maximize the probability of finding contaminants, sampling plans specify sampling within the areas of the PRS judged most likely to contain contaminants. The area judged most likely to contain contaminants is defined using the conceptual model and field reconnaissance information, including areas of discoloration, presence of deposits, geomorphic structures, and field screening tests.

The primary sampling strategy for this OU will be reconnaissance sampling, as described in Appendix H of the IWP (LANL 1992, 0768). Reconnaissance sampling addresses the primary question stated above. It is based on two design criteria: f, the fraction of the area being sampled that contains contaminants in concentrations above the SALs, and P, the probability of observing at least one contaminated sample. These two design criteria must be chosen for each sampling plan. The choice must reflect the conceptual model and minimize wasted sampling. Because we plan to sample the area most likely to contain contaminants, which is a subset of the total PRS area, the value of P for the whole PRS will be higher than the value of P chosen for the area to be sampled.

The value of f chosen for a sampling plan reflects what the conceptual model says about the depositional process and contaminant movement. If the conceptual model shows that contaminants would be widely distributed within the area judged most likely to contain them, then f will be assumed to be high. If confidence in the conceptual model is high and the conceptual model says contaminants should be present in all the area judged most likely to be contaminated, f may conservatively be set at 50%. If confidence in the conceptual model is less strong, then f should be lowered. A lower f requires a larger number of samples.

The value of P, the probability of observing at least one sample above SALs for a given f, is chosen according to a combination of factors, including the confidence in the conceptual model, the fraction of contaminated area specified (f), degree of concern about missing the contaminants, and the size of the area judged most likely to be contaminated in the PRS compared to the total size of the PRS . If confidence in the conceptual model is high, then P may be set at 50%. If confidence in the conceptual model is less or there is strong preference not to miss the possible contaminants, then P may be raised (e.g., to 90%). If there is strong confidence in the conceptual model and f is set high or the area judged most likely to be contaminated is very small, then P may be set lower.

These choices are summarized in the Source Characterization sections of Chapter 5 in statements having the form "The number of samples will be sufficient to detect contaminants above SALs with at least a P% certainty if the contaminants are present in f% or more of the area being sampled. Sampling will take place where contaminants are judged most likely to be present." The number of samples required by the P and f chosen is taken from Table H-1 of Appendix H of the IWP (LANL 1992, 0768) and is given in the Sampling and Analysis Plan section of Chapter 5. .

The choice of f and P is a judgment that we have attempted to make as objective as possible, but an element of expert opinion and subjectivity is present in the selection of these decision criteria. The values selected are those the experts on the team felt satisfactorily reflected what was known and what they believed about the site. The completed sampling plans and the number of samples were reviewed by the team to evaluate the overall quality of the plans.

Sampling plans for PRSs are included in Chapter 5; specifications are for the minimum numbers of samples. Additional locations that may contain contaminants will be identified during the field survey or during sampling; these locations will also be sampled. The basis for sample placement and collection of additional samples will be documented with verbal descriptions, test results, or photographs.

Engineering drawings and preliminary field investigations (field surveys, geophysical surveys, and/or trenching) will be used in determining the locations for sampling. The field survey crew will include a geologist or hydrologist qualified to select sample locations. Locations for sampling will be identified and mapped. Corrections to existing drawings and new drawings will be prepared, as necessary, to provide accurate base maps for sampling locations. This information will be submitted to the Facility for Information Management, Analysis, and Display.

LANL-ER-SOPs-01.01 through 01.06 (LANL 1993, 0875) will be followed for all sampling activities. Sampling may include collecting surface soil samples, soil and rock cores, chips or cores of asphalt and concrete, swipes, and liquid and sludge samples. Field screening techniques, the field laboratory, and the analytical laboratory will be used for analysis of samples. Detailed information on sampling techniques is found in ER Program standard operating procedures (SOPs).

Surface soil samples (0-6 in.) will be collected by the spade and scoop method (LANL-ER-SOP-06.09), the stainless steel surface soil sampler method (LANL-ER-SOP-06.11), or equivalent methods. Sampling in areas where VOCs are believed to be present will follow LANL-ER-SOP-06.03 or an equivalent method (LANL 1993, 0875).

Soil cores will be collected with hollow-stem augers equipped with a continuous tube or split-barrel sampler system (LANL-ER-SOP-06.10) or an equivalent method. If solid materials (e.g., concrete, wire, wood, metal, rocks) are encountered that make collection impossible at a selected location, soil cores will be collected to the same depth at a new location as close as practicable to the original sampling location. If solid materials make collection impossible, the spade and scoop method (LANL-ER-SOP-06.09) may be used; pieces, chips, or swipes of the nonsoil material may also be collected. If it is not possible to sample to the depth required by the sampling plan, that fact will be recorded. Cores will be photographed and unusual features recorded. Specifications may be given for removal of samples from cores at particular depths. The specified depth will be the centerline of material removed from the core in sufficient quantity for the analyses specified. Samples will be homogenized before analysis unless they are to be analyzed for VOCs (Section 6.4.5, LANL-ER-SOP-09.05).

Drilling to collect samples of soil and tuff will be conducted according to LANL-ER-SOP-04.01 and other SOPs now under development. Stream sediment, sludge, or liquid samples may be collected by the methods listed for sediment material collection (LANL-ER-SOP-06.14), by a Coliwasa sampler (LANL-ER-SOP-06.15), by a Trier sampler (LANL-ER-SOP-06.17), by a weighted bottle sampler (LANL-ER-SOP-06.19), or equivalent methods (LANL 1993, 0875).

Samples of water from springs and seeps will be collected according to the surface water sampling procedure, LANL-ER-SOP-06.13, or an equivalent method (LANL 1993, 0875).

Concrete samples, asphalt samples and samples of soil under asphalt will be collected according to an ER Program SOP that is being developed.

Swipe samples will be collected by rubbing an inert medium (such as filter paper) across deposits or by scraping deposits into an appropriate collection vessel. An ER Program SOP is being developed.

Field duplicates (samples collected as close as practicable to other samples) will be collected in all sampling plans as suggested in the Quality Assurance Project

Plan (QAPjP, Annex II) at about the rate of one per twenty samples or one per batch. Other QA samples will be included as specified by the QAPjP.

4.6 Analytical Methods

Enough material will be collected for each sample to satisfy the requirements of the analytical methods specified.

4.6.1 Field Surveys

All samples will be screened in the field for radionuclides and explosives. Hand-held instruments will be used for radionuclide screening, and the M-1 explosives test kit (Baytos 1991, 0741) will be used for explosives. Because radiological contamination is expected to be low or nonexistent, radiological screening is specified primarily as a health and safety measure and, unless otherwise specified, will follow standard health and safety protocols. The data from radiological screening, however, will also be used as data in the RFI. Typically, radiological screening is used for decisions on sample placement. SOPs for explosives sites require that all samples removed from the site be screened for explosives. Results of these screening tests may be used as criteria for placement of sampling locations. The detection levels used will be those specified for the respective screening methods for the ER Program.

4.6.2 Field Laboratory Methods

The mobile field laboratory will be used for a few sampling plans where a quick turnaround and higher levels of QA than field screening can give are required. In this work plan, the field laboratory or another laboratory that can give a quick turnaround time for analyses is specified for combined sampling and removal actions for sumps (Section 5.3) and septic tanks (Section 5.6).

4.6.3 Analytical Laboratory Methods

Most samples will be submitted to the analytical laboratory. The primary analytical methods for identifying hazardous constituents at OU 1111 are the following:

- RCRA-regulated metals (SW 846 Method 6010) (EPA 1986, 0291),
- volatile organic analysis (SW 846 Method 8240) (EPA 1986, 0291),
- semivolatile organic analysis (SW 846 Method 8270) (EPA 1986, 0291),
- Los Alamos National Laboratory methods for high explosives (Harris et al. 1989, 0876),
- gamma spectrometry, and
- isotopic uranium.

Isotopic uranium analysis is specified because it is currently less expensive than total uranium analysis. The results from these analyses for total uranium will be the primary results on which decisions will be based. If relative costs change, total uranium analysis may be substituted for isotopic uranium analysis.

Nonstandard media such as asphalt and concrete will be sampled for some PRSs. Methods to be specified by the ER Program for these nonstandard media will be used.

Approved methods will also be used in specific sampling plans for strontium-90, cesium-137, sulfates, chromates, nitrates, nitrites, fluoride, cyanide, and PCBs. The historical records for OU 1111 suggest that only a few of these hazardous components are expected to be present in most PRSs.

The methods listed above cover all potential contaminants listed in Table 4-6.

4.6.4 Quality Levels for Field and Analytical Data

The quality of field and analytical data collected at OU 1111 is governed by the need to make defensible, risk-based decisions for each PRS. Phase I investigations will be performed under analytical Levels I, II, III, and IV, as discussed in Section 4.4.9 of the IWP (LANL 1992, 0768). Quality levels for analytical data are further discussed in Gautier et al. (1992, 0947).

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Executive Summary

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Appendix A

Chapter 5

- Aggregate 1, Materials Disposal Area F and Adjacent Pit
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5.0 EVALUATION OF POTENTIAL RELEASE SITES

5.1 Aggregate 1, Materials Disposal Area F and Adjacent Pit

The following solid waste management units (SWMUs) are included in this aggregate.

- 6-005
- 6-007(a)
- 6-007(b)
- 6-007(c)
- 6-007(d)
- 6-007(e)

5.1.1 Background

5.1.1.1 Description and History

Aggregate 1 is located north of Two-Mile Mesa Road in Technical Area (TA) 6 (Figure 5-1). The two fenced areas [6-007(a)] are commonly designated as Materials Disposal Area (MDA) F. In this work plan, we have designated the gray area shown in Figure 5-1 as MDA F. SWMUs located in MDA F are the two

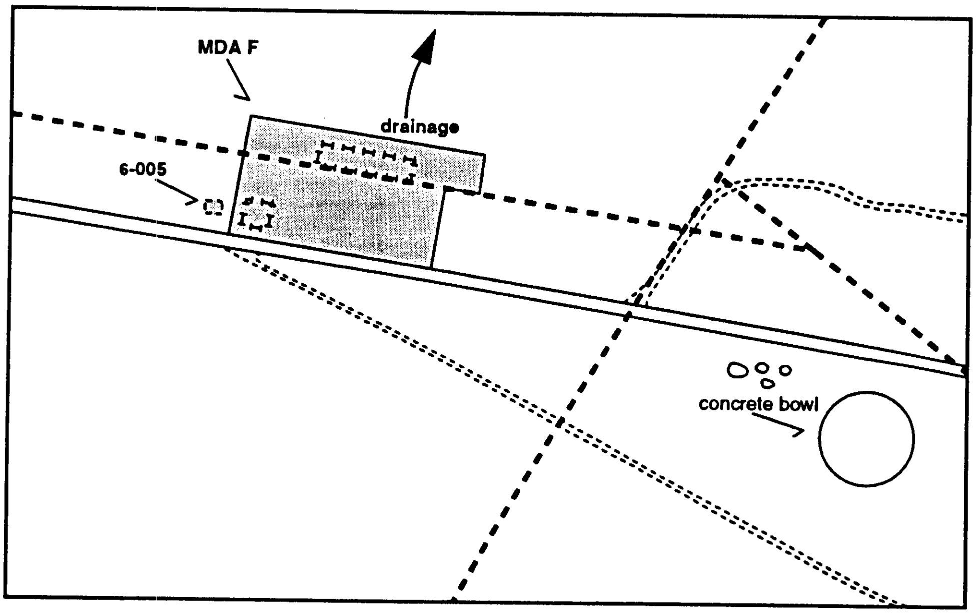


Figure 5-1. Locations of Aggregate 1 PRSs.

▨ Aggregate 1
Paved road or parking area
Unpaved road
Power line
Fence
Depressions possibly resulting from lens destruction

fenced areas [6-007(a)]. SWMUs probably located in MDA F are a pit estimated to be 40 ft x 70 ft from photos taken in the 1940s [6-007(b)]; pits 6-007(c, d), for which work orders exist; and the pits described by 1946 and 1947 memorandums (Bradbury 1946, 19-0048; Bradbury 1947, 19-0049). The locations of these SWMUs (other than the two fenced areas) are unknown, but all disposal pits on Two-Mile Mesa were probably dug in and around the fenced areas (Van Vessem 1992, 19-0045). No evidence has been found to firmly associate any of the work orders or memorandums with particular locations. Pit 6-007(e) and two other pits sampled in 1987 (LANL 1990, 0145) cannot be located, but if they are not near the two fenced areas, they were probably not used for burial of waste.

Also included in this aggregate, but not in the definition of MDA F, is a timbered pit (6-005). SWMU 6-005 is included in this aggregate because it is close to MDA F. Depressions observed south of Two-Mile Mesa Road between MDA F and the concrete bowl may have resulted from destruction of explosive lenses in 1945. Because the pits are close to MDA F, this activity and the potential contamination resulting from it are also considered under Aggregate 1.

Table 5-1 summarizes information from documents relevant to disposal pits on Two-Mile Mesa. All information that pertains to dimensions of pits, contents, or people to contact is included in the table. In no case is an exact location given. A history based on information from these documents, interviews with people listed in these documents, site location drawings, and aerial photographs follows.

In 1945, defective explosive lenses manufactured for use in the Fat Man implosion weapon were destroyed in this area by detonation (Van Vessem 1992, 19-0045). Some of these lenses contained Baratol, which contains barium and TNT.

In 1946, a pit was dug for disposal of large classified objects that could not easily be destroyed by cutting (Bradbury 1946, 19-0048). The objects were buried to protect their classification (Van Vessem 1992, 19-0045). It was expected that, in a few years, the objects could be recovered and declassified (North 1974, 19-0056). In 1947, another pit was dug for disposal of classified material (Bradbury 1947, 19-0049). Two large disturbed areas, which may be these pits, can be seen on 1954 aerial photographs (Guthrie 1992, 19-0063).

From 1949 through 1951, work orders were written for three smaller pits to be used for occasional disposal (Table 5-1). The locations and contents of these pits are unknown.

From 1950 to 1952, three shafts were drilled to dispose of spark gaps containing small amounts of cesium-137 (Kunz 1950, 19-0065; Kunz 1952, 19-0066; Kunz 1952, 19-0067; Van Vessem 1992, 19-0045). None of these disposals correlates with job and work orders found in the archives. These shafts are probably in the area of the smaller fence at MDA F (Van Vessem 1992, 19-0045).

The two chain-link fences (Figure 5-1) were constructed in 1981 (Jacobson 1992, 19-0060). The smaller fenced area appears to correspond to the location of disturbed areas on aerial photographs, but the larger fenced area appears to be mostly north of the larger pits (Guthrie 1992, 19-0063). The areas inside the fences at MDA F have been monitored for radioactivity on a continuing basis since 1981 as part of the Los Alamos Environmental Surveillance Program. No readings above background have been observed (Jacobson 1992, 19-0060).

TABLE 5-1

CHRONOLOGICAL LISTING OF DOCUMENTS RELATING TO MATERIAL DISPOSAL AT TWO-MILE MESA

Date	Author/Identifier	Content
May 15, 1946	N. E. Bradbury	"An obsolete material pit for the disposal of classified objects and shapes has been prepared at TD Site where such material will be made secure by burying. This pit will be open until 1 June. It is urged that divisions and groups "clean house" of obsolete, non-usable, but classified material by the use of this pit. Division and group leaders desiring to use the pit will notify Security Office, Ext. 541, prior to their delivery of the obsolete classified material. The Security Office will record and locate such material in the pit." (Bradbury 1946, 19-0048)
July 16, 1947	N. E. Bradbury	"Special facilities for the disposal of classified scrap material are available at Two Mile Mesa effective today for a period of two weeks....The Associate Director's office may be contacted for details regarding transportation and disposal of this material." (Bradbury 1947, 19-0049)
August 2, 1949	Job Order 195291 (Lab Job 1757)	Job Location: 2 M. Mesa "Dig one hole approximately 40' x 20' x 10' deep to bury material. After material is placed in hole it is to be filled. Contact Charles Kunz at 2 M. Mesa for instructions concerning location." (LASL 1949, 19-0050)
August 3, 1949	Work Order 812,916 (Lab Job 1757)	Instructions the same as Job Order 195291 (LASL 1949, 19-0051)
February 21, 1950	A. D. Van Vessem, Job Order 209540	Job Location: Two Mile Mesa "Dig hole on Two Mile Mesa to bury classified material. See Meyers or Van Vessem at TD Site. Approx. 6' x 6' x 6'." (LASL 1950, 19-0046)
February 24, 1950	Work Order 817,283 (Lab Job 1757)	"Dig hole 6' x 6' x 6' on Two Mile Mesa for burying material. Non-Hazardous." (LASL 1950, 19-0052)
September 29, 1950	C. G. Kunz	Serial numbers of spark gaps to be disposed of, spark gaps contained ^{137}Cs .(Kunz 1950, 19-0065)
August 16, 1951	A. D. Van Vessem, Job Order 240928	"Dig hole 2' x 2' x 4' deep for disposal purposes--Refill...See Johnson for exact location." (LASL 1951, 19-0047)
August 21, 1951	Work Request (Lab Job 1757)	Instructions the same as Job Order 240928 except name is expanded to Henry Johnson, who is listed as field engineer. (LASL 1951, 19-0053)
March 27, 1952	C. G. Kunz	Serial numbers of spark gaps to be disposed of, spark gaps contained ^{137}Cs .(Kunz 1952, 19-0066)
July 22, 1952	C. G. Kunz	Serial numbers of spark gaps to be disposed of, spark gaps contained ^{137}Cs .(Kunz 1952, 19-0067)

TABLE 5-1 (concluded)

Date	Author/Identifier	Content
December 10, 1964	W. C. Courtright	Ira D. Hamilton "recalls the burial of a lot of large classified obsolete weapons parts at a location on Two Mile Mesa about 1/2 mile north or towards town of the TD-Site Quonset Buildings." L. M. Jercinovic said that large navy guns "could have been taken back to two-Mile Mesa and TD-Site since that was home base. A. D. Van Vessem and Walt Meyers worked with him on the project. . . . Mr. Jercinovic recalls the large burial pit on Two-Mile Mesa which was west of the concrete saucer, east of Two-Mile Mesa Buildings and near north edge of Mesa. This location and material put in it was probably not recorded because of questionable authority to do such a job." Harvey North "stated that his group was primarily responsible for having the pit dug on Two-Mile Mesa in late 1946 for disposing of unsalvageable, classified objects. Lots of large metal parts were placed in this pit, his group put in some tuballoy, less than 5 pounds, and it does contain some high explosives. They placed some 'large blocks of HE, Primacord, etc., in the pit, but put them at one side'." A. D. Van Vessem "recalled that the 50-caliber gun and some ammunition was brought back to TD-Site and stored west of the site. . . . Mr. Van Vessem recalled one large and one small burial pits at Two-Mile Mesa. These are shown on the current ENG-3 drawings. The small one was used for firing unit gaps which had contained small amounts of radioactive material and small detonators with squibs. He would consider it hazardous to disturb this material. The large pit was used for casings and handling equipment of the Fatman unit and many other metal parts from other groups of the Laboratory. There was an attempt to cut up this material to declassify it but this proved too arduous a job so that a burial method was decided upon. He does not recall that there is any radioactive contaminated material or any high explosives buried in the large pit. Mr. Van Vessem stated that Herb Jewett and Tiny Hamilton were the members of the group who operated the equipment to place the material in the large pit." (Courtright 1964, 19-0054)
August 13, 1974	M. A. Rogers, Letter H8-74-129	Request to H. S. North for information on Area F or the disposal pit at TD Site on Two-Mile Mesa. (Rogers 1974, 19-0055)
August 17, 1974	H. S. North	"The Disposal Pit at TD Site on Two Mile Mesa was a bulldozed trench some 50' wide by 20' deep at deepest point and sloping up to ground level at each end, with the overall length some 100' to 150'. It was prepared for use by any organization having non-explosive and non-radioactive classified materials to dispose of. There were many tons of metal parts, concrete mock-ups, handling fixtures, etc., but so far as I know there were no hazardous placed there. However, so far as I know there were no photographic or other records kept of this pit. I left LASL Feb. '47 and up to that time there were no disposal areas on Two Mile Mesa for HE or radioactive waste. I had no control of radioactive materials, but it was our rule that no HE be disposed of by burying. It was our intention that the pit be for classification protection only and after a number of years it could be declassified and the ground returned to public use." (North 1974, 19-0056)
February 1, 1985	A. J. Ahlquist	Quotes North and Van Vessem interviews from Courtright memorandum (Ahlquist 1985, 19-0057)
September 15, 1992	L. W. Creamer, Letter M-7-92-0496	Request to H. S. North for clarification on conflicting reports of buried material at Two-Mile Mesa. (Creamer 1992, 19-0058)
September 25, 1992	H. S. North	"I was transferred to Sandia Lab. before the pit was back filled, so my comments apply only to materials deposited before 1947. This pit was also used by other organizations, so my comments apply only to own deposits. I do not recall of any live H.E. or tuballoy being deposited in this pit, these items were destroyed at other locations and Walt or Van would know more about this than I. There were 'inert' dummy shapes for use in training and may have been in the pit or mentioned in other correspondence." (North 1992, 19-0059)

During the 1986 Comprehensive Environmental Assessment and Response Program (CEARP) survey, severe erosion was found near the larger fenced area (Hakonson 1986, 19-0064). As a corrective measure, erosion channels were filled with topsoil, and a gravel mulch was applied to part of the area to stabilize the surface against further erosion (Hakonson 1986, 19-0064; Myers 1986, 19-0070; Mahoney 1986, 19-0069).

As part of the CEARP, most of MDA F was surveyed with ground-penetrating radar and magnetometry in an attempt to find the locations of pits and buried material (Weston 1986, 19-0071). Data from this survey are difficult to interpret because of the wide grid spacing and because the fences were not removed (Sandness 1987, 19-0072).

Courtright (1964, 19-0054) quotes Harvey S. North as saying that large blocks of explosives were buried in a pit at MDA F. In a later memorandum, Ahlquist (1985, 19-0057) quotes the Courtright memorandum. However, letters from North state that no hazardous materials were buried and that burying was not the accepted practice for disposal of explosives (North 1974, 19-0056; North 1992, 19-0059). Experienced explosives personnel believe that explosives would have been burned or detonated rather than buried (Van Vessem 1992, 19-0045). We have found no primary sources that state that explosives were buried in these pits.

Reports of squibs, detonators, depleted uranium, and strontium-90 buried in pits at MDA F are also from secondary sources [CEARP Report (DOE 1987, 0264) and SWMU Report (LANL 1990, 0145)] with no referenced support from interviews or primary sources. As is the case for other explosive devices, the standard methods for disposing of squibs and detonators have been burning or detonation.

Pit TA-6-42 (6-005), located just west of MDA F, is shown on site location drawings (LASL 1944, 19-0002; LASL 1944, 19-0029). This pit may have been used for test firing Jumbino vessels [6-003(b), Chapter 6], and a 1944 progress report contains a photo showing a Jumbino in a pit (LASL 1944, 19-0121). The 1986 geophysical survey located an anomaly in this area (Weston 1986, 19-0071). Other features north of TA-6-42 and west of MDA F are several pipes emplaced in the ground and what has been described as a "sinkhole" (Weston 1986, 19-0071). These features will also be investigated.

5.1.1.2 Conceptual Exposure Model

5.1.1.2.1 Nature and Extent of Contamination

Interviews and archival sources suggest that most of the material disposed of at MDA F was buried to protect classification and that explosives were probably not buried there. However, records are incomplete, and the possibility cannot be discounted that other hazardous materials, such as solvents and other chemicals, were placed in the pits. Documentation states that spark gaps, electrical devices that contain cesium-137 but no explosives, were buried, probably in this area. In 1964, the total amount of cesium-137 was estimated to be no more than 30 µCi (Dummer 1964, 19-0062). Almost a complete cesium-137 half-life has passed since that estimate was made; the amount of cesium-137 now in MDA F can be conservatively estimated at less than 20 µCi. Existing information gives reason to believe that explosives, squibs, detonators, uranium, and strontium-90 are not present, but they are listed in secondary sources. The extent of any contamination other than cesium-137 is unknown.

Because there is no evidence that explosives were buried and commonly accepted disposal practices were burning or detonation of explosives, we conclude that it is highly unlikely explosives were buried in any of the MDA F pits. However, because buried explosives could present a safety hazard to environmental restoration activities, we have designed the sampling plan under the assumption that explosives could be buried in the MDA F pits. Likewise, although we believe it is unlikely that depleted uranium and strontium-90 are present, their possible presence was considered in the design of the sampling plan.

5.1.1.2.2 Potential Pathways and Exposure Routes

The primary source of potential contaminants is any hazardous material that may have been buried in the pits. If hazardous materials were deposited in this aggregate, secondary sources could include soils, tuff, air, surface water, sediments, or plants.

The pits were probably unlined and covered with the unconsolidated soil and tuff that was removed at the time of pit construction. No engineered covers or caps were placed on the pits to limit the movement of water into or through the pits. A gravel mulch was placed over a portion of MDA F in 1986. This portion of Aggregate 1 probably does not include any of the pits, but the gravel mulch has lessened erosion of surface soil. Water may have moved into the pits and could have carried contaminants outside pit boundaries. If hazardous constituents are present in the pits, vertical and horizontal plumes of relatively mobile constituents may have formed since the pits were closed. The driving forces for plume formation could be water movement and movement of liquid or gaseous constituents.

Depth to the main aquifer in this area is probably more than 1000 ft. It is unlikely that water moves to this depth from the mesa tops. Most water that enters the soil surface moves laterally rather than percolating down into the tuff (Section 3.5.2.1). Therefore, constituent movement will be more lateral than vertical. There are springs and seeps in Two-Mile Canyon, approximately 0.5 mi. east and apparently downgradient (relative to flow in the main aquifer) of MDA F. The source of water appears to be small alluvial and colluvial deposits in the canyon bottom (Guthrie 1993, 19-0073; Guthrie 1993, 19-0074) and is most likely from shallow subsurface zones. The springs and seeps are not considered an indication of a major groundwater pathway (Section 3.5). Although surface water could move from the area of Aggregate 1 into Tributary A of Two-Mile Canyon and from there into Two-Mile and Pajarito canyons and out of the operable unit (OU) during intense summer thunderstorms, transport of constituents by surface water is possible only if constituents are exposed on the surface (e.g., by the action of burrowing animals or if contaminants are present on the surface as a result of lens destruction). Visual inspections of the site gave no indication that this has happened. Uptake of constituents by plants, especially deep-rooted plants, is possible. Vegetation was sampled in 1981 and 1983 for radioactive contaminants; none were found (Jacobson 1992, 19-0060).

Exposure may also occur from intrusion into the pits by human action. However, this aggregate is not accessible to the public, and digging activities by Laboratory personnel are unlikely.

Barium compounds and TNT may have been dispersed into surface soil in this area by the destruction of defective explosive lenses by detonation. If the lenses were destroyed in the area that later became MDA F, the surface soil may no longer contain barium compounds and TNT. The pits in MDA F were constructed after the destruction of the lenses, and the surface soil may have been removed, covered, or mixed with deeper soil. Erosion and transport of sediments may also have moved constituents. Depressions found south of Two-Mile Mesa Road may be craters from the disposal operation and, therefore, are the areas most likely to contain barium and TNT from the disposal operation.

The timbered pit (6-005) may have been used for Jumbino tests. Because the purpose of the Jumbino vessels was to contain the products of explosives tests, contaminants from operations during 1944 and 1945 are unlikely to be present. However, the anomaly found during the 1986 geophysical survey indicated the presence of metallic material in this area. This suggests that this pit may have been used for disposal when it was filled in, but the contents are unknown.

5.1.2 Remediation Decisions and Investigation Objectives

Remediation alternatives for this aggregate include no further action, capping and monitoring, removal of the contents of the pits, and a combined operation in which the contents of the pits are sampled and removed. If contaminated soil is found, remediation alternatives include capping and monitoring, removal for disposal or treatment, or *in-situ* treatment. No further action will be recommended if the aggregate is shown to meet risk-based criteria for a worst case in which the contents of the pits become exposed. Capping and monitoring will be recommended if materials in the pits must be contained and if contaminants are not migrating out of the pits. If contaminants are migrating out of the pits, the contents of the pits and contaminated media will be removed. A combined sampling and removal operation will be undertaken if detailed characterization of the pit contents is necessary to define a removal operation.

The objectives of the Phase I investigation are to determine whether contaminants are migrating out of pits in Aggregate 1 and to determine whether known and possible contaminants may present a risk to human health.

Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) Phase I data will be collected to answer these questions.

- Where are the pit boundaries? This information is required to define the locations for Phase I sampling. Sampling in (rather than around) the pits may be dangerous if cesium-137 and explosives are present and their locations are not known. If the locations of the pits can be defined, then cesium-137 and explosives that may have been deposited can be avoided.

- Are contaminants of concern present in the media surrounding the pits? This information is required to decide whether a Phase II investigation is necessary. If no contaminants of concern are present and risk-based criteria are met, no further action will be recommended. If contaminants of concern are present, a Phase II investigation will be recommended.

- Are barium and TNT present in surface soils south and east of MDA F as a result of the destruction of explosive lenses? This information is required to decide whether a Phase II investigation is necessary. If barium and TNT are not found above screening action levels (SALs), the extent of contamination will be concluded not to include surface contamination by barium and TNT. If barium or TNT is found above SALs, a Phase II investigation will be recommended.

5.1.3 Data Needs and Data Quality Objectives

5.1.3.1 Data Needs for Evaluating Health and Safety Risks

5.1.3.1.1 Source Characterization

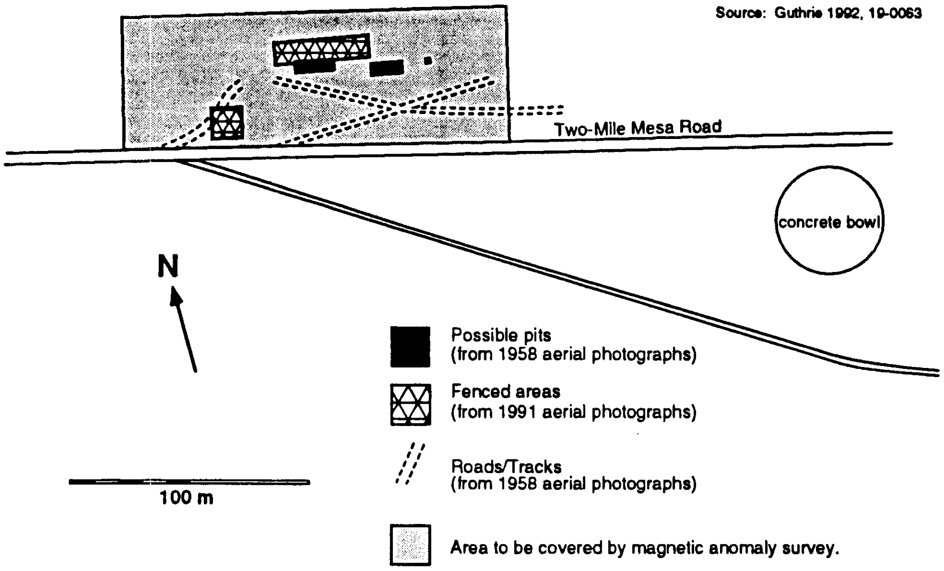
Aerial photographs, memorandums, and eyewitness accounts suggest that at least three landfills or pits were constructed in MDA F. One pit, or group of shafts, is believed to contain cesium-137. The other pits are believed to contain large metal objects. Pit 6-005 may also have been used for disposal when it was filled in. Surface soils may contain barium and TNT. This potential surface soil contamination may cover MDA F but is expected to be more prevalent to the southeast of MDA F.

MDA F and 6-005 will be field mapped. Depressions outside MDA F that appear to indicate soil disturbance by explosion will also be mapped. All surface features indicating the possible presence of pits will be noted on the maps. Aerial photographs will be used to help define possible disturbed areas, and these areas will be included on the maps. The maps will be used to define locations for the geophysical surveys. Information from geophysical surveys and trenching will be used to map the probable boundaries of the pits.

A 1-m grid will be used for the radiological and geophysical surveys. The chain-link fences will be removed for the geophysical surveys; several trees may also need to be removed to assure full coverage of the area.

During the radiological survey, alpha, beta, and gamma activities will be recorded at every 3 meters. This will provide at least an 80% chance of finding radioactive areas greater than 1.6 meters in diameter (Gilbert 1987, 0312). If radioactivity above SALs is detected at any point, a surface soil sample will be collected. At a minimum, these samples will be analyzed for radioactive constituents and explosives.

A stepwise strategy will be used to determine the locations of pit boundaries. A magnetometry survey will first attempt to locate large metal buried objects; Figure 5-2 shows the survey location. The survey is expected to give the locations of some, but not necessarily all, pits; it will locate metal in the pits but not the pit boundaries. The magnetometry survey will have a high probability of locating metal objects larger than a 2-ft-diameter sphere at a 20-ft depth. Additional geophysical techniques will then be tested in a selected area to determine their effectiveness in finding the boundaries of pits. Electromagnetic and ground-penetrating radar surveys will be done; dc resistivity and seismic surveys may be



Source: Guthrie 1992, 19-0063

Figure 5-2. Location of magnetic anomaly survey in the vicinity of MDA F.

done. These geophysical techniques may be tested in any sequence. The test area(s) will be determined by analysis of aerial photographs and the results of the magnetometry survey. After the geophysical techniques have been applied to the test area, shallow trenching will locate pit boundaries. Trenches will be no more than one meter in depth to locate the near-surface expression of the pit. If explosives were buried at MDA F, they would be deeper in the pit because heavy equipment was used to fill the pit. Techniques or combinations of techniques that are successful in locating the boundaries of pits in the test area will be used to survey the whole area. If the noninvasive techniques are unsuccessful, a Phase II investigation will be proposed to identify the boundaries of the pits.

Areas identified as possible pits by geophysical surveys, aerial photographs, and a disturbed surface will be sampled. Individuals with expertise in earth sciences and explosives handling and safety will determine the sampling locations. Cores will be taken around the perimeters of all pits located; samples will be removed from the cores at three depths. At a minimum, samples will be analyzed for radionuclides, volatile and semivolatile organics, explosives, and metals. The number of samples will be sufficient to provide at least a 90% probability of finding a contiguous area of contamination of 10 ft or more in lateral extent. No coring into pits will be done until the geophysical and core data are analyzed and safety is assessed.

The soil sampling data, radiation screening values, historical information, and expert opinion will be used to conduct an investigation into risk to determine what constituent levels would produce unacceptable risks under different scenarios. Site factors to be investigated in the scenarios include whether contaminants have migrated outside the boundaries of the pits, whether pit boundaries can be located, whether the shafts containing cesium-137 have been located, and the probability that explosives and depleted uranium have been buried in the pits. The risk information will be used to evaluate possible remedial actions including containment, removal of pit contents, and intrusive sampling. From this evaluation, a decision will be made on what added information is needed and whether intrusive techniques are acceptable to obtain this added information.

Decisions for no further action or a Phase II investigation of MDA F will be based on all information acquired during Phase I.

Surface soils south and east of MDA F will be sampled for barium and TNT. Reconnaissance sampling (Appendix H, LANL 1992, 0768) will determine whether barium and TNT are present above their SALs and whether a Phase II investigation is necessary. The number of samples will be sufficient to detect contaminants above SALs with at least an 80% certainty if the contaminants cover 20% or more of the area being sampled. Sampling will take place where contaminants are judged most likely to be present. If no samples are found to contain barium or TNT above their SALs, no further action will be recommended. If barium or TNT is present above its SAL, a Phase II investigation will be recommended. At a minimum, samples will be analyzed for barium and TNT.

5.1.3.1.2 Environmental Setting

Although water in the springs and seeps in Two-Mile Canyon is probably from shallow subsurface zones and appears not to be an indication of a groundwater pathway from MDA F, the springs and seeps will be sampled four times over a period of a year. The presence or absence of contaminants of concern will be part of the information on which decisions for no further action or a Phase II investigation will be based.

5.1.3.1.3 Potential Receptors

No data are needed for Phase I decisions.

5.1.3.2 Data Needs for Evaluating Other Impacts

No other impacts are expected. No other data are needed to make a Phase I decision.

5.1.4 Sampling and Analysis Plans

Engineering drawings, aerial photographs, and preliminary field investigations will be used to determine the probable locations of pits. All locations that have not been mapped will be mapped. A 1-m grid will be emplaced for radiological and geophysical surveying.

A radiological survey will be conducted over the entire aggregate to determine whether radioactive contamination exists at the surface. This survey is primarily for health and safety purposes, but the data will be used for the RFI as well. Alpha, beta, and gamma activity will be measured with a hand-held counter at every 3 m on the 1-m grid. If radiation levels higher than SALs are found, surface soil samples will be collected to a 6-in. depth at those points. Sample locations will be mapped, and samples will be submitted to the analytical laboratory for analysis of radionuclides and explosives.

A magnetometry survey will be done of the area shown on Figure 5-2. The fences, surface metal, and trees will be removed, as necessary. The data will be processed by standard magnetic mapping methods, and a map of buried metal objects will be produced.

Areas will be selected for tests of electromagnetic and ground-penetrating radar surveys. The areas will be selected on the basis of information from aerial photographs and magnetic mapping to have a high probability of containing at least two boundaries. Seismic and dc resistivity surveys for locating pit boundaries may also be tested in these areas. The same test areas will be used for all geophysical techniques so that results can be compared or combined to provide maximum information on the effectiveness of these techniques for locating pit boundaries. The grids for these surveys will be referred to the grid for magnetic mapping.

The electromagnetic survey will consist of five short, high-density profiles. Five lines, each about 150 ft long, will be surveyed. A high-power ground-penetrating radar survey is proposed on the 1-m grid. The dc resistivity survey is proposed to include three dipole-dipole profiles. Plans for the dc resistivity and ground-penetrating radar surveys may change on the basis of results from the magnetometry and electromagnetic surveys. Seismic surveys are not currently planned but may be used if appropriate methods can be found. A shallow trench will then be excavated across the test area to determine the pit boundaries. The results of the geophysical surveys will be evaluated with respect to the results of the trenching. The techniques that located the pit boundaries to within 2 ft will be used to survey the entire area previously surveyed by magnetometry. Pit boundaries will be mapped.

Intact cores will be taken along the perimeter of the pits at intervals of 11 ft and within 3 ft of the perimeter of the pit. If pits or shafts are located in close proximity, cores may be taken around a group of pits or shafts. Minimum numbers of samples are estimated on the basis of four pits believed to be present in Aggregate 1 (Table 5-2). Exact numbers of samples will not be known until all pits are located. Lithologies along each core will be logged at 5-ft intervals and at every boundary. Fracture locations within the core will also be logged. Samples will then be removed from the cores at a depth of 1 ft, at the judged depth of the pit, and at 3 ft below the judged depth of the pit or at the soil-tuff interface, whichever is shallower. All samples will be analyzed in the analytical laboratory for radionuclides, volatile and semivolatile organics, explosives, and metals.

Four sets of three water samples will be collected from the seeps and springs in Two-Mile Canyon. One set at each area will be collected in February, May, August, and November of a single year. All samples will be analyzed in the analytical laboratory for radionuclides, explosives, metals, and volatile and semivolatile organics.

At least eight widely spaced surface soil samples will be collected from the area extending 100 ft south and 100 ft east of MDA F. Sample location will be biased to the most likely lens disposal area. An indicator of explosive lens disposal is a shallow depression or crater. If additional locations for sampling are identified in the field survey or during sampling, additional samples will be collected from those locations. Indicators of additional locations for sampling include the results of field screening tests, discoloration, and the presence of deposits. Samples will be analyzed in the analytical laboratory for barium and TNT.

TABLE 5-2

ESTIMATED ANALYTICAL SAMPLES NEEDED FOR AREAS BELIEVED TO EXIST AT AGGREGATE 1

		Field Surveys			Samples			Field Screening			Field Lab. Measr.		Laboratory Analysis													
SWMU or AOC	SWMU Type	Land Survey	Gross Gamma	Geophysics	Sampled Media	Samples	Duplicate	Gross Gamma	High Explosives (M-1 Kit)	Lithological Logging	Gamma Spectrometry	Volatile Organics (SW 8240)	Gamma Spectrometry	Isotopic Uranium	Strontium-90	Cesium-137	Metals (SW 6010)	Volatile Organics (SW 8240)	Semivolatile Organics (SW 8270)	High Explosives (LANL Method)	PCB (SW 8080)	Sulfates/Chromates/Copper Salts	Nitrates and Nitrites	Fluoride	Cyanide	Phosphate
MDA F	Large Fenced Area, two 40 ft by 70 ft pits	X	X	X	Soil/Tuff	132	7	X	X	X	X			X	X	X		X	X	X						
MDA F	Small Fenced Area, one 20 ft by 20 ft pit	X	X	X	Soil/Tuff	30	2	X	X	X	X			X	X	X		X	X	X						
6-005	Timbered Pit, 20 ft by 20 ft	X	X	X	Soil/Tuff	45	2	X	X	X	X			X	X	X		X	X	X						
	Seeps and Springs	X			Water	12	1	X			X			X	X	X		X	X	X						
	Lens Disposal Area	X			Soil	8	1	X			X			X	X	X			X	X						

5.2 Aggregate 2, Plating and Etching Outfall and Related Run-off Area, SWMU 22-015(c)

5.2.1 Background

5.2.1.1 Description and History

A plating laboratory was opened, probably in 1953, as a part of the operations in Building TA-22-52 (H-Division 1953, 0624). It operated until the early 1960s. The laboratory was unused until 1974 and was then converted to a printed circuit etching operation that continued until 1984, when a new facility became available in TA-22-91 (Meyers 1993, 19-0101). Floor drains under the plating baths and the rinse tank overflow drained directly to an outfall [22-015(c)] behind the building (LASL 1955, 19-0079) (Figure 5-3). The outfall drains into a pond near the edge of the mesa. Drainage from the pond runs down a wagon road, which predates the Laboratory, and then down several channels to the stream in Pajarito Canyon. Because the outfall and its run-off area have a complex history and the outflow has stained a significant area, this SWMU is discussed alone in this section.

Gold, copper, nickel, chromium, silver, cadmium, rhodium, zinc, and platinum were used in the plating process (Creamer 1993, 19-0026; Stearns 1954, 19-0081). Metal parts were plated, suspended over the plating bath to drip dry, and rinsed in a water bath. The rinse water was the primary contributor to the outflow and typically contained very dilute amounts of plating chemicals. In 1956, for example, the rinse water was found to contain concentrations from 0.0 to 3.2 ppm of cyanide (H-Division 1956, 0674). Spent plating baths were not disposed of in this outflow. The remaining metal was plated onto scrap metal and the solution was drummed for transport to the waste treatment plant (Creamer 1993, 19-0026; H-Division 1956, 0469). On one occasion, a tank of gold cyanide solution (720 to 960 grams of gold, 95 to 130 grams of cyanide) was accidentally flushed to the outfall (Creamer 1993, 19-0026). Hazardous chemicals used in this laboratory included sulfuric, chromic, hydrochloric, nitric, hydrofluoric, and phosphoric acids; cyanides; benzene; trichloroethylene; perchloroethylene; sodium thiosulfate; hydrogen peroxide; and sodium hydroxide (H-Division 1953, 0465; H-Division 1953, 0849; Stearns 1954, 19-0081; Schulte 1958, 19-0028).

In 1956, an irradiated reactor part was stripped of a gold coating and replated (H-Division 1956, 0856). Before this operation was carried out, a pilot operation indicated that radioactive constituents would be contained (H-Division 1956, 0856). Monitoring of the part before stripping and replating showed only low levels of radioactivity (Mitchell and McKown 1956, 19-0016). The radionuclides that might have been present in this part would have been neutron activation products; these typically have short half-lives and will have decayed to negligible levels.

Standard printed circuit etching operations began in 1974. Copper and aluminum were used as circuit metals. The process steps were (1) a photosensitive "resist" coating was applied over the metal, (2) the resist was covered with a circuit pattern and exposed to light, (3) the unexposed resist was removed by washing with solvent so that only the desired circuit is covered with resist, (4) the exposed unwanted metal was removed by etching with a ferric chloride solution, and (5) the remaining resist was removed by a caustic water solution. The standard practice from 1974 to 1977 was to dispose of the

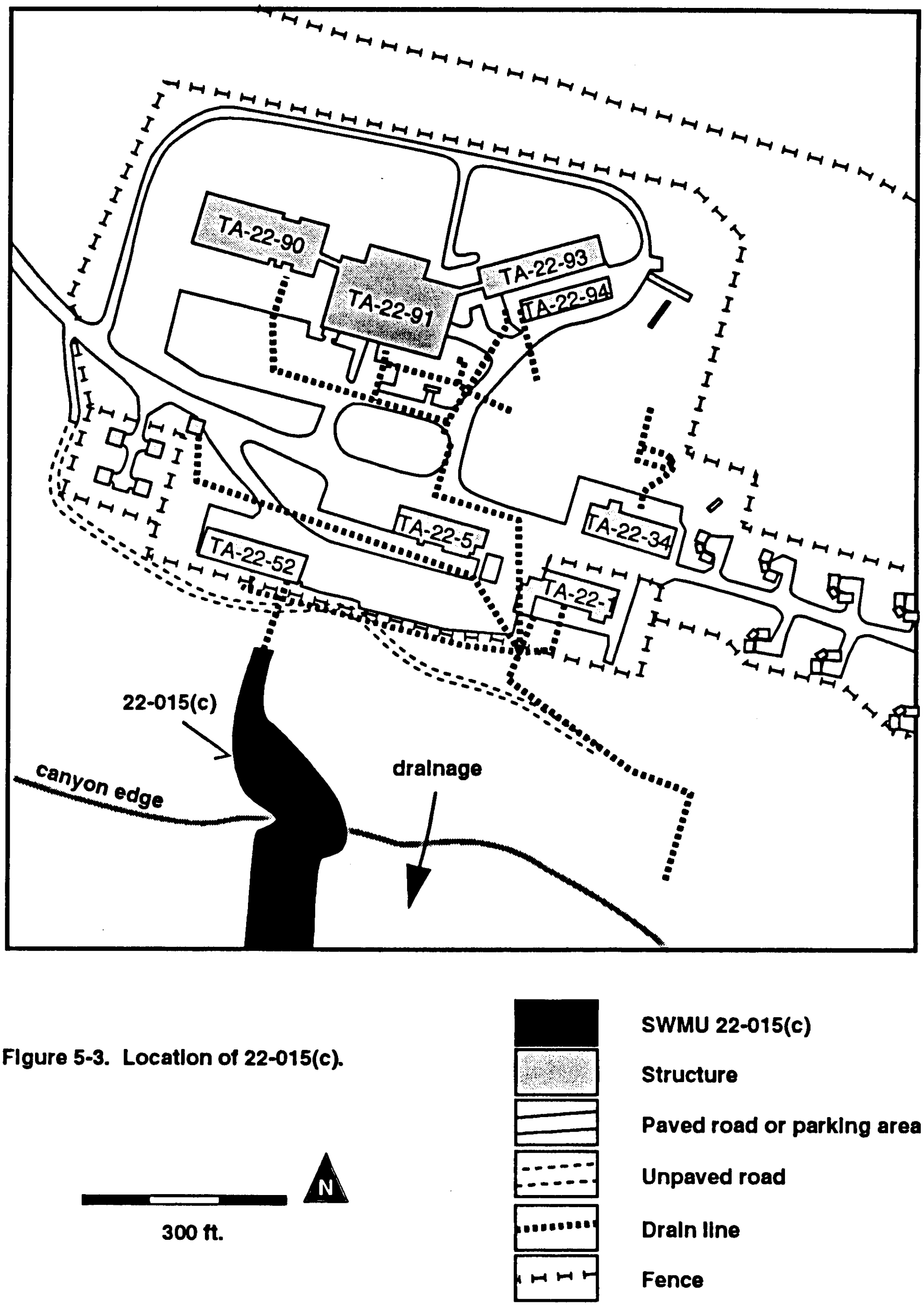


Figure 5-3. Location of 22-015(c).

depleted ferric chloride solution, which contained iron and copper, through the outfall. From 1977 to 1985, depleted ferric chloride solution was drummed and sent to the liquid waste treatment plant (Meyers 1993, 19-0101).

The outfall pipe remains in place. During the 1986 CEARP survey, discolored material was observed from the outfall to the stream at the bottom of the canyon (DOE 1987, 0264).

5.2.1.2 Conceptual Exposure Model

5.2.1.2.1 Nature and Extent of Contamination

Based on the historical evidence, possible contaminants in this SWMU are acids or their anions, including sulfate, chromate, nitrate, nitrite, fluoride, phosphate, and cyanides; metals; and other compounds used in the plating laboratory, such as sodium thiosulfate, sodium hydroxide, and sodium carbonate. Metals used in the plating laboratory included gold, silver, rhodium, and platinum, which were conserved because of their value; copper; nickel; chromium; cadmium; zinc; and iron. Metals used in the etching operation were copper, iron, and aluminum.

Only rinse water with very dilute amounts of chemicals from the plating operation was a regular contributor to the outflow while plating operations took place in TA-22-52. Iron, copper, and aluminum from the printed circuit operations may be present in higher concentrations. Acids were probably neutralized by interaction with other constituents of the outflow or by soil and tuff, but their anions may be present. The organic solvents that may have been disposed of in the outflow included benzene, trichloroethylene, and perchloroethylene. They have probably evaporated from the surface, but testing for them is proposed in subsurface samples. Cyanide is susceptible to oxidation and, therefore, is expected to be absent. However, because of its high toxicity, all samples will be tested for cyanide. There are no records of sampling in the run-off area.

The run-off area is visible because of a red stain that extends from the outfall to the bottom of the canyon. The stain may be made up of iron compounds deposited from 1974 to 1977, when etching solutions were disposed of through the outfall. Because these solutions probably flowed through drainage channels established earlier, the stain may be a marker for other constituents. In addition, if the soil surrounding the channels was saturated with outflow solutions, constituents may have been carried by percolation through the soil into areas that are not stained. Residence times for wastewater were longer in the pond than in the flow channels, which could allow additional percolation into soils surrounding the pond. If constituents were deposited in the flow channels or the pond, their concentrations in the wastewater would have decreased with distance from the outfall. If this was the case, concentrations of constituents would be expected to be lower in the areas below the pond.

5.2.1.2.2 Potential Pathways and Exposure Routes

The outfall and run-off area are the primary sources of potential contaminants. Outflow ran downhill along the path of least resistance, ponded in a depression near the edge of Pajarito Canyon, and continued to the bottom of the canyon. Constituents may have been carried into the stream in Pajarito Canyon and out of the OU. Contaminants may be present anywhere along the drainage but would be most concentrated in sediment traps or in the pond. The pond and stained drainage channels are dry most of the year but may contain water during summer thunderstorms or winter snowmelt.

Transport mechanisms include overland flow and associated sediment transport, infiltration, percolation, wind erosion, and uptake by plants. Receptors include plants, animals, and humans. The plants and animals are potential ecological receptors and also a potential exposure pathway to humans. Exposure routes to receptors include direct skin contact with contaminated soils or sediments, ingestion, and inhalation when a contaminated area is disturbed. Herbivores living on site may be exposed by eating plants that grow in contaminated soils.

5.2.2 Remediation Decisions and Investigation Objectives

Remediation alternatives include no further action, fixing contaminants in place, and removal of contaminated soil and rock. If no contaminants of concern are found, no further action will be recommended. If remediation is required, alternatives include stabilization of contaminated media, removal of contaminated media for treatment or disposal, *in situ* treatment, and capping contaminated media and monitoring the stabilized area.

The extent of the run-off areas and the slope of the stained canyon wall indicate that soil removal will be extremely expensive. To allow timely decisions on the risks posed by the run-off areas and to identify potential remediation technologies early, a pilot study is in progress to determine the mineralogy of the deposits in the run-off areas (stained and unstained). This study focuses on the minerals formed by the action of the outflow on soil and tuff, in particular their stability, leachability, and health effects. Information on whether hazardous constituents are present and how they are bound is essential for decisions on remediation alternatives. If remediation is required, information on mineralogy will also contribute to selection of a remedy. For example, soil washing can be targeted at a particular mineralogical fraction of the soil.

The objectives of the Phase I investigation of 22-015(c) are to determine whether the media within and outside the stained area contain contaminants of concern.

RFI Phase I data will be collected to answer these questions.

- Are contaminants of concern present in the stained area from the outfall to the wagon road? This information will be used to make decisions on the necessity and extent of a Phase II investigation for that area.
- Are contaminants of concern present in the unstained area adjacent to the stained area (the enclosed white area in Figure 5-4)? This information will be used to make decisions on the necessity and extent of a Phase II investigation for that area.
- Are contaminants of concern present in the diffuse drainage area below the wagon road? This information will be used to make decisions on the necessity and extent of a Phase II investigation for that area.

5.2.3 Data Needs and Data Quality Objectives

5.2.3.1 Data Needs for Evaluating Health and Safety Risks

5.2.3.1.1 Source Characterization

The stained area will be field mapped. All surface features, such as the pond, wagon road, and drainage channels, will be included on the map.

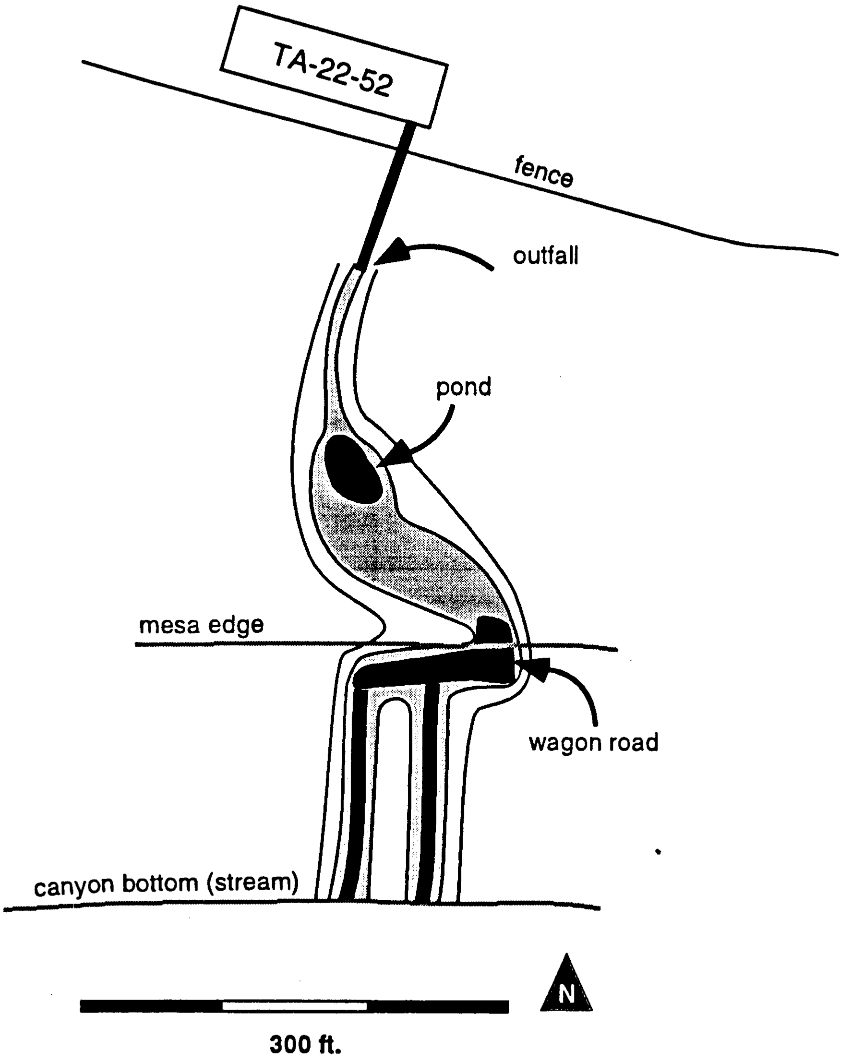


Figure 5-4. Diagram showing approximate location of stained areas associated with 22-015(c). Black areas are heavily stained, grey areas are mildly stained, and the white area is not stained but will be sampled.

For sampling and decision purposes, the stained area will be divided into the following units: S1, the pond and the drainage area above the pond; S2, the drainage area from the pond to the wagon road (a break in the slope) and the wagon road; and S3, the drainage area below the wagon road (Figure 5-5). Information on constituents will be needed from the soil surface, where the constituents were deposited, and at the soil-tuff interface, where constituents may collect.

Potential contaminants of concern are expected to be homogeneously distributed in S1. Samples from three locations will be composited to reduce costs while increasing the possibility of finding high concentrations if the assumption that constituents are homogeneously distributed is incorrect. One composite from the drainage channel and two composites from the pond will characterize S1 for Phase I decisions. Because constituents are expected to be homogeneously distributed, the average constituent concentrations of each composite will be compared to the SALs. Potential contaminants for which data are needed are the metals enumerated in Section 5.2.1.2.1, semivolatile organics, and cyanide.

In addition to the composite samples, information on volatile organics will be collected from the pond in S1. If volatile organics were present in the outflow, the pond is the area most likely to have retained them. Evenly spaced samples will be collected at the surface and at the soil-tuff interface. Samples will be analyzed for volatile organics, for which compositing is inappropriate. Information from the analyses of these samples and the composited samples will be used to check the assumption of homogeneous distribution. If compositing is found to be appropriate for the pond, there will be no further check of the compositing assumptions. If no contaminants of concern are found in any sample from S1, it will be concluded that the extent of contamination in this potential release site (PRS) does not include S1. If any sample contains volatile organics above SALs, a Phase II investigation will be recommended for the entire outflow area. If any

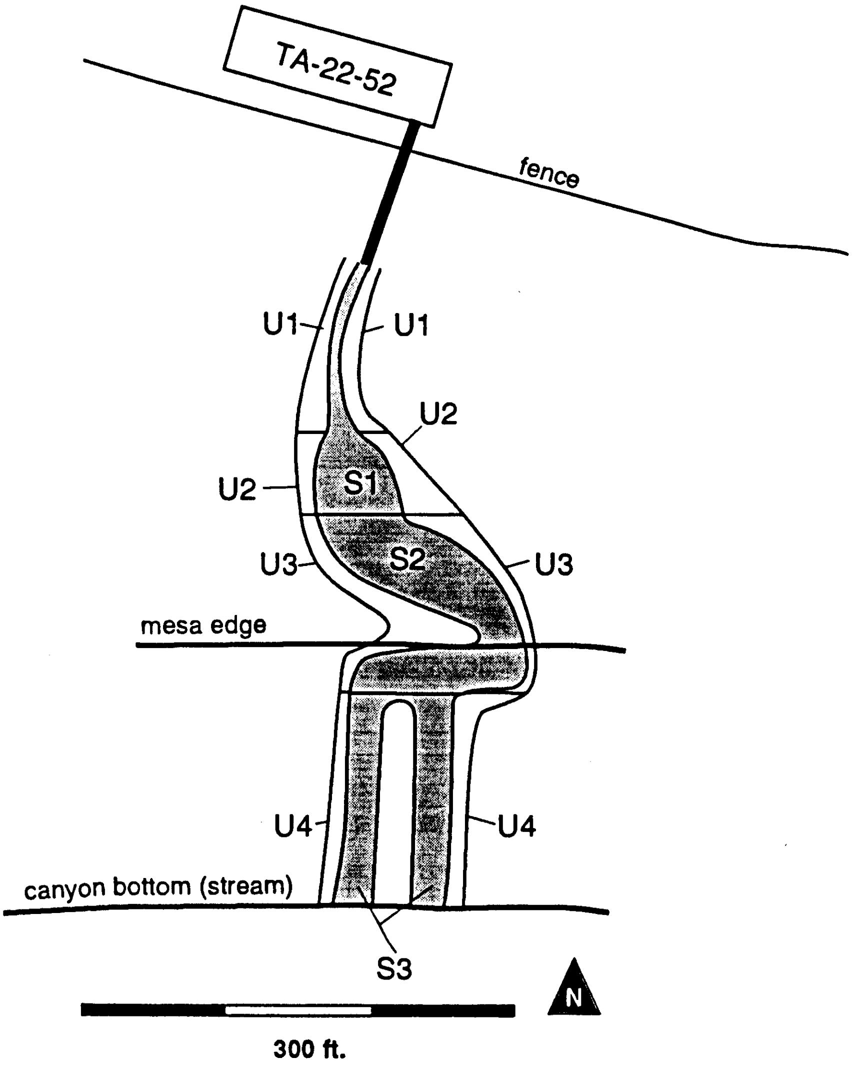


Figure 5-5. Areas designated for sampling.

other contaminants of concern are found, a Phase II investigation will be recommended for S1.

Potential contaminants of concern are also expected to be homogeneously distributed in S2; therefore, samples will be composited. One composite for the drainage channel and two composites for the wagon road will characterize those areas for Phase I decisions. Sample analysis will be the same as for S1. The constituent concentrations of each composite will be compared to SALs. Decisions using these data will be the same as those for S1.

Reconnaissance sampling, described in Appendix H of the installation work plan (IWP) (LANL 1992, 0768), will be used for S3. Surface soil samples will be collected from sediment accumulations where contaminants are judged most likely be present. Sample analysis will be the same as for composited S1 and S2 samples. If no contaminants of concern are found in S3 samples, it will be concluded that the extent of contamination in the PRS does not include S3. If contaminants of concern are found, a Phase II investigation will be recommended for S3. The number of samples will be sufficient to detect contaminants above SALs with at least an 80% certainty if the contaminants cover 20% or more of the area being sampled. Samples will be collected where contaminants are judged most likely to be present.

The unstained area may contain contaminants of concern, which could be heterogeneously distributed. Sampling the unstained area will allow its elimination from further study if no contaminants of concern are found. The unstained area will be divided into four sampling units: U1, which extends from the outfall drain line to the upper edge of the pond; U2, which extends from the upper edge to the lower edge of the pond; U3, which extends from the lower edge of the pond to just below the wagon road, and U4, which extends from below the wagon road to the canyon bottom. Constituent information is needed for the surface, where solids may have been deposited, and the soil-tuff interface, where contaminants may have collected. Five sample locations will be evenly spaced along lines that parallel both sides of the stained area at a distance between 1 and 5 ft. To lower the sampling costs while increasing the chance of finding isolated areas of high contaminant concentration, composites will be formed from samples collected at a given depth. Because all areas are believed not to contain contaminants of concern and to assure not missing a sampled area above SALs, the concentrations of constituents in each composite will be compared to one-fifth of the SALs because there are five samples per composite (or 1/n of the SALs, where n is the number of samples in the composite). Constituents of interest are the metals enumerated in Section 5.2.1.2.1, cyanide, and semivolatile organics. If no constituents are found above SALs, we will conclude that the extent of contamination in the PRS does not include the unstained area. If constituents above SALs are found in any of the composites, a Phase II investigation will be recommended. The number of samples will be sufficient to detect contaminants above SALs with at least 90% certainty if the contaminants cover 40% or more of the unstained area being sampled at each depth. Forty samples formed into eight composites will more than satisfy these limits of uncertainty and will also provide a "high" certainty that no large "hot spot" areas exist in this unstained area. The value of "high" can be determined only after mapping the area and sampling locations.

5.2.3.1.2 Environmental Setting

No data are needed for Phase I decisions. If contaminants of concern are present in soil, tuff, or sediments, Phase II may require data to characterize environmental migration pathways.

5.2.3.1.3 Potential Receptors

No data are needed for Phase I decisions.

5.2.3.2 Data Needs for Evaluating Other Impacts

No other impacts are expected. No other data are needed to make a Phase I decision.

5.2.4 Sampling and Analysis Plans

Specifications are given here for minimum numbers of samples to be collected. If additional locations for sampling are identified during the field survey or during sampling, samples will be collected from those locations. Indicators of additional locations for sampling include all findings that may indicate the presence of contaminants, including the results of field screening tests, discoloration, the presence of deposits, and geomorphic structures that may trap contaminants.

Aerial photographs and field surveying will be used to delineate the extent of the stained area. The stained area and all sample locations will be mapped.

Soil samples from cores will be collected in the upper soil horizon from 0 to 6 in. and at a 3-ft depth or at the soil-tuff interface, whichever is shallower. Only one sample will be collected at locations where the soil-tuff interface is less than 8 in. deep. Samples not being analyzed for volatile organics will be homogenized in the field or in the laboratory. For composites, aliquots will be removed from the homogenized samples and will be homogenized with the other samples specified. Enough material will be composited to meet analytical requirements. The uncomposited portion of samples will be stored for possible further investigation; however, they will not be stored at a specific temperature or in a specific environment. If future investigations need information on volatile organics, fresh samples will be collected. All samples will be analyzed in the analytical laboratory for metals (gold, copper, nickel, cadmium, silver, chromium, rhodium, zinc, platinum, iron, and aluminum), nitrate, fluoride, phosphate, cyanide, and semivolatile organics.

Stained Area. The stained area is divided into three units for sampling (Figure 5-5).

In S1, three evenly spaced sampling locations will be sited in the drainage area; samples from these locations will be composited into one analytical sample for each depth. Six evenly spaced sampling sites will be located in the pond; these will be composited into two analytical samples for each depth.

In S2, three evenly spaced sampling locations will be sited in the drainage area between the pond and the wagon road; at least one will be collected at the point where the drainage area and the wagon road meet. These samples will be composited into one analytical sample for each depth. Six samples will be collected along the wagon road; at least one will be collected where the drainage area meets the wagon road. Sample locations in the wagon road will be biased toward the outer edge of the road where staining is heaviest. These samples will be composited into two analytical samples for each depth.

In S3, eight soil samples will be collected at each depth in the drainage area below the wagon road; these will be analyzed as individual samples.

Additional Samples in Pond. Three additional samples will be collected near three of the six pond sampling locations used for composite samples. Intact cores will be taken at these three locations, with samples collected from the 2-6 in. section of the core and at the soil-tuff interface if it is deeper than 8 in. If the soil-tuff interface is greater than 3 ft, the subsurface sample should be collected at the level judged most likely to contain contaminants.

Unstained Area. Sample locations will be evenly spaced in the unstained area (Figure 5-5) along lines that parallel the stained area at a distance between 1 and 5 ft. Five samples will be collected on each side of the stained area in each unit; a total of 40 samples will be collected. Each composite will be formed from the five samples collected at the same depth in each unit.

Total numbers of samples to be collected are summarized in Table 5-3.

5.3 Aggregate 3, Sump and Dry Well Systems and Adjacent Wash Pad

The following SWMUs are included in this aggregate.

- 22-012
- 22-014(a)
- 22-014(b)
- 22-015(a)
- 22-015(b)
- 22-015(d)
- 22-015(e)
- 40-005

5.3.1 Background

5.3.1.1 Description and History

Five sump systems [22-014(a, b), 22-015(b, e), and 40-005], a concrete wash pad (22-012), an explosives drain and seepage pit system [22-015(d)], and a dry well system [22-015(a)] are discussed in this section. A structure identified in the SWMU Report (LANL 1990, 0145) as a disposal pit (22-011) will also be discussed in this section. This structure was, in fact, a seepage pit [22-015(d)] (Meyers 1993, 19-0102).

TABLE 5-3

ANALYTICAL SAMPLES FOR SWMU 22-015(C), PLATING AND ETCHING OUTFALL AND RELATED RUN-OFF AREA

	Field Surveys			Samples			Field Screening			Field Lab. Measr.		Laboratory Analysis													
SWMU Type	Land Survey	Gross Gamma	Geophysics	Sampled Media	Samples	Duplicate	Gross Gamma	High Explosives (M-1 Kit)	Lithological Logging	Gamma Spectrometry	Volatile Organics (SW 8240)	Gamma Spectrometry	Isotopic Uranium	Strontium-90	Cesium-137	Metals (SW 6010)	Volatile Organics (SW 8240)	Semivolatile Organics (SW 8270)	High Explosives (LANL Method)	PCB (SW 8080)	Sulfates/Chromates/Copper Salts	Nitrates and Nitrites	Fluoride	Cyanide	Phosphate
S1 (Composites)	X			Soil/Tuff	6	1	X	X				X				X		X						X	
S2 (Composites)	X			Soil/Tuff	6		X	X				X				X		X						X	
S3	X			Soil/Tuff	16	1	X	X				X				X		X						X	
Pond	X			Soil/Tuff	6		X	X				X				X	X	X			X	X	X	X	
U1 (Composites)				SoilTuff	4	1	X	X				X				X		X						X	
U2 (Composites)				Soil/Tuff	4		X	X				X				X		X						X	
U3 (Composites)				Soil/Tuff	4		X	X				X				X		X						X	
U4 (Composites)				Soil/Tuff	4		X	X				X				X		X						X	

The wash pad is included in this aggregate because it is adjacent to one of the sump systems [22-015(e)]. The explosives drain and seepage pit system and the dry well system are included because they were also used to trap solids while allowing liquids to pass through.

The sump systems described here have all been used to remove solid explosives from wastewater. They include a settling basin in which outflow from explosives operations is collected to allow solid explosives to settle out of the water, the drain lines connecting the basin to a building, an outflow drain line, and an outflow area (run-off area or seepage pit).

The settling basin, commonly referred to as an explosives sump or simply a sump, is directly adjacent to the building it serves and contains an internal structure of baffles or other flow-interrupting devices. Solid explosives settle at the bottom of the sump, while wastewater flows out at a high point. An early attempt (1948) to isolate explosives from wastewater was a gravel-filled pit to which wastewater was directed [22-015(d)] (Meyers 1993, 19-0102). During the 1950s, concrete sumps with an aluminum liner and baffles were constructed (Creamer 1992, 19-0075). All explosives sumps were modified in 1966 as part of a general upgrading of explosives safety practices; the baffles were removed and aluminum tanks with weirs were inserted into the concrete structures (LASL 1966, 19-0022; LASL 1966, 19-0023). Sealants were used in the construction of the tank to prevent leaking. Figure 5-6 shows the structure of a typical explosives sump. The outlet may be connected to a pipe that discharges onto the surface or into a dry well or seepage pit.

Sludges in explosives sumps are picked up on request and transported to TA-16 for treatment and burning according to LANL standard operating procedures. The detonator production operations at OU 1111 use only small amounts of explosives and, therefore, produce small amounts of waste (Meyers 1993, 19-0044). For that reason, sludge removal from sumps is required infrequently.

The dry well system includes drain lines and two dry wells bored into the soil and tuff (Creamer 1993, 19-0076). Figure 5-7 shows the cross section of a dry well (LANL 1982, 19-0103). The gravel in the wells collects solid wastes; the water percolates into the soil and tuff.

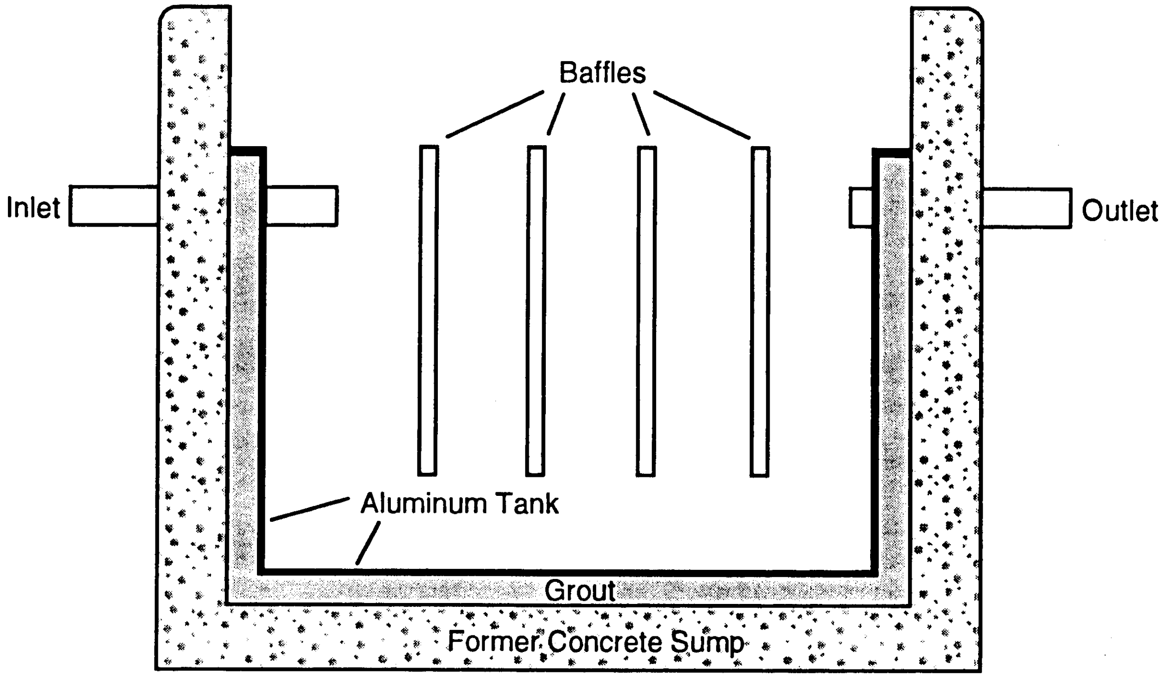
The wash pad, which includes a concrete pad and a drain line into the adjacent sump (LASL 1960, 19-0025), was used for washing explosives-contaminated equipment (Griffin 1992, 19-0077). The washwater from the pad drained into the adjacent sump.

Table 5-4 gives SWMU designations and operational information for the SWMUs in this aggregate. Table 5-5 gives physical descriptions. Planning is now in progress for all explosives sumps to be capped, and outflow will be collected for treatment. If this is done in the near future, outflow areas may be inactive when sampling is done.

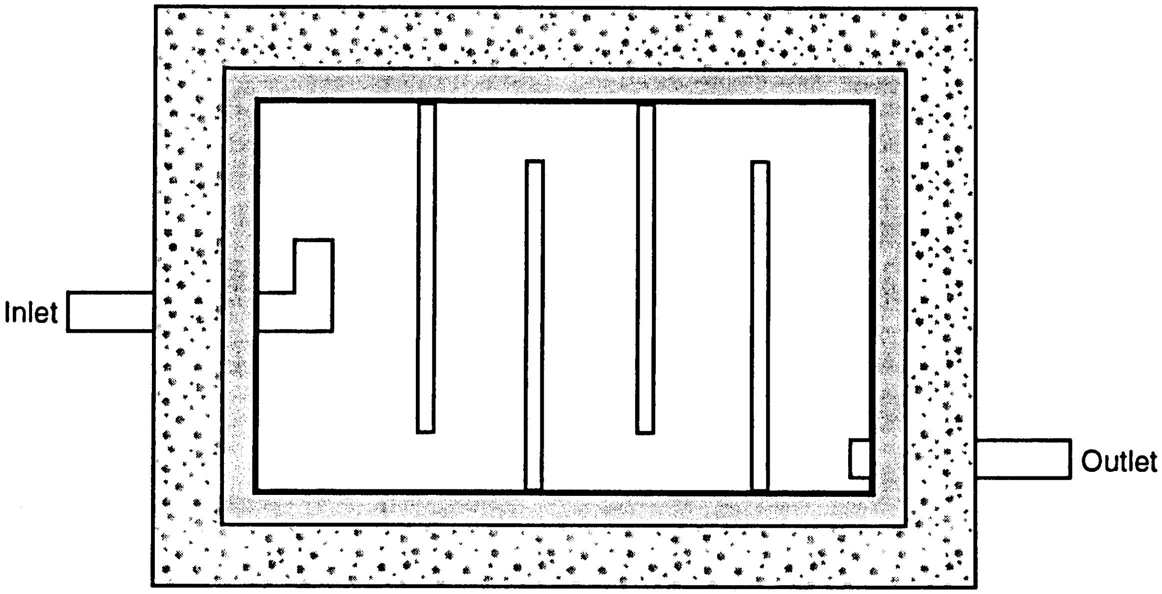
Histories are given below.

SWMU 22-014(a), Active Explosives Sump. This sump serves Building TA-22-93. It receives rinse water from a washing facility for parts and clothing from explosives compacting operations (LANL 1990, 0145) and discharges to a

Source: LASL 1966, 19-0022

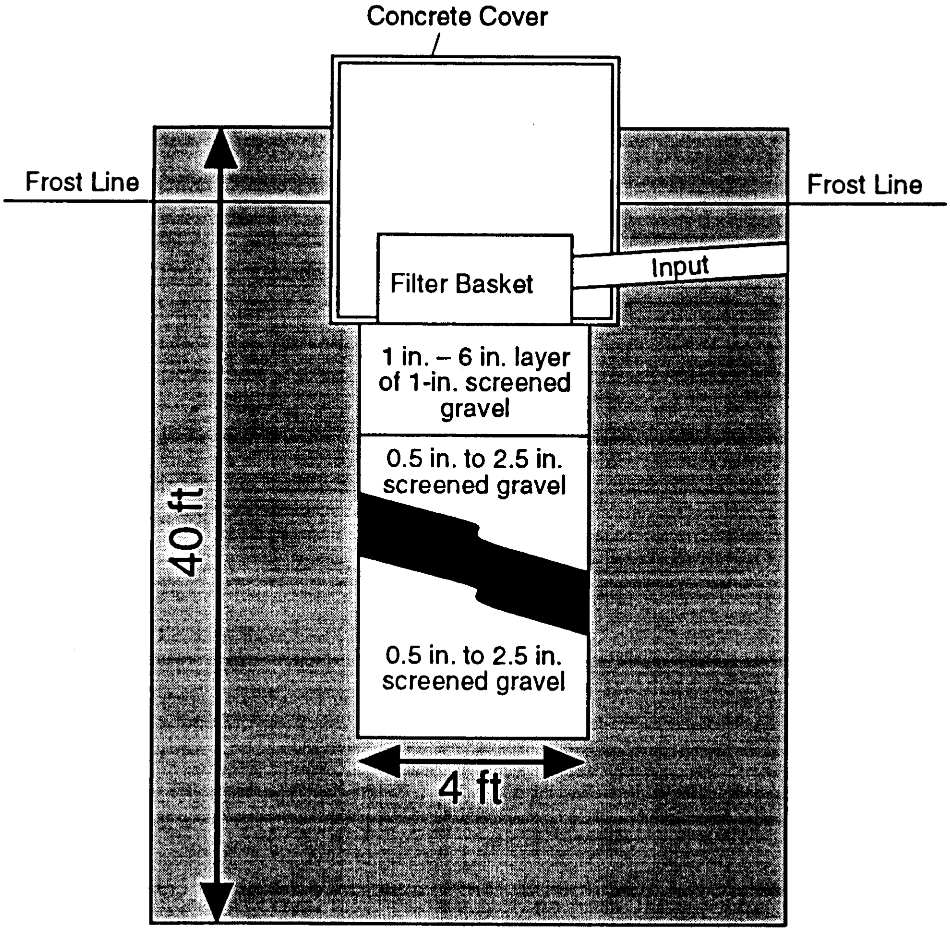


CROSS SECTION



PLAN VIEW

Figure 5-6. Diagram of a typical explosives sump. One possible arrangement of baffles is shown; other flow-modifying devices have been used.



Source: LANL 1982, 19-0103

Figure 5-7. Cross section of a dry well.

seepage pit in the upper part of Tributary B. According to the CEARP report (DOE 1987, 0264), the wastewater volume is approximately 100 gal. per week. This discharge is currently unpermitted. No permit will be requested, however; the outfall from the sump will be capped. All types of Laboratory-approved explosives are possible contaminants in this system. Figure 5-8 shows the location of 22-014(a).

SWMU 22-014(b), Active Explosives and Chemical Waste Line. Building TA-22-34, which 22-014(b) serves, has housed a chemistry laboratory (now a laser laboratory), an explosives laboratory, and a photographic laboratory that does not have a silver recovery unit (DOE 1987, 0264). A chemical waste line is connected to the drain in the chemistry/laser laboratory. An explosives sump is connected to a drain in the explosives laboratory (Santa Fe Engineering 1991, 19-0108). Currently no explosives waste is discharged to this sump; the outlet will be capped in the near future. Recent drain tracing has shown that the chemical line, the explosives sump, and the outflow from the photographic laboratory all drain to a common outfall (Santa Fe Engineering 1991, 19-0108). Action is being taken to bring these outflows into compliance with the National Pollutant Discharge Elimination System. Hazardous wastes that may be present in this sump system include explosives, solvents, acids, and photographic chemicals. Figure 5-8 shows the location of 22-014(b).

TABLE 5-4

AGGREGATE 3 SWMUs

Current SWMU Number	HSWA Permit SWMU Numbers	SWMU Title	Associated Structure	Operational Status	Period of Use
22-012	22-012	Wash pad	TA-22-77	Inactive	1960-1984
22-014 (a)	22-004(a, b)	Sump and seepage pit	TA-22-93	Active	1985-present
22-014(b)	22-005	Sump and outfall	TA-22-34	Active	1950-present
22-015(a)	22-006	Dry wells and outfall	TA-22-91	Inactive	1985-1987
22-015(b)	22-007	Sump and outfall	TA-22-25	Inactive	1949-1960s
22-015(d)	22-009 and 22-011	Explosives drain and seepage pit	TA-22-01	Inactive	1948-1949
22-015(e)	22-009	Sump and outfall	TA-22-01	Inactive	1950-1984
40-005	40-005	Sump and outfall	TA-40-41	Active	1950-present

SWMU 22-015(a), Inactive Dry Wells. The industrial drains and waste from etching and plating operations in Building TA-22-91 discharged to two dry wells in series from 1985 to 1987 (DOE 1987, 0264). The system failed because the infiltration rate of liquid into the tuff was slower than the production rate of effluent, and the wells overflowed through the vent pipes (Creamer 1993, 19-0076). Observers reported that the overflow continued for a few months (Creamer 1993, 19-0076). The dry wells were replaced with waste treatment and storage tanks from which the waste is regularly collected (22-013, Chapter 6). The wells have not been filled in. Metals that may be present in the dry well system include copper and iron. In addition, sulfuric, chromic, hydrochloric, nitric, hydrofluoric, and phosphoric acids; cyanides; aluminum oxide; magnesium oxide; lime; trichloroethylene; sodium hydroxide; and sodium carbonate may have been present in the effluent. Figure 5-8 shows the location of 22-015(a).

SWMU 22-015(b), Inactive Explosives Sump. This sump served Building TA-22-25. It received mixtures of pentaerythritol tetranitrate (PETN) and solvents from a PETN recrystallization process (Meyers 1993, 19-0044). Explosives signs were noted in the general outfall area during the CEARP field survey in 1987 (DOE 1987, 0264). This system is not in use; the outfall is in place (Creamer 1992, 19-0075). PETN and solvents may be present in this sump system. The maximum amount of PETN that could have drained into this sump is estimated at 1 lb. (Meyers 1993, 19-0044). Figure 5-9 shows the location of 22-015(b).

SWMU 22-015(d), Inactive Explosives Drain and Seepage Pit. Building TA-22-1, served by 22-015(d), was used for detonator development (LANL 1990, 0145). PETN was recrystallized in acetone and water in Room 109 (Meyers 1993, 19-0044), and wastewater from that operation was piped to a pit south of Building TA-22-1. This pit appears to be the location described in the SWMU Report for 22-011 and also appears to be the outfall described in 22-015(d) in the SWMU Report (LANL 1990, 0145). Although the SWMU Report states that wastewater from 22-015(d) flowed onto the ground, in fact, it flowed into this pit (Meyers 1993, 19-0102). The pit was dug in 1948 and filled with a layer of gravel and a layer of sand to catch solid explosives from wastewater and to allow the water to

TABLE 5-5

PHYSICAL DESCRIPTION OF SWMUs IN AGGREGATE 3

SWMU Number	Drain Lines	SWMU		Waste Destination
		Construction	**Size**	
22-012		Reinforced concrete pad[a]	8 ft by 8 ft by 10 in. thick[a]	SWMU 22-015(e), washdown liquid may have spilled over edges of pad
22-014(a)	From Rooms C112, C114	Concrete sump containing an aluminum tank[a]	4 ft deep, 9 ft 2 in. long, 3 ft 2 in. wide[a]	Seepage pit (4-ft diameter and 40 ft deep)[b]
22-014(b)	From Rooms 101-113	Concrete sump containing an aluminum tank[a]	4 ft by 2 ft by 3 ft deep[a]	Outfall in Tributary B of Two-Mile Canyon (Figure 3-1), outfall channel is downcut about 3-6 ft for 100 ft, channel drains into a cattail pond
22-015(a)	From Rooms B102, B104, B107, B121, B123, B145, B160	Two holes drilled in tuff and filled with stones[c]	4-ft diameter and 20 ft deep, 4-ft diameter and 26 ft deep[c]	Outfall in Tributary B of Two-Mile Canyon, outfall channel is downcut about 3-6 ft for 100 ft, channel drains into a cattail pond
22-015(b)	From Room 101	Concrete sump containing an aluminum tank[a]	4 ft 6 in. by 3 ft by 3 ft 6 in. deep[a]	Outfall north of the building
22-015(d)	From Room 109	Pit filled with gravel		Drainage to Pajarito Canyon
22-015(e)	From Room 108	Concrete sump,[d] filled with concrete in 1984[a]	4 ft 6 in. by 3 ft by 3 ft 6 in.[a]	Drainage to Pajarito Canyon
40-005	From Room 101	Concrete sump containing an aluminum tank[a]	4 ft 6 in. by 6 ft 4 in. by 5 ft deep[a]	Outfall north of the building[e] into Tributary B of Two-Mile Canyon[a]

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[a] (LANL 1990, 0145)

[b] (LANL 1982, 19-0103)

[c] (Creamer 1993, 19-0076)

[d] (Griffin 1992, 19-0077)

[e] (Creamer 1992, 19-0075)

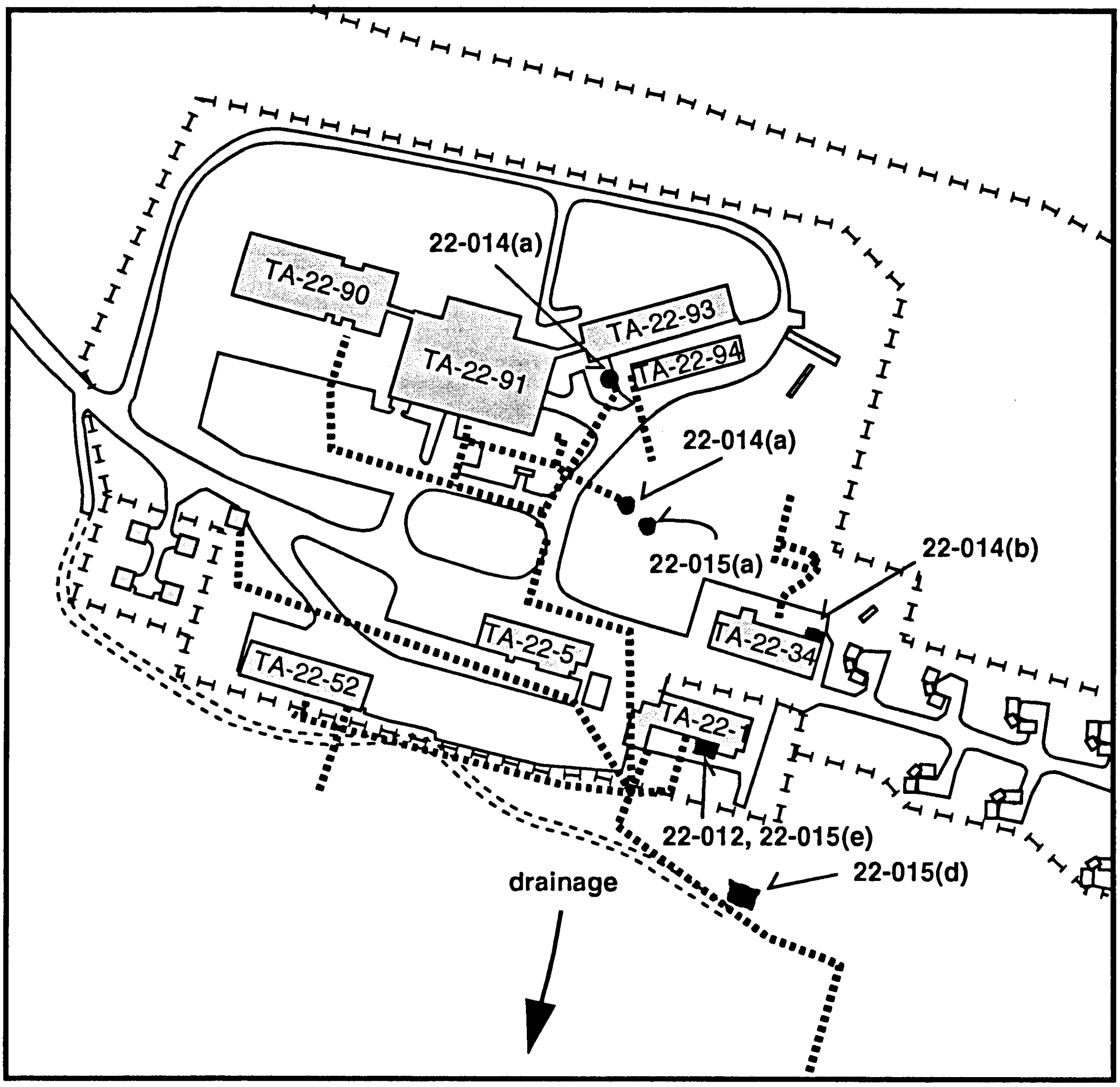
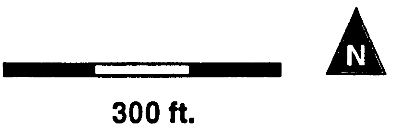


Figure 5-8. Locations of 22-012, 22-014(a, b) and 22-015(a, d, e).



■ **PRSs**

▨ **Permanent Structure**

▭ **Paved road or parking area**

┅ **Unpaved road**

▪▪▪ **Drain line**

⊢⊣ **Fence**

evaporate and percolate into the soil (Meyers 1993, 19-0102). The maximum amount of PETN that could have drained out of Room 109 is estimated at 0.02 lb. (Meyers 1993, 19-0044). Figure 5-8 shows the location of 22-015(d).

SWMUs 22-015(e), Inactive Explosives Sump, and 22-012, Wash Pad. In 1950, Room 108 of Building TA-22-1 was fitted for wet grinding of PETN wedges, and 22-015(e), an explosives sump, was installed at that time (Meyers 1993, 19-0024). It is believed that the sink drain in Room 108 is connected to 22-015(e). A concrete pad (22-012) for washing explosives-contaminated equipment with water was added in 1960 (LANL 1990, 0145). The two structures are adjacent to the building and each other and are surrounded by asphalt paving. The wastewater from the pad drained into 22-015(e) until 1984 (Griffin 1992, 19-0077). The sump was filled with concrete after TA-22-1 was abandoned in 1984 (LANL 1990, 0145). Its outfall pipe is still in place (Creamer 1992, 19-0075). Hazardous wastes that may be present include explosives, acetone, and other solvents. Figure 5-8 shows the locations of these SWMUs.

SWMU 40-005, Active Explosives Sump. This sump is located outside Building TA-40-41. The building and sump were part of TA-22 before being incorporated into TA-40 (LANL 1990, 0145), and the sump is shown as TA-22-75 on ENG-C-27705 (LASL 1966, 19-0022; LASL 1966, 19-0023). This system serves an occasional explosives grinding operation at TA-40-41 (Meyers 1993, 19-0024) and is used infrequently. Only a small amount of liquid drains from the sump. Hazardous wastes that may be present in this sump system include explosives, alcohol, and acetone. Figure 5-9 shows the location of 40-005.

SWMUs 22-014(a), 22-014(b), and 22-015(a) drain into a marshy area in the upper part of Tributary B of Two-Mile Canyon. Near-surface and subsurface

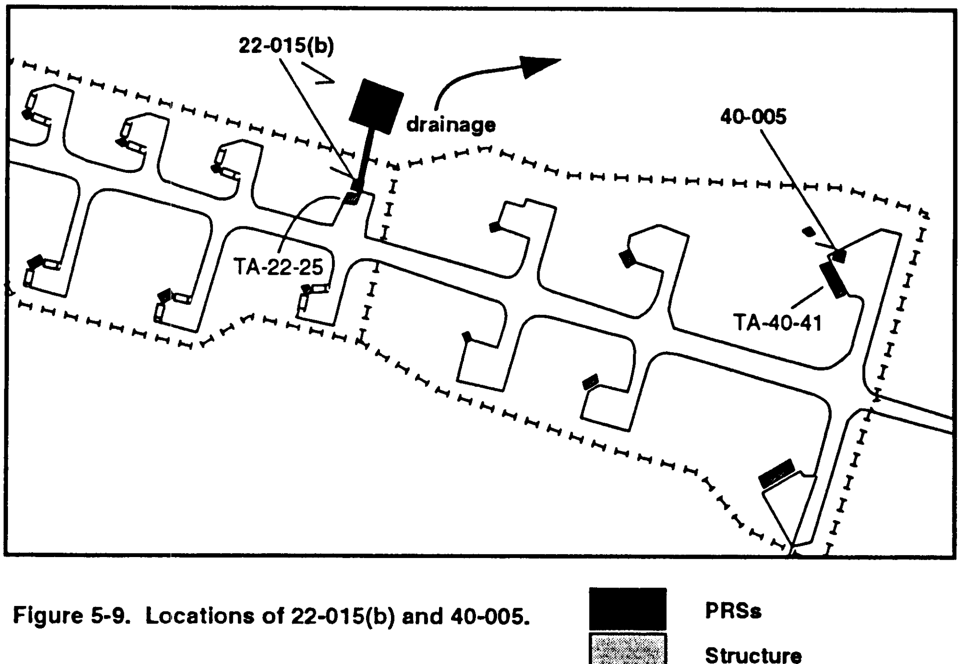


Figure 5-9. Locations of 22-015(b) and 40-005.

300 ft.
N

■ **PRSs**
▨ **Structure**
▭ **Paved road or parking area**
ᴴ ᴴ ᴴ **Fence**

soils were sampled in this area during a Department of Energy (DOE) survey (LANL 1989, 19-0124). No explosives or asbestos fibers were found in the samples. Results are summarized in Table 5-6.

5.3.1.2 Conceptual Exposure Model

5.3.1.2.1 Nature and Extent of Contamination

Based on archival evidence, possible contaminants in these SWMUs are several types of explosives, acids, solvents, heavy metals, cyanide, volatile and semivolatile organics, and photographic chemicals. In all cases, archival information suggests that levels of contaminants are likely to be low because total amounts of hazardous materials used in operations are low. The explosive most often used is PETN; total amounts used and discharged to the environment have been estimated (Table 4-5) (Meyers 1993, 19-0044).

5.3.1.2.2 Potential Pathways and Exposure Routes

Sumps, drain lines, and the wash pad (if leaks or overflows occurred); dry wells; seepage pits; surrounding soils; and outflow areas are possible primary sources of contaminants. The outflow areas are the most likely parts of the systems to contain contaminants because they have received outflow from the sumps since their installation, whereas solids are removed periodically from the sumps, and the drain lines are subject to flushing by continued flow. Dry wells and seepage pits are designed to allow liquids to percolate into soils or tuff; dissolved contaminants or fine particulates may be carried with the liquids.

Because the sump is designed to allow solids to settle out, the constituents most likely to have been carried to the outflow areas are those that are soluble in water, those that are lighter than water, or fine particulates that could have been entrained in the water flow. Thus, soluble metal salts and solvents that are lighter than water or soluble in water are the constituents most likely to have been carried into the outflow areas. Although the explosives used in operations at OU 1111 are very insoluble in water, fine particulates may have been carried to the outflow areas. Solvents are expected to have evaporated from surface areas, but explosives, being less volatile, can be expected to remain in place and may have decomposed by oxidation in air or by bacterial action. Thus, decomposition products may also be present. Cyanides may oxidize under atmospheric conditions and may now be absent even if they were once deposited. Discharge from the outflow drain line will run downhill along the path of least resistance and will pond in depressions. Contaminants may be present anywhere along the drainage but would be most concentrated in sediment accumulations or ponding areas.

The direction of drainage is indicated on Figures 5-8 and 5-9. The systems drain into Pajarito Canyon and Tributary B of Two-Mile Canyon. Transport mechanisms include overland flow and associated sediment transport, infiltration, percolation, wind erosion, and uptake by plants. Receptors include plants, animals, and humans. The plants and animals are potential ecological receptors and also a potential exposure pathway to humans. Exposure routes to receptors include direct skin contact with contaminated soils or sediments, ingestion, and inhalation when a contaminated area is disturbed. Herbivores living on site may

TABLE 5-6

RESULTS OF DOE SAMPLING IN TA-22 MARSHY AREA[a]

Sample Number	LA85601	LA85602	LA85603	LA85604	LA85605	LA81501	LA81502	LA81503
Medium	Subsurface soil	Subsurface soil	Subsurface soil	Subsurface soil	Subsurface soil	Soil	Soil	Soil
Depth (ft)	1-5	1-5	1-5	1-5	1-5	0-1	0-1	0-1
Analytes								
Acetone (µg/kg)	54	ND	32	ND	ND	NA	NA	NA
1,1,1-Trichloroethane (µg/kg)	ND	ND	3	ND	2	NA	NA	NA
Toluene (µg/kg)	4	ND	8	ND	ND	NA	NA	NA
Ethyl benzene (mg/kg)	19	ND	ND	ND	ND	NA	NA	NA
Antimony (mg/kg)	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic (mg/kg)	ND	ND	ND	ND	ND	ND	ND	ND
Barium (mg/kg)	124	151	132	115	114	151	141	176
Beryllium (mg/kg)	1.3	1.2	1.1	0.99	ND	ND	ND	ND
Cadmium (mg/kg)	ND	4.8	3.8	2.8	ND	ND	ND	3.3
Chromium (mg/kg)	69.9	19.9	ND	ND	43.0	11.5	9.0	13.0
Copper (mg/kg)	50.1	84.2	78.7	45.7	47.2	66.2	43.2	ND
Lead (mg/kg)	ND	ND	ND	ND	ND	ND	ND	ND
Nickel (mg/kg)	27.0	ND	ND	ND	20.4	ND	ND	ND
Selenium (mg/kg)	ND	ND	ND	ND	ND	ND	ND	ND
Silver (mg/kg)	ND	ND	ND	ND	ND	ND	ND	ND
Thallium (mg/kg)	ND	ND	ND	ND	ND	ND	ND	ND
Zinc (mg/kg)	27.5	34.4	25.6	25.6	23.8	35.5	30.3	39.8

Table 5-6 (concluded)

Thorium-232 (pCi/kgW)[b]	<7100±2000	<6900±900	<7500±900	<6700±1500	<6900±900	<8500±900	<7100±900	<12400±1900
Uranium-234 (pCi/kgW)	ND	ND	ND	ND	ND	ND	ND	ND
Uranium-235 (pCi/kgW)	ND	ND	ND	ND	ND	95.0±50.0	ND	90.0±96.0
Uranium-238 (pCi/kgW)[c]	ND	ND	ND	ND	ND	ND	ND	ND
Aluminum-26 (pCi/kgW)	ND	ND	ND	ND	ND	ND	ND	ND
Potassium-40 (pCi/kgW)	11300±4100	11700±1600	13100±2100	14200±3500	12800±1600	13200±2200	11600±1600	14900±2200
Cobalt-56 (pCi/kgW)	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt-60 (pCi/kgW)	ND	ND	ND	ND	ND	ND	ND	ND
Cesium-134 (pCi/kgW)	ND	ND	ND	ND	ND	ND	ND	ND
Cesium-137 (pCi/kgW)	ND	93.0±34.0	97.0±36.0	ND	ND	ND	ND	410±100

NA = Not analyzed for.
ND = Not detected.
[a] (LANL 1989, 19-0124)
[b] Radionuclide results are from screening only.
[c] Activity in excess of uranium-238 natural chain.

be exposed by eating plants that grow in contaminated soils or drinking water from the marshy area. On the basis of the information currently available, sources of contaminants are expected to be small or nonexistent. Therefore, potential public health and environmental impacts are expected to be extremely limited.

5.3.2 Remediation Decisions and Investigation Objectives

Remediation alternatives differ for active and inactive SWMUs in Aggregate 3. The preferred remediation alternative for inactive sumps appears to be removal of the structure while sampling. Although no study has been done specifically for sumps, studies on septic tanks indicate that sampling without removal is more expensive than removal and concurrent sampling (Den-Baars 1991, 19-0021). Remediation alternatives for other components of the inactive SWMUs include no further action; removal or *in situ* treatment of contaminated media surrounding the sump, drain lines, and wash pad; removal or *in situ* treatment of contaminated media in the outfall and run-off area, the seepage pit, and the dry wells; and capping and monitoring contaminated media and structures. If both radioactive and hazardous components are present in the sumps, they must be disposed of in an appropriate mixed-waste facility. Therefore, sampling of inactive systems will first determine whether sump disposal can be in existing disposal facilities. If sump disposal must be in an appropriate mixed-waste facility, removal and sampling of the sump will be deferred until such a facility is available.

Three sumps are active and are expected to remain active until the outflows are redirected to a planned wastewater treatment system. If these sumps are inactive at the time of sampling, they will be sampled as inactive sumps. Remediation alternatives for active sumps include deferred action; redirecting the outflow to a storage or treatment facility and removal or *in situ* remediation of contaminated soil around the sump, outfall and run-off area, and drain lines; replacement or repair of the sump and associated drain lines; and capping and monitoring of contaminated soil and structures.

The objective of the Phase I investigation of Aggregate 3 is to determine whether the sumps, seepage pits, dry wells, wash pad, present and historical outfalls and related run-off areas, and the surrounding media contain contaminants of concern.

RFI Phase I data will be collected to answer these questions.

- Are contaminants of concern present in the outfall and run-off areas of sump systems, in seepage pits and dry wells, or around the wash pad? These areas are the most likely to retain hazardous materials that may have been discharged into the systems. Sumps are poorer indicators of past waste stream contamination because solids are removed periodically. This information will be used to make decisions on whether a Phase II investigation is necessary.

- Are contaminants of concern present in the media surrounding the sump? This information is required to decide whether a Phase II investigation is necessary before inactive sumps can be removed. For active sump systems, this information is required to decide whether a Phase II investigation is necessary.

No further action will be recommended for outflow drain lines if no contaminants of concern are found in the areas that have received outflow. If contaminants of concern are found in the outflow areas, a Phase II investigation of the outflow drain lines will be recommended.

5.3.3 Data Needs and Data Quality Objectives

5.3.3.1 Data Needs for Evaluating Health and Safety Risks

5.3.3.1.1 Source Characterization

Each SWMU in this aggregate will be field mapped. Sumps, dry wells, seepage pits, present and historical outfalls and run-off areas, and present and historical drain lines will be included on the map.

Reconnaissance sampling (Appendix H, IWP) (LANL 1992, 0768) at each SWMU will determine whether contaminants of concern are present in the outflow areas. Results from the analysis of outflow area samples will produce data for decisions for the outflow area and the outflow drain lines. If no samples are found to contain contaminants of concern, no further action will be recommended. If contaminants of concern are found, a Phase II investigation will be recommended for the outflow area and for outflow drain lines. Samples will be analyzed for possible contaminants as listed for individual SWMUs in Section 5.3.1.1. The number of samples will be sufficient to detect contaminants above SALs with at least an 80% certainty if the contaminants cover half or more of the area being sampled. Samples will be collected where contaminants are judged most likely to be present.

For active sumps, soil samples will be collected outside the bottom corners of the sump. If no contaminants of concern are found, further action will be deferred until decommissioning. If contaminants of concern are found, a Phase II investigation will be recommended. The number of samples will be sufficient to detect contaminants above SALs with at least an 80% certainty if the contaminants cover half or more of the area being sampled. Samples will be collected where contaminants are judged most likely to be present.

For inactive sumps, samples will be collected from the contents of the sump, and soil samples will be collected outside the bottom corners of the sump. Results of the analyses will help determine where to dispose of the sump. More than one sample will be taken from the contents of the sump for the following reasons: it is uncertain whether the contents are homogeneous, statistical analysis is not possible with just one sample, and three samples provide a check for laboratory analysis. If contaminants of concern that imply the presence of mixed waste are found, deferred action will be recommended; otherwise, the sump will be removed.

After the sump is removed, sampling of the surface of the excavated area will proceed. Samples will be collected in areas where flaws are observed in the sump or where there is evidence of leakage (e.g., staining). If no such areas exist, samples will be collected from widely spaced locations. If no contaminants of concern are found, the excavation will be filled and no further action will be recommended for the excavated area and the drain lines. If contaminants of concern are found, a Phase II investigation will be recommended for the media surrounding the sump and the drain lines. The number of samples will be sufficient to detect contaminants above SALs with at least an 80% certainty if the contaminants cover half or more of the area being sampled. Samples will be collected where contaminants are judged most likely to be present.

Cores will be taken around the perimenter of the seepage pits and dry wells. The contents of inactive pits and wells will be sampled and analyzed. If no contaminants of concern are found in the cores and the contents, further action will be deferred until decommissioning for active systems, and no further action will be recommended for inactive systems. If contaminants of concern are found in the cores or the contents, a Phase II investigation will be recommended. The number of samples outside active and inactive pits and wells will be sufficient to detect contaminants above SALs with at least an 80% certainty if the contaminants cover half or more of the media surrounding the pit at each of the three depths. The number of samples of the contents of inactive pits and wells will be sufficient to detect contaminants above SALs with at least an 80% certainty if the contaminants cover half or more of the volume in inactive pits and wells. Samples will be collected where contaminants are judged most likely to be present.

The wash pad and adjacent concrete-filled sump will be treated as a single unit for sampling. Soil samples from underneath the asphalt will be collected from each of the three sides of the wash pad/sump surrounded by asphalt. In addition, samples of the asphalt surrounding the wash pad will be collected and analyzed to provide information on contaminants that may have drained from the wash pad. The number of surface asphalt samples and soil samples will be sufficient to detect contaminants above SALs with at least an 80% certainty if the contaminants cover 35% or more of the media surrounding the wash pad. Samples will be collected where contaminants are judged most likely to be present.

The marshy area in the upper part of Tributary B will be sampled as a catchment area for 22-014(a, b) (sumps), 22-015(a) (dry wells), and 22-010(a) (septic system described in Section 5.6). If no samples contain contaminants of concern, it will be concluded that the extent of contamination does not include Tributary B above 22-015(b). If contaminants of concern are found, it may not be possible to attribute the origin of the contaminants to a single SWMU, and a Phase II investigation will be recommended. The number of samples will be sufficient to detect contaminants above SALs with at least an 80% certainty if the contaminants cover half or more of the area being sampled. Samples will be collected where contaminants are judged most likely to be present.

The logic flow diagrams (Figures 5-10 and 5-11) summarize Phase I sampling. In Figure 5-10, the word "structure" refers to sumps and seepage pits.

5.3.3.1.2 Environmental Setting

No data are needed for Phase I decisions. If contaminants of concern are present in soil, tuff, or sediments, Phase II may require data to characterize environmental migration pathways.

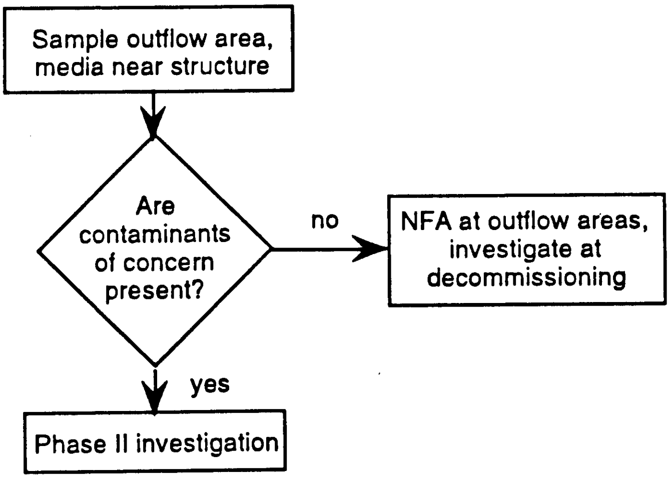


Figure 5-10. Logic flow diagram for Phase I sampling of active SWMUs in Aggregate 3.

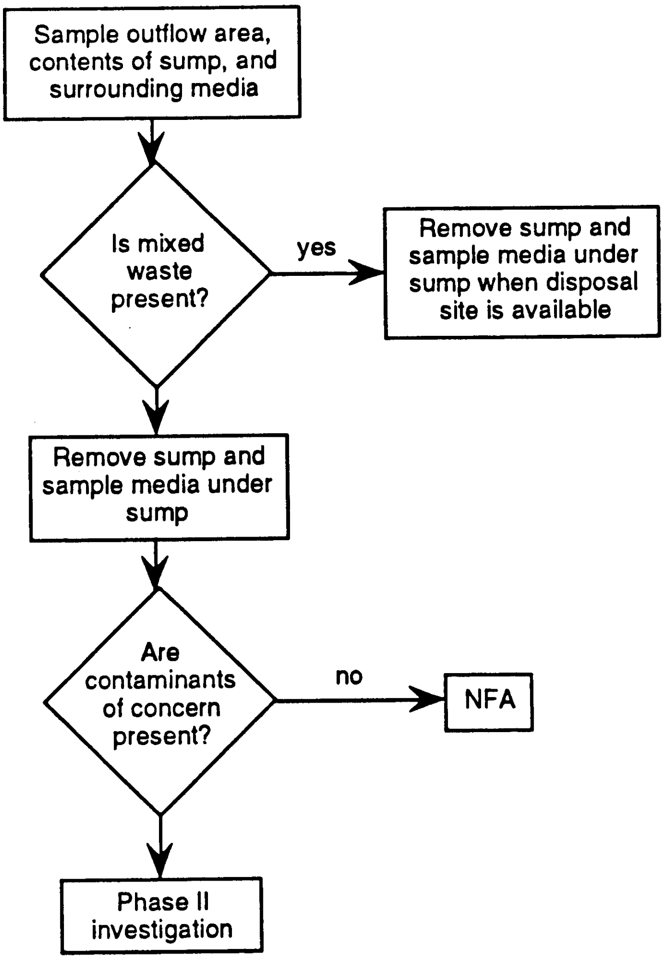


Figure 5-11. Logic flow diagram for Phase I sampling of inactive sump SWMUs.

5.3.3.1.3 Potential Receptors

No data are needed for Phase I decisions.

5.3.3.2 Data Needs for Evaluating Other Impacts

The primary use for some of the source characterization data will be to determine constraints on the scheduling and budgeting of a combined sampling and voluntary corrective action (VCA) for inactive sumps. If no hazardous constituents or only hazardous constituents are found early in the source characterization, combined removal and sampling of inactive sumps may proceed. If mixed waste is present, removal of contaminated soil or structures may be deferred until suitable waste disposal capacity is available.

5.3.4 Sampling and Analysis Plans

Specifications are given here for minimum numbers of samples to be collected. If additional locations for sampling are identified in the field survey or during sampling, additional samples will be collected from those locations. Indicators of additional locations for sampling include all findings that may indicate the presence of contaminants, including the results of field screening tests, discoloration, the presence of deposits, and geomorphic structures that may trap contaminants.

Engineering drawings and preliminary field investigations (field surveys, geophysical surveys, and/or trenching) will be used to determine the locations of the components of all the SWMUs. All locations that have not been mapped will be mapped. Sampling locations will also be mapped.

Sampling plans for the various system components are given below. Sampling plans are summarized in Tables 5-7 and 5-8; numbers of samples given in those tables are derived from the discussions in the sampling plans below. The recommended chemical analyses are derived from the information in Section 5.3.1.1.

Outfalls and Related Run-off Areas. Three surface soil samples will be collected within 25 ft downslope of the outfall pipe. Samples will be located at sediment accumulations or other areas likely to contain contaminants. If no such areas are found, samples will be evenly spaced downslope of the outfall. Three intact soil cores to a depth of 3 ft or the soil-tuff interface, whichever is shallower, will be collected in the marshy area of Tributary B east of Building TA-22-91 and north of Building TA-22-34. Samples will be removed from each core at the surface and at a 3-ft depth or the soil-tuff interface, whichever is shallower. Soil and core samples will be analyzed in the analytical laboratory.

Active Sumps. One intact core will be taken to a depth of 3 ft below the bottom of the sump and as close as practicable to each corner of the sump but no farther than 6 ft away (Figure 5-12). Another core will be taken to a depth of 3 ft below the bottom of the sump and as close as practicable to the outflow pipe but no farther than 6 ft away. Samples will be removed from the cores at the surface, at the level of the bottom of the sump, and at 3 ft below the bottom of the sump and will be submitted to the analytical laboratory.

TABLE 5-7

TYPES OF SAMPLES TO BE COLLECTED IN AGGREGATE 3

SWMU Number	Outfall and Run-off Areas	Active Sump	Inactive Sump	Seepage Pits and Dry Wells	Wash Pad and Sump
22-014(a)		4 cores[a]		3 cores[b] 3 pit contents	
22-014(b)	3 surface	5 cores[a]			
22-015(a)				3 cores[b] 3 pit contents	
22-015(b)	3 surface		3 each layer of contents 5 cores[a] 3 soil after removal		
22-015(d)				3 cores[b] 3 of pit contents	
22-015(e) and 22-012			5 cores[a] 3 cores[a] after removal		3 asphalt 6 surface soil
40-005	3 surface	4 cores[a]			
Tributary B Marshy Area	3 cores[c]				

[a] Three analytical samples to be removed from these cores
[b] Four analytical samples to be removed from these cores
[c] Two analytical samples to be removed from these cores

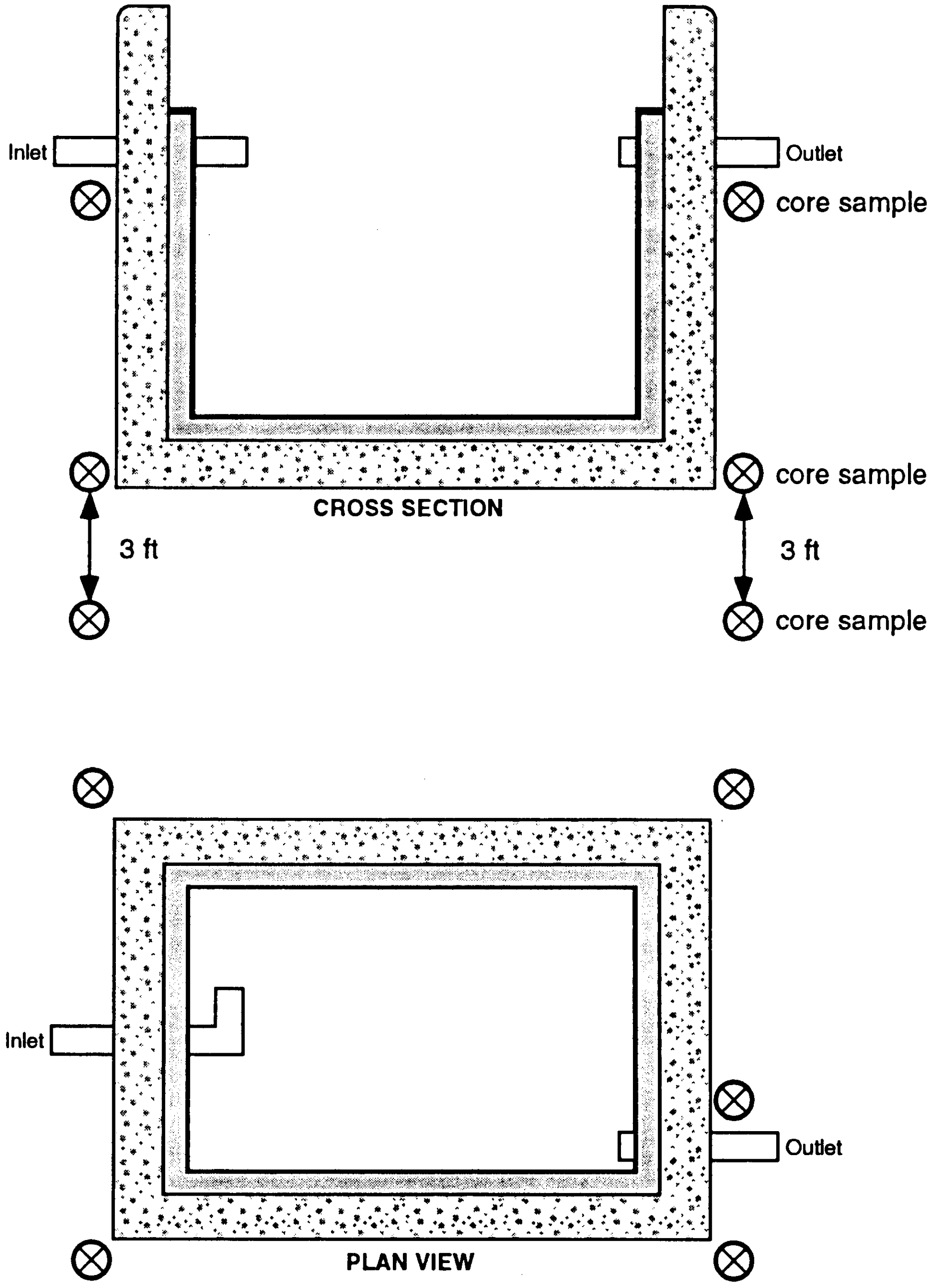
Inactive Sumps. Before the sump can be removed for disposal, three samples will be collected from each layer of sludge or liquid present or, if the tank is empty, three scrape or swipe samples will be collected from the tank's side or bottom. The scrape/swipe samples will be judgmentally located to maximize the probability of finding contaminants. Such a judgment might be based on coloration of the tank or the presence of deposits. Soil cores will be taken outside the corners of the sump and at the outflow pipe as described for active sumps, but samples will be removed at the surface and at the depth of the bottom of the tank. These samples will be submitted to the analytical laboratory.

If no contaminants of concern indicating the presence of mixed waste are found within or immediately outside the sump, removal of the sump and sampling of the media surrounding the sump may proceed. The sump will be inspected for structural flaws, and the sump and excavation will be inspected for evidence of leaks. Soil samples will be collected where structural flaws or leaks indicate liquid may have escaped from the sump. Samples will be collected from at least three locations, including the areas where leaks may have occurred; other samples will be dispersed about the excavation to obtain wide coverage. These samples will be collected to a 6-in. depth from the surface of the excavation and a 3-ft depth or the soil-tuff interface, whichever is shallower. Samples will be submitted to a laboratory that can provide rapid turnaround times for analysis so that decisions can be made quickly and the pit can be filled to minimize safety hazards.

TABLE 5-8

ANALYTICAL SAMPLES FOR AGGREGATE 3

		Field Surveys			Samples			Field Screening			Field Lab. Measr.		Laboratory Analysis													
SWMU or AOC	SWMU Type	Land Survey	Gross Gamma	Geophysics	Sampled Media	Samples	Duplicate	Gross Gamma	High Explosives (M-1 Kit)	Lithological Logging	Gamma Spectrometry	Volatile Organics (SW 8240)	Gamma Spectrometry	Isotopic Uranium	Strontium-90	Cesium-137	Metals (SW 6010)	Volatile Organics (SW 8240)	Semivolatile Organics (SW 8270)	High Explosives (LANL Method)	PCB (SW 8080)	Sulfates/Chromates/Copper Salts	Nitrates and Nitrites	Fluoride	Cyanide	Phosphate
20-014(a)	Active Sump	X			Soil/Tuff	12	1	X	X											X						
					Soil/Tuff	12	1	X	X	X										X						
					Liquid/Sludge	3	1	X	X											X						
22-014(b)	Active Sump	X			Soil	3	1	X	X								X		X	X		X	X	X	X	
					Soil/Tuff	15	1	X	X								X	X	X	X		X	X	X	X	
22-015(a)	Inactive Dry Wells	X			Soil/Tuff	12		X	X	X							X	X	X	X		X	X	X	X	
					Liquid/Sludge	3		X	X								X	X	X	X		X	X	X	X	
22-015(b)	Inactive Sump	X			Soil	3		X	X											X						
					Soil/Tuff	16	1	X	X									X		X						
					Liquid/Sludge	3		X	X											X						
22-015(d)	Inactive Seepage Pit	X			Soil/Tuff	12		X	X	X								X		X						
					Liquid/Sludge	3		X	X											X						
22-015(e)	Inactive Sump and Wash Pad	X			Asphalt	3	1	X	X											X						
22-012					Soil	9		X	X											X						
					Soil/Tuff	15		X	X									X		X						
40-005	Active Sump	X			Soil	3	1	X	X											X						
					Soil/Tuff	12	1	X	X									X		X						
	Tributary B Marshy Area	X			Soil	6		X	X				X	X		X	X	X		X						



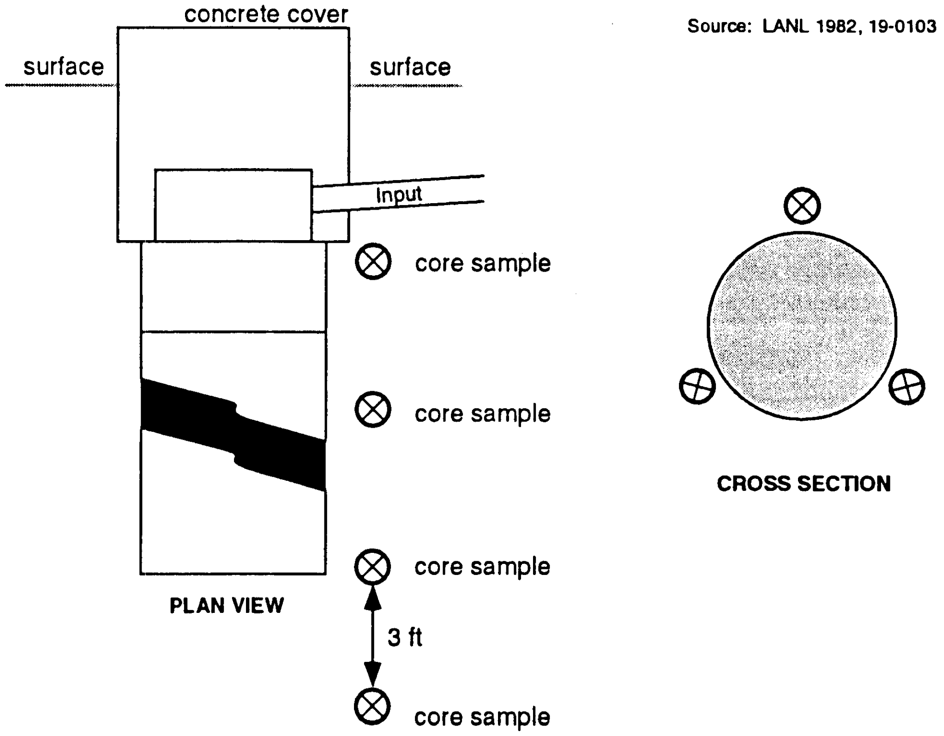
Source: LASL 1966, 19-0022

Figure 5-12. Diagram of sampling strategy for an active sump. Sample locations are approximate.

If no contaminants of concern are found, no further action will be recommended. If contaminants of concern are found, a Phase II investigation will be recommended. In either case, the excavation will be backfilled after enough samples have been analyzed to support the decision.

Seepage Pits and Dry Wells. Three evenly spaced intact cores will be taken to 3 ft below the depth of the pit and as close as practicable to the pit or dry well but no farther than 6 ft away. Boundaries between lithologies and fracture locations along each core will be logged. After the lithology of the core is recorded, samples for analysis in the analytical laboratory will be removed from each core at the surface, at the bottom depth of the pit, and 3 ft below the bottom depth of the pit (Figure 5-13). Another sample will be taken between the surface and bottom of the pit at any location that indicates the possible presence of contaminants. If no such location exists, the sample will be taken at the middle depth of the pit. One sample each of sludge, liquid, and any other media that may be present will be taken from the contents of the pit at three levels: the top, middle, and bottom of the height of the contents. Sampling of the pit contents will be done by appropriate methods for liquids, sediments, or other materials, depending on the nature of the contents of the pit.

Wash Pad and Concrete-Filled Sump. One surface asphalt sample will be collected from each of the three sides of the pad and sump surrounded by asphalt. Two soil samples will be collected from under the asphalt at each side at distances of 3 in. and 12 in. from the pad and sump. Samples will be collected from the middle of the side or at a location where possible contaminants are judged most likely be present. Such judgment may be based upon the appearance of deterioration or discoloration of the asphalt or depressions in the asphalt where contaminants might collect. The outside of the sump will be sampled as specified for inactive sumps. This information will be used to decide whether mixed waste is present for sump and wash pad disposal. After removal of the sump and wash pad, the excavation will be sampled as specified for inactive sumps.



Source: LANL 1982, 19-0103

Figure 5-13. Diagram of sampling strategy for a dry well. Sampling locations are approximate.

5.4 Aggregate 4, Inactive Firing Sites

The following PRSs are included in this aggregate.

- 6-003(a)
- 6-003(c)
- 6-003(d)
- 6-003(e)
- 6-003(f)
- 6-003(g)
- 6-008
- C-6-019
- 7-001(a)
- 7-001(b)
- 7-001(c)
- 7-001(d)
- Building TA-6-8 and surrounding area

5.4.1 Background

5.4.1.1 Description and History

During the 1940s, TA-6 was used for development of methods to recover plutonium in case of a nuclear misfire during the Trinity test and for development of detonators. The recovery effort was designed to evaluate engineered methods at small scale. No fissionable materials were used. Test firing of explosives assemblies was part of both the recovery and detonator development efforts. Test firing for detonator development continued at TA-6 until 1952, when this activity moved to TA-40. Test firing and explosives disposal took place at TA-7 (now a part of TA-6) from the early 1940s through 1959.

Initially, the recovery effort investigated the dispersal of material from small-scale tests designed to simulate the dynamics of a nuclear implosion. Results of these experiments led to the testing of three recovery methods: (1) shots were detonated in a container of water to slow metal fragments down, and an asphalt pad or a concrete bowl received the fragments; (2) shots were detonated under piles of sand, which retained metal fragments; and (3) steel vessels called Jumbinos were designed to withstand the force of explosion and contain metal fragments. Methods 1 and 3 were investigated at firing sites in TA-6; these sites are now inactive and are included in this aggregate and in Aggregate 1.

Experiments to determine the dispersal of material from explosions were conducted at a gravel pad [6-003(f)] shown on a 1944 engineering drawing (LASL 1944, 19-0002). Its location is shown in Figure 5-14. These experiments used metal parts made of irradiated copper. After a shot, the dispersed copper fragments were located with radiation detectors, retrieved, and sent to another TA for analysis. Few shots were fired because the radioactivity decayed too quickly, making the metal debris difficult to find. Nonradioactive cobalt was also used as a tracer, separated from sand and soil, and sent to another TA for analysis.

Water recovery shots were probably carried out at an asphalt pad [6-003(c)] (Figure 5-14) during the summer of 1944. The pad is a rectangle, about 40 ft by

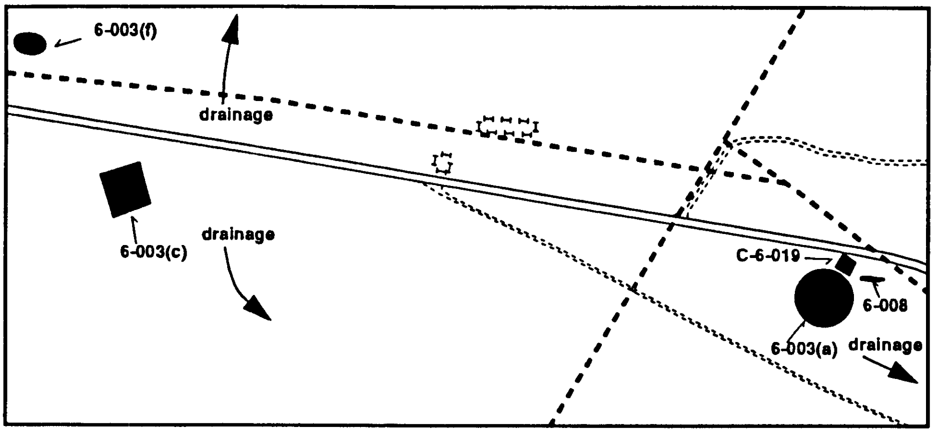


Figure 5-14. Locations of 6-003(a, c, f), 6-008, and C-6-019.

60 ft, with a rectangular concrete-lined pit (2 ft by 5 ft by 2 ft deep) located toward the east side (Catlett 1992, 19-0113). The pit may have been used to catch metal fragments when the pad was washed down after a shot. The asphalt is now badly cracked and deteriorating, the pit contains metal and wood, and some of the concrete around the edge of the pit appears to have been chiseled away, possibly in an attempt to remove contaminants (Catlett 1992, 19-0113). Metal plates are present on the pad and nearby (Catlett 1992, 19-0113). Cobalt (LASL 1944, 19-0094) and depleted uranium were used as tracers in these shots. The pad was monitored in 1978 and found to contain 3 to 6 times background uranium (Elliot 1978, 19-0093). A part of the pad was monitored with a highly sensitive alpha radiation detector during the summer of 1992 (Catlett 1992, 19-0113; Rofer 1992, 19-0080). Results show low levels of uranium and cesium-137 present on the asphalt.

A large concrete bowl [TA-6-37, 6-003(a)], 100 ft in radius, was constructed for water recovery shots in late 1944 (Schaffer 1944, 19-0122). Testing continued until spring 1945. SWMU 6-008, an underground storage tank that received material washed out of this structure, was removed in 1987 (McInroy 1993, 19-0106). C-6-019 is the former site of a generator building that was removed by burning in 1960 (LANL 1990, 0145). These PRSs are included in this aggregate because they are located near the concrete bowl. The locations of 6-003(a), 6-008, and C-6-019 are shown in Figure 5-14. The water recovery shots used depleted uranium (Schaffer 1945, 19-0027). Recovery of the uranium from individual shots ranged from 50% to percentages higher than 100%, the latter apparently resulting from incomplete recovery from previous shots (Schaffer 1945, 19-0027). Sample plates placed outside the bowl showed that approximately 10% of the uranium was distributed up to 160 ft beyond the concrete bowl (Schaffer 1945, 19-0027). Shake tests, probably of explosives assemblies, were conducted in this structure in 1945 (LASL 1945, 19-0095). Distribution of hazardous materials is unlikely from this operation. This area was monitored with a Phoswich counter in 1978 (Elliot 1978, 19-0093). No radiation above background was found.

The structure number TA-6-10 has been used for a two-sided steel barricade (LASL 1944, 19-0010) and for a building constructed later at the same site (LASL 1944, 19-0032). The site is designated 6-003(g) (previously Area of Concern C-6-002) and is shown in Figure 5-15. The use of the barricade is not known, but it may have been the site of early Primacord timing experiments and tests of Model I Jumbino vessels. The barricade was probably used only for a few months between its construction and the construction of a building on this site. During the summer of 1944, a building was constructed on the western footing of the barricade (LASL 1944, 19-0032). This building was used for PETN recrystallization with acetone and carbon tetrachloride (Meyers 1993, 19-0044). It was decommissioned in 1960 by burning (Ahlquist and Blackwell 1983, 19-0008).

In 1945, detonator development operations were consolidated at TA-6, and TA-6-7, -8, and -9 were constructed for test firing of detonators (Creamer 1993, 19-0107). These firing chambers are constructed of reinforced concrete and steel plate (LASL 1945, 19-0020) and are located north of TA-6-6 (Figure 5-15). TA-6-7 is listed in the SWMU Report as 6-003(d), and TA-6-9 is listed as 6-003(e). TA-6-8 appears to have been used as a firing chamber for less time than the other two chambers. A structure was built around the firing chamber. Because it may have been used for firing, it will be investigated as part of Aggregate 4. Test-firing operations continued in 6-003(d) and 6-003(e) until 1952, when operations

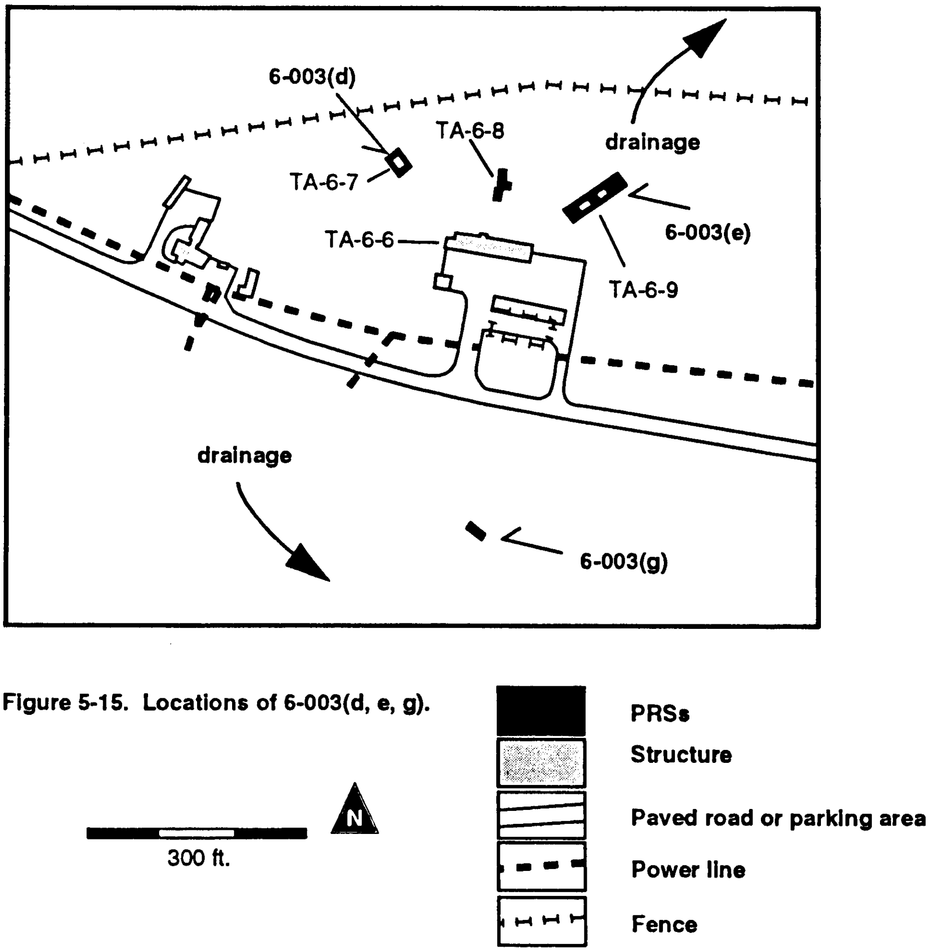


Figure 5-15. Locations of 6-003(d, e, g).

were moved to TA-40 (Creamer 1993, 19-0107). TA-6-8 was used for experiments with UF_6 from 1972 through 1976 (Schott 1993, 19-0125).

SWMUs 7-001(a) and 7-001(b), located east of the concrete bowl (Figure 5-16), are two areas surrounded by annular berms that are about 4 ft high. Their original use is unknown. One reference notes that Gomez Ranch (the name at that time for TA-7) was used "very seldom" (LASL 1944, 19-0123). In the 1950s, these sites were used for destruction of scrap detonators and explosives. Scrap detonators and explosives were mixed with Composition B scraps or flaked TNT, and the mixture was detonated (Spaulding 1959, 19-0091). Experiments were also performed to determine optimum conditions for disposing of scrap detonators (Spaulding 1959, 19-0091). Explosives fragments were found around both pits in 1959, and detonators have washed out of the soil berms during rainstorms (Spaulding 1959, 19-0091). The waste operation was moved to a burning and detonation area about 450 ft east of Building TA-40-15 in the 1950s (Spaulding 1959, 19-0091).

In an amphitheater-like area [7-001(c)] located about 0.25 mile east of SWMUs 7-001(a, b) (Figure 5-16), soft metal disks with imbedded bullets have been found. It is possible that ballistic tests carried out at 7-001(c) were related to the development of nuclear initiators. If this is the case, the only hazardous material used was lead. Full testing of initiators was considered sufficiently hazardous that an enclosed facility was built for this purpose (McMillan 1944, 19-0092).

SWMU 7-001(d) is a large crater slightly to the west of 7-001(c) (Figure 5-16). This crater may have been formed by explosives testing. Detonator parts have been found in the vicinity of the crater.

During early testing activities, blasting caps were used and may be found in any of these areas.

5.4.1.2 Conceptual Exposure Model

5.4.1.2.1 Nature and Extent of Contamination

Because the purpose of many of the tests carried out at the inactive firing sites was the recovery of metal fragments, few contaminants should remain in those

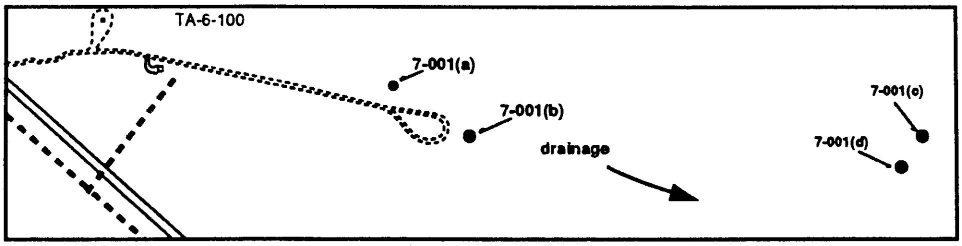


Figure 5-16. Locations of 7-001(a, b, c, d).

300 ft.

■ **PRSs**
▨ **Structure**
▤ **Paved road or parking area**
┅ **Unpaved road**
╍ **Power line**

areas. However, recovery was never complete. Explosives are mostly consumed in the tests but may leave residues. If a test failed and dispersed fragments of explosives around the firing pad, current safety practices would require that these fragments be recovered and disposed of at an approved disposal site. It is not clear whether such practices were followed at the time most of these tests were performed. In some cases, explosives fragments have been found in the areas of firing sites. Small particles of explosives and metal fragments may have been deposited. Residues from oxidation and bacterial degradation of the explosives may also be present. The half-life of the radioactive copper is short enough that its activity has decayed to negligible levels. PETN and solvents may also be present from processing activities at the Building TA-6-10. PETN was recrystallized from acetone and carbon tetrachloride at TA-6-10. No records are available of spills at the generator building (C-6-019). Possible contaminants in this area are hydrocarbon fuels and polychlorinated biphenyls (PCBs) that may have been used in electrical equipment.

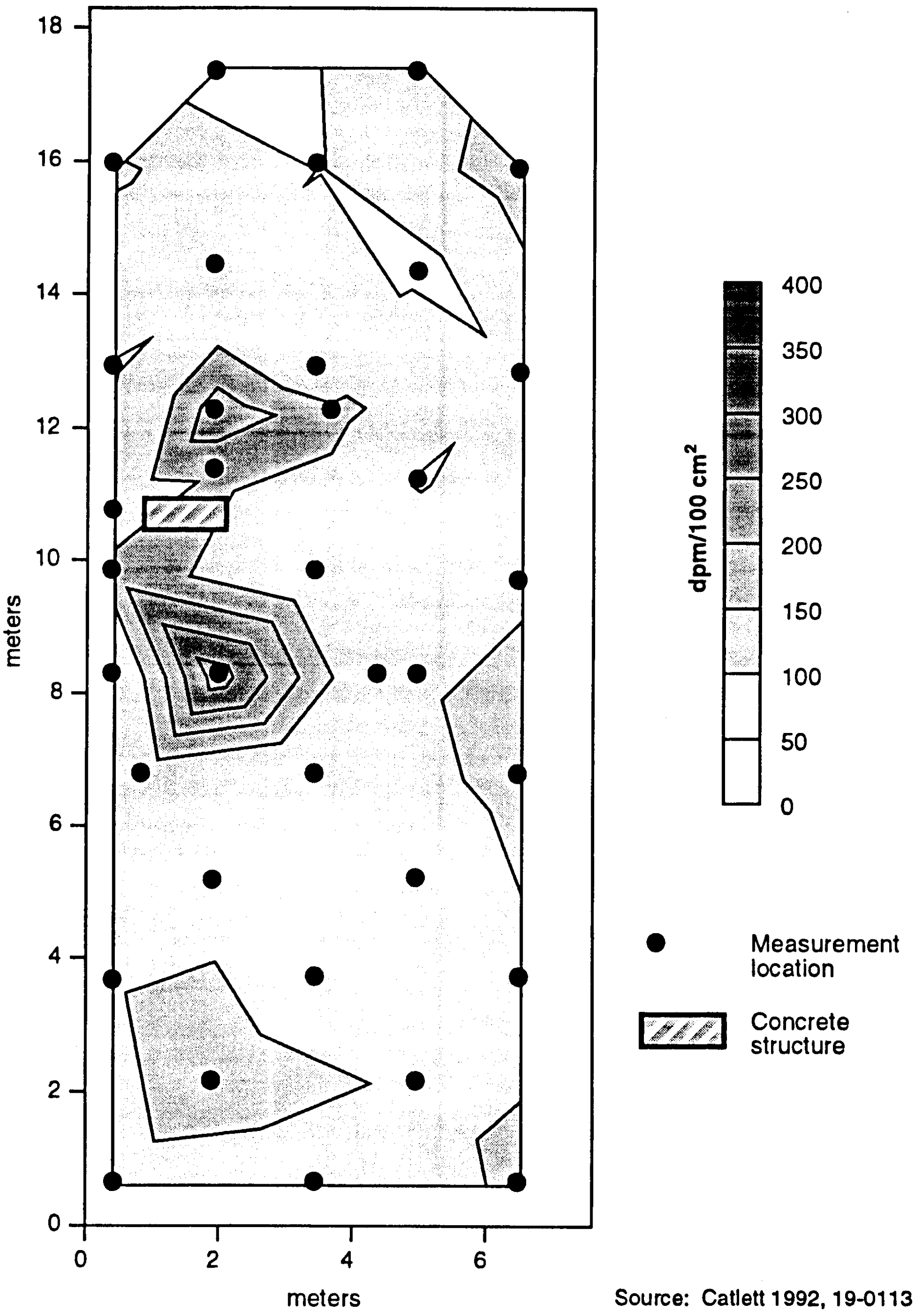
The results of the 1992 alpha radiation survey of the asphalt pad [6-003(c)] are given in Figure 5-17. A developmental instrument designed to survey alpha activity over a large area was used on the eastern part of the pad. Results were verified with a hand-held Ludlum alpha counter at points in areas where higher readings were observed. Two large metal plates had average alpha radiation levels of 283 dpm/100 cm^2 and 406 dpm/100 cm^2. Gamma-ray analysis showed that most of the activity could be attributed to uranium isotopes but that cesium-137 was present above background (Catlett 1992, 19-0113).

Blasting caps are a safety hazard. Their possible presence in these areas must be taken into consideration in planning field activities. Lead or mercury compounds may be released in small quantities from blasting caps.

5.4.1.2.2 Potential Pathways and Exposure Routes

The primary source of possible contaminants is hazardous material that may have been deposited by explosions and not recovered. All firing sites in this aggregate are located near the center of the mesa. In an explosion, solid debris including metals (shrapnel) may be thrown some distance, and a dust cloud that may contain hazardous constituents is formed. Generally, particulates from the dust cloud will be deposited in decreasing concentrations with increasing distance from the explosion site. Contaminants are most likely to be in and around the firing site itself. Tests during the 1940s indicated that most of a uranium tracer was deposited within the firing pad area. Secondary sources could include soils, tuff, air, surface water, sediments, or plants.

Contaminants are most likely to be present in porous media such as soil, gravel, and deteriorating asphalt that has been used as a firing pad. The asphalt was probably impervious when it was used, but deterioration over time may have allowed percolation of contaminants into the soil beneath it. For the concrete bowl, contaminants are most likely to be present in the soil around its perimeter. For all firing sites, contaminants are expected to decrease in concentration with distance from the pad. Most contamination from shots would initially be uniformly distributed to unshielded areas of equal distance from the firing pad. Contaminants associated with the recrystallization operation in TA-6-10 may be present in the soil where this building was located and in the drain line from this



Source: Catlett 1992, 19-0113

Figure 5-17. Contour diagram showing the distribution of α-radiation at the asphalt pad in the summer of 1992.

building, which is still in place. Investigation of the drain line is discussed in Section 5.8 as a part of SWMU 6-002. Contaminants remaining from 6-008 and C-6-019 may be present in the soils in the former structure locations.

The direction of drainage is indicated on Figures 5-14, 5-15, and 5-16. The systems drain into Tributaries A and B of Two-Mile Canyon. Transport mechanisms include overland flow and associated sediment transport, infiltration, percolation, wind erosion, and uptake by plants. Receptors include plants, animals, and humans. Exposure routes to receptors include direct skin contact with contaminated soils or sediments, ingestion, and inhalationwhen a contaminated area is disturbed. The concrete bowl retains water from snowmelt and rain. Large animals drink from it, and small animals, including frogs, salamanders, and snails, live in it. Herbivores living on site may be exposed by eating plants that grow in contaminated soils.

5.4.2 Remediation Decisions and Investigation Objectives

Possible remediation alternatives include no further action if no contaminants of concern are found. If remediation is required, alternatives include removal or *in situ* treatment of contaminated soil and capping of contaminated soil and monitoring of the stabilized area. On the basis of the historical evidence, our hypothesis is that no contaminants of concern are present in Aggregate 4.

The objective of the Phase I investigation of the inactive firing sites is to determine whether the firing sites and surrounding media contain contaminants of concern.

RFI Phase I data will be collected to answer these questions.

- Are contaminants of concern present in the firing sites and nearby media? Firing sites are most likely to contain contaminants directly under the firing position and at close radii. This information will be used to make decisions on whether a Phase II investigation is necessary.
- Is shrapnel present around the firing sites, and if so, has it contaminated soil? This information will be used to make decisions on whether a Phase II investigation is necessary.

5.4.3 Data Needs and Data Quality Objectives

5.4.3.1 Data Needs for Evaluating Health and Safety Risks

5.4.3.1.1 Source Characterization

Each firing site, the former site of the storage tank, and the former generator building site will be field mapped. All features that appear to be manmade or show evidence of explosions will be included on the map; shrapnel pieces will also be included.

Reconnaissance sampling (Appendix H, IWP) (LANL 1992, 0768) at each firing site will be used to collect data to determine whether contaminants of concern are present and whether a Phase II investigation is necessary. Results from the analysis of samples will produce data for decisions on remediation alternatives. If no samples are found to contain contaminants of concern, no further action will be recommended. If contaminants of concern are found, a Phase II investigation will be recommended.

Two areas will be sampled for PRSs 6-003(a, c, f, g) and 7-001(a, b, d): the firing pad itself and an area that may have received shot debris around the perimeter of the pad. For 7-001(c), combined retrieval of metal fragments and soil sampling is recommended. Samples will be analyzed for possible contaminants listed in Table 5-9.

Soil samples will be collected at two depths in firing pads. A surface sample will give data on depositions from explosions. A subsurface sample at a 3-ft depth or the soil-tuff interface, if shallower, will give information on constituents that have moved into the soil or were forced into the soil by explosions. For 6-003(c), samples will be collected near the concrete structure, under the metal plates, and in other areas shown in Figure 5-17 as having the highest alpha counting rates. For 6-003(a), sediments in the water-filled area and asphalt or sediments in the expansion joints will be sampled. The number of samples will be sufficient to detect contaminants above SALs with at least an 80% certainty if the contaminants cover half or more of the area being sampled. Sampling will take place where contaminants are judged most likely to be present.

The perimeter areas around the firing pads will be surveyed with a metal detector to locate shrapnel. For PRSs 6-003(a, c, f, g), the area to be sampled extends 10 ft beyond the perimeter of the firing pad. For PRSs 7-001(a, b), where it is believed the sizes of shots may have been larger, the distance from the perimeter to the outside boundary will be 20 ft. The area will be divided into equal sectors, and at least one sample will be collected from each sector. The number of samples will be sufficient to detect contaminants above SALs with at least an 80% certainty if the contaminants cover half or more of the area being

TABLE 5-9

POSSIBLE CONTAMINANTS AT AGGREGATE 4 PRSs

PRS Number	Possible Contaminants
6-003(a)	Explosives,* depleted uranium
6-003(c)	Explosives, cesium-137, cobalt, depleted uranium
6-003(d)	Explosives, metals*
6-003(e)	Explosives, metals
6-003(f)	Explosives, barium, cobalt, copper, lead, mercury
6-003(g)	Explosives, PETN, acetone, carbon tetrachloride, lead, mercury
6-008	Explosives, depleted uranium
C-6-019	Hydrocarbons, PCBs
TA-6-8	Explosives, metals
7-001(a)	Explosives, metals, semivolatiles
7-001(b)	Explosives, metals, semivolatiles
7-001(c)	Lead
7-001(d)	Explosives, metals

*A full suite analysis will be done when no specific explosives or metals are specified.

sampled. Sampling will take place where contaminants are judged most likely to be present.

PRSs 6-003(d, e) and TA-6-8 are enclosed structures. The steel plating in each of the firing chambers is expected to have received the bulk of the constituents and will be surface sampled for explosives and metals. Decisions regarding further investigation will be made for each firing chamber. The number of samples will be sufficient to detect contaminants above SALs with at least an 80% certainty if the contaminants cover half or more of the area being sampled. Sampling will take place where contaminants are judged most likely to be present.

For 6-008, soil cores to the soil-tuff interface will be taken; samples will be removed at the surface and at two depths relating to the depth of the bottom of the tank. This will provide information on constituents that were not removed with the tank or that may have moved back into the excavation. The number of samples will be sufficient to detect contaminants above SALs with at least an 80% certainty if the contaminants cover half or more of the area being sampled. Sampling will take place where contaminants are judged most likely to be present.

For C-6-019, the highest concentrations of constituents would most likely be present on the surface or near surface. Sample analyses should give information on explosives, metals, and hydrocarbons. The number of samples will be sufficient to detect contaminants above SALs with at least an 80% certainty if the contaminants cover half or more of the area being sampled. Sampling will take place where contaminants are judged most likely to be present. Because C-6-019 is within the area that might have received debris from explosions in the concrete bowl, samples will be analyzed for explosives and depleted uranium as well as contaminants associated with the generator operations.

For 7-001(c), soils and pieces of metal will be excavated and disposed of appropriately as a VCA. Surface soil samples will be used to determine what residual constituents persist after the VCA. Samples will be collected adjacent to the pieces of metal where constituent concentrations are expected to be highest. The number of samples will be sufficient to detect contaminants above SALs with at least an 80% certainty if the contaminants cover half or more of the area being sampled. Sampling will take place where contaminants are judged most likely to be present.

5.4.3.1.2 Environmental Setting

No data are needed for Phase I decisions. If secondary contamination is present in soil, tuff, or sediments, Phase II may require data to characterize environmental migration pathways.

5.4.3.1.3 Potential Receptors

No data are needed for Phase I decisions.

5.4.3.2 Data Needs for Evaluating Other Impacts

No other impacts are expected. No other data are needed to make a Phase I decision.

5.4.4 Sampling and Analysis Plans

Specifications are given here for minimum numbers of samples to be collected. Tables 5-10 and 5-11 summarize sampling for Aggregate 4. Justification for the numbers given in these tables is discussed in Section 5.4.3.1.1 and detail is given below. If additional locations for sampling are identified in the field survey or during sampling, additional samples will be collected from those locations. Indicators of additional locations for sampling include all findings that may indicate the presence of contaminants, including the results of field screening tests, the presence of shrapnel or deposits, discoloration, and geomorphic structures that may trap contaminants.

TABLE 5-10

SAMPLING FOR EACH PRS IN AGGREGATE 4

PRS Number	Firing Chamber	Firing Pad	Perimeter Areas
6-003(a)		3 sediment	3 core*
6-003(c)		3 core	3 core
6-003(d)	3 surface		
6-003(e)	6 surface		
6-003(f)		3 core	3 core
6-003(g)		3 core	3 core
6-008			3 core
C-6-019			3 core
7-001(a)		3 core	3 core
7-001(b)		3 core	3 core
7-001(c)			3 surface
7-001(d)		3 core	3 core

*For all cores, analytical samples will be removed at two depths, except those associated with 6-008, from which samples will be removed at three depths.

Engineering drawings and a preliminary field survey will be used to determine the shapes and locations of structures. Locations for sampling will be identified and mapped. All areas will be surveyed radiologically on a 10-ft grid; this survey will be performed primarily for health and safety reasons to protect workers in these areas. All areas will also be surveyed with a metal detector to locate surface or buried shrapnel. Locations of higher radioactivity or locations containing metal will be flagged in the field and mapped for potential sampling.

All samples will be screened in the field for radioactivity and explosives and will be analyzed in the analytical laboratory for possible contaminants listed in Table 5-9.

TABLE 5-11

ANALYTICAL SAMPLES FOR AGGREGATE 4

		Field Surveys			Samples			Field Screening			Field Lab. Measr.		Laboratory Analysis													
SWMU or AOC	SWMU Type	Land Survey	Gross Gamma	Geophysics	Sampled Media	Samples	Duplicate	Gross Gamma	High Explosives (M-1 Kit)	Lithological Logging	Gamma Spectrometry	Volatile Organics (SW 8240)	Gamma Spectrometry	Isotopic Uranium	Strontium-90	Cesium-137	Metals (SW 6010)	Volatile Organics (SW 8240)	Semivolatile Organics (SW 8270)	High Explosives (LANL Method)	PCB (SW 8080)	Sulfates/Chromates/Copper Salts	Nitrates and Nitrites	Fluoride	Cyanide	Phosphate
6-003(a)	Inactive Firing Site	X	X	X	Sediment	3	1	X	X				X	X			X			X						
					Soil/Tuff	6		X	X				X	X			X			X						
6-003(c)	Inactive Firing Site	X	X	X	Asphalt/Soil	6		X	X				X	X			X			X						
					Soil/Tuff	6	1	X	X				X	X			X			X						
6-003(d)	Inactive Firing Site	X	X	X	Steel	3	1	X	X				X	X			X			X						
6-003(e)	Inactive Firing Site	X	X	X	Steel	6		X	X				X	X			X			X						
6-003(f)	Inactive Firing Site	X	X	X	Soil/Tuff	12	1	X	X				X	X			X			X						
6-003(g)	Inactive Firing Site	X	X	X	Soil/Tuff	12		X	X				X	X			X	X		X						
6-008	Former Underground Storage Tank Location	X	X		Soil/Tuff	9	1	X	X				X	X			X			X						
C-6-019	Former Building Location	X	X		Soil/Tuff	6		X	X				X	X			X	X	X	X	X					
7-001(a)	Inactive Firing Site	X	X	X	Soil/Tuff	12	1	X	X				X	X			X			X						
7-001(b)	Inactive Firing Site	X	X	X	Soil/Tuff	12		X	X				X	X			X			X						
7-001(c)	Inactive Firing Site	X	X	X	Soil	3		X	X				X	X			X			X						
7-001(d)	Inactive Firing Site	X	X	X	Soil/Tuff	12	1	X	X				X	X			X			X						
TA-6-8	Inactive Firing Site	X	X	X	Steel	6	1	X	X				X	X			X			X						

Firing pad areas of 6-003(c), 6-003(f), 6-003(g), 7-001(a), 7-001(b), and 7-001(d). Three soil samples will be collected for each firing pad at the surface and at a 3-ft depth or the soil-tuff interface, whichever is shallower. Figure 5-18 shows approximate sampling locations for 6-003(c, f, g) and 7-001(d). Figure 5-19 shows sampling locations for 7-001(a, b).

Firing pad area of 6-003(a). One sample will be collected of sediments in the water-filled area, and two samples will be collected of sediments that have accumulated in breaks in asphalt in the expansion joints or of asphalt in the expansion joints. Figure 5-18 shows approximate sampling locations for 6-008(a).

Firing chamber TA-6-8 and SWMUs 6-003(d, e). For each chamber, three surface samples will be collected of the interior steel plating. Samples will be collected where material appears to have been driven into the steel by the force of the explosions.

Perimeter areas of 6-003(a), 6-003(c), 6-003(f), 6-003(g), and 7-001(d). The perimeter area, which extends for 10 ft beyond the firing pad, will be divided into three equal sectors (Figure 5-18). At least one core will be collected from each

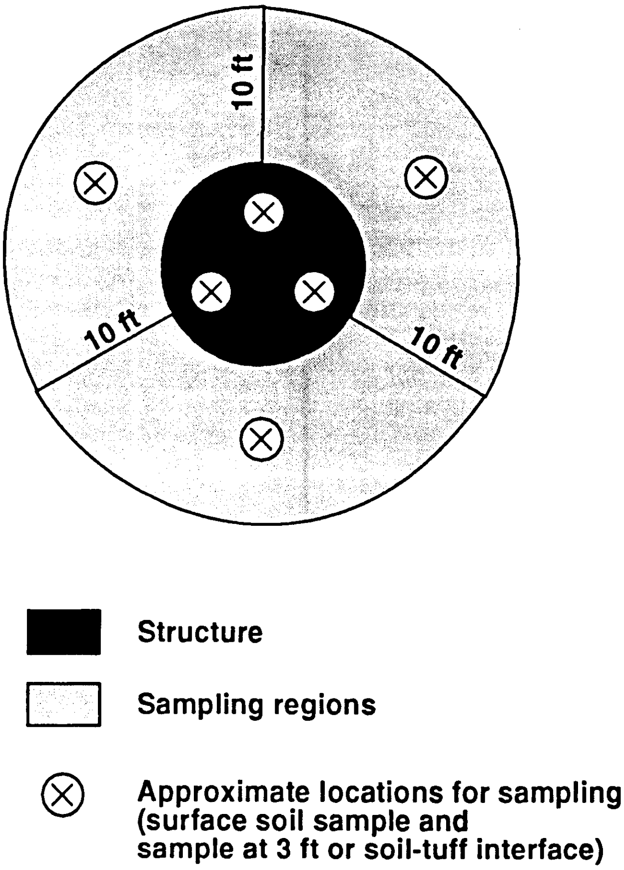


Figure 5-18. Diagram showing sampling strategy for 6-003 (a, c, f, g) and 7-001(d). Structure is shown as a circle.

sector to a depth of 3 ft or the soil-tuff interface, whichever is shallower. Preferred collection points are where higher than normal radiation readings or metal deposits were found during the surveys. If no such indications are found, the samples may be collected from near the center points of the sectors. An additional core at 6-003(g) will be located as close as practicable to the existing drain pipe but no farther than 6 ft away. Samples will be removed from the cores at the surface and at the maximum depth.

Perimeter areas of 7-001(a) and 7-001(b). Sampling will be the same as for the perimeter areas described above, but the area will extend 20 ft from the perimeter of the firing pad (Figure 5-19).

6-008. Three soil cores will be taken in the former location of the underground storage tank to the soil-tuff interface, and samples will be removed at the surface, the middle depth, and the depth of the soil-tuff interface.

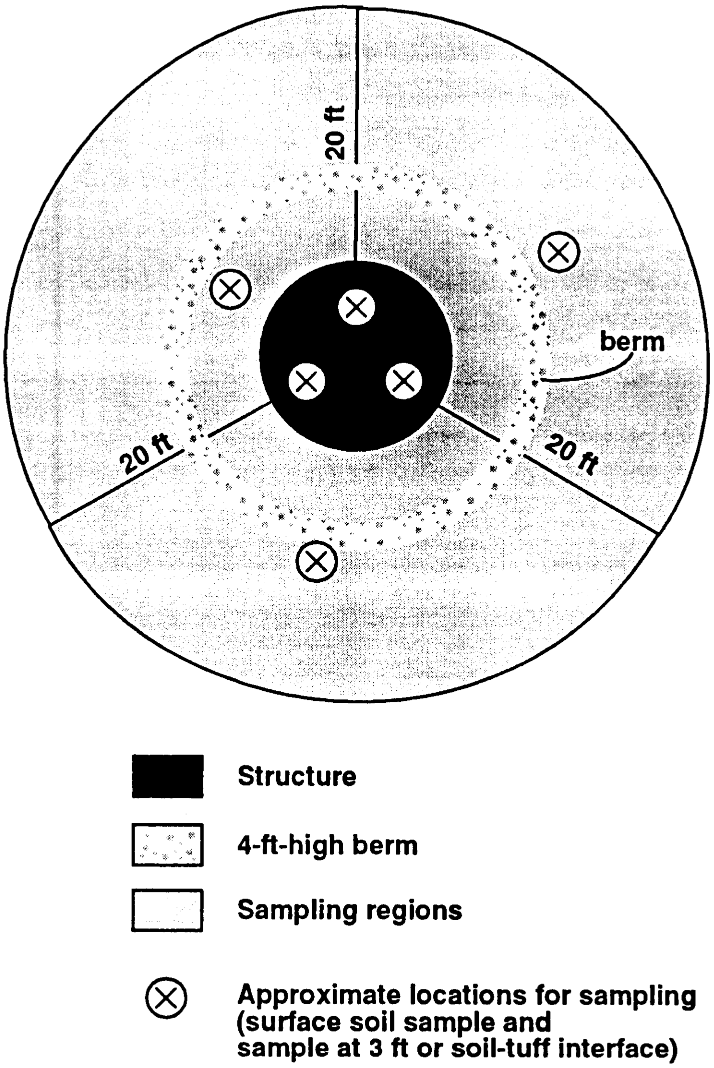


Figure 5-19. Diagram showing sampling strategy for 7-001(a and b). Structure is shown as a circle.

C-6-019. Three surface soil samples will be collected in the former building location.

7-001(c). A metal detector will be used to locate surface and buried metal. Pieces of metal will be excavated and disposed of appropriately as a VCA. At least three surface soil samples will be collected adjacent to pieces of metal. If no pieces of metal are found, the samples will be collected from widely spaced locations within the excavation.

5.5 Aggregate 5, Surface Disposal Areas

The following SWMUs are included in this aggregate.

- 6-007(f)
- 6-007(g)
- 40-010

5.5.1. Background

5.5.1.1 Description and History

SWMU 6-007(f) is described in the SWMU Report (LANL 1990, 0145). SWMUs [6-007(g) and 40-010] were identified as surface disposal areas during the preparation of this work plan (LANL 1992, 19-0099; LANL 1992, 19-0098). No documentation earlier than the SWMU Report has been found describing any of the SWMUs in this aggregate.

SWMU 6-007(f). This SWMU is described as including four locations (LANL 1990, 0145). It is not clear whether these locations refer to scattered Jumbino parts as well as a surface disposal site of about 20 ft by 30 ft located about 150 ft north of TA-6-3 (Creamer 1993, 19-0076). For this report, 6-007(f) is taken to include the surface disposal site only, and the Jumbino parts are discussed in Chapter 6 [6-003(b)]. This site contains empty chemical bottles and equipment, electrical equipment, barbed wire, and other apparently nonhazardous materials. No hazardous materials are evident on the surface, but an empty and broken chemical bottle is labeled “carbon tetrachloride.” A security fence is now between TA-6 buildings and the disposal site (Figure 5-20). The nearby presence of Jumbino parts suggests that this site was used for disposal in the 1940s and may have served TA-6-1, -3, and -6. Chemical laboratories and shop facilities were located in these buildings. Activities in these buildings are discussed more fully in Section 5.6.1.1, SWMUs 6-001(a) and 6-001(b).

SWMU 6-007(g). This SWMU was formerly Area of Concern C-6-004, the former site of Building TA-6-12 (LANL 1990, 0145) (Figure 5-20). Explosives, particularly PETN, were pressed in this building, which was moved from this site in 1949 and attached to Building TA-6-1 (LASL 1949, 19-0111). During field investigations for preparation of this work plan, a pile of exploded detonator housings approximately 5 ft by 5 ft was found adjacent to the former building location. Parts that appeared likely to contain explosives were tested and found to be free of explosives (Griffin 1992, 19-0090).

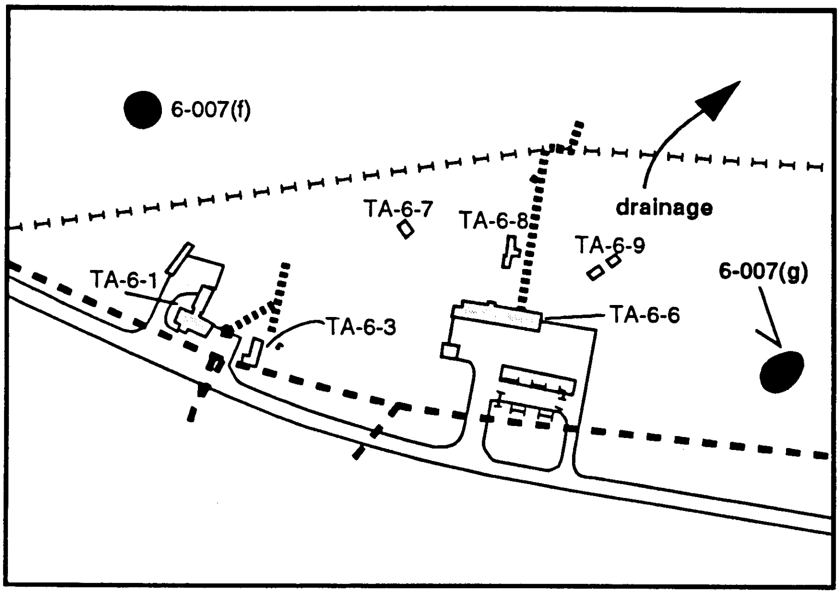


Figure 5-20. Locations of 6-007(f, g).

SWMU 40-010. This SWMU includes an area on the edge of Pajarito Canyon extending about 50 ft along the canyon edge and about 50 ft down the canyon side (Figure 5-21). Debris in this area includes farm and home implements that probably predate Manhattan Project activities and approximately twenty 30-gal. drums of a type that may have contained chemicals.

5.5.1.2 Conceptual Exposure Model

5.5.1.2.1 Nature and Extent of Contamination

Based on field observations and indirect archival evidence, the possible contaminants in these SWMUs are explosives, metals, and semivolatile and volatile organics. There are no records on the SWMUs in this aggregate; therefore, whether contaminants are present in them and the depth to which waste may be buried are unknown.

5.5.1.2.2 Potential Pathways and Exposure Routes

The primary source of possible contaminants is hazardous material that may have been deposited in the disposal areas. In 40-010, all material deposited

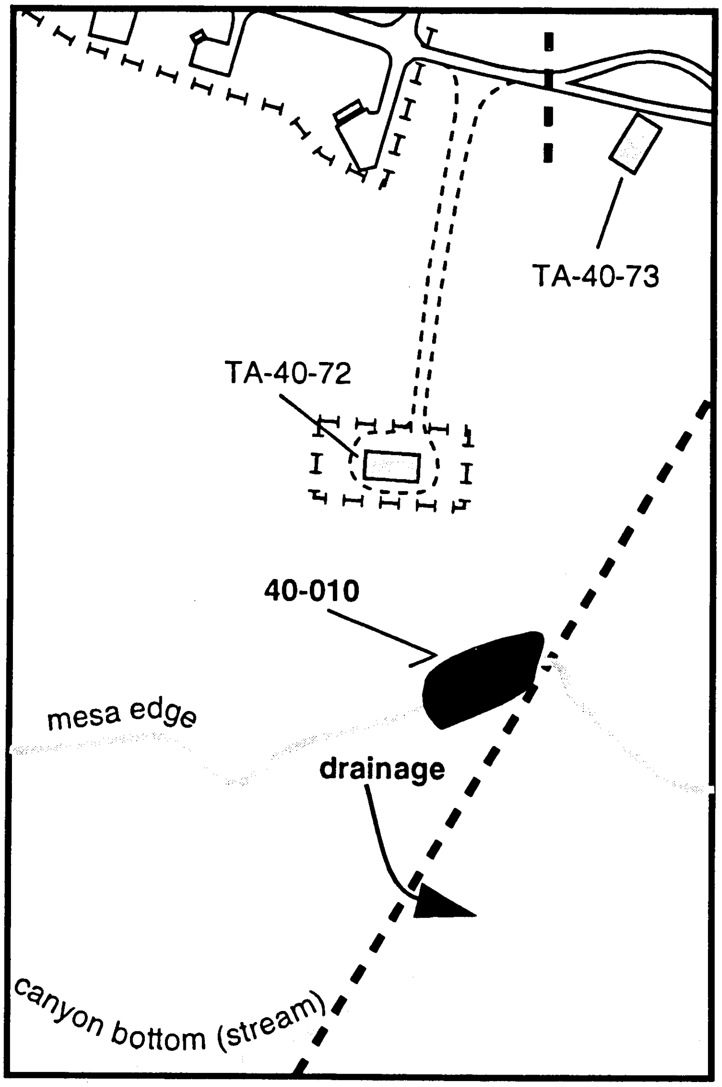
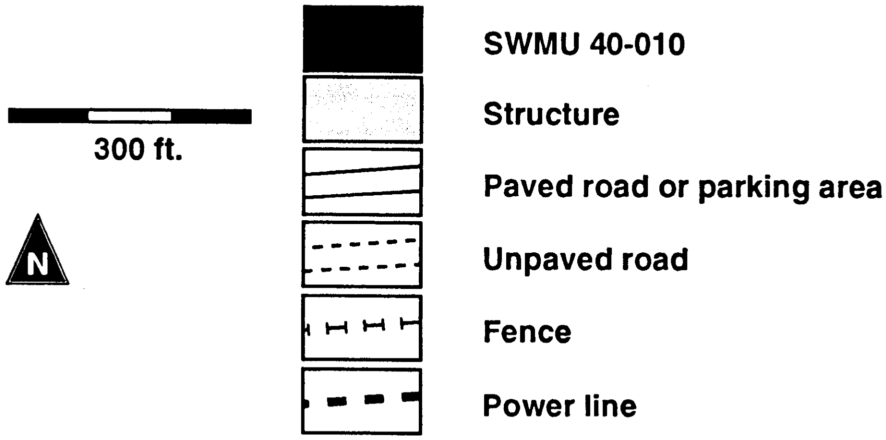


Figure 5-21. Location of 40-010.



appears to be on the surface. The current state of 6-007(f) and 6-007(g) precludes an assessment of the depth of waste deposition. If chemical containers were deposited with their contents, breakage and spilling followed by weathering could have washed the material into the soil. Some of the material could also have been transported into canyons by surface run-off. If hazardous materials were deposited, secondary sources of contamination could include soils, tuff, air, surface water, sediments, or plants.

SWMUs 6-007(f) and (g) drain into Tributary A of Two-Mile Canyon, and 40-010 drains into Pajarito Canyon. Transport mechanisms include overland flow and associated sediment transport, infiltration, percolation, wind erosion, and uptake by plants. Receptors include plants, animals, and humans. Exposure routes to receptors include direct skin contact with contaminated soils or sediments, ingestion, and inhalation when a contaminated area is disturbed. Herbivores living on site may be exposed by eating plants that grow in contaminated soils.

5.5.2 Remediation Decisions and Investigation Objectives

Possible remediation alternatives include no further action if no contaminants of concern are found. Removal of surface debris from 6-007(f) and 6-007(g) is recommended as a VCA to remove physical hazards such as barbed wire and possible hazardous constituents and to allow sampling of soil below the surface debris. If remediation of soil is required in any of the SWMUs in this aggregate, alternatives include removal or *in situ* treatment of contaminated soil and capping of contaminated soil and monitoring of the stabilized area.

The objective of the Phase I investigation of the surface disposal sites is to determine whether the sites contain contaminants of concern.

RFI Phase I data will be collected to answer the following question.

- Are contaminants of concern present in the surface disposal sites and nearby media? If hazardous material was present, contaminants of concern are most likely to be found under the material deposited on the surface. This information will be used to make decisions on whether a Phase II investigation is necessary.

5.5.3 Data Needs and Data Quality Objectives

5.5.3.1 Data Needs for Evaluating Health and Safety Risks

5.5.3.1.1 Source Characterization

The locations of the surface deposits of debris will be mapped. The debris will be monitored in place with hand-held instruments for radionuclides; this survey is primarily for health and safety purposes. Containers that may have held explosives will be screened for explosives.

Surface debris will be removed as a VCA at 6-007(f) and 6-007(g). If closed containers are found during the VCA, they will be disposed of as hazardous waste in an appropriate disposal site. If mixed waste is found during the VCA, action will be deferred until an appropriate disposal site is available.

Reconnaissance sampling (Appendix H, IWP) (LANL 1992, 0768) for the soil under each disposal site will determine whether contaminants of concern are present and whether a Phase II investigation is necessary. Results from the analysis of samples will produce data for decisions on remediation alternatives. If debris is on the surface only and if no contaminants of concern are found, no further action will be recommended. If debris, such as metal and glass parts, is found buried in the soil or if contaminants of concern are found, a Phase II investigation will be recommended.

For all SWMUs in this aggregate, soil will be sampled at the surface and at the 3-ft depth or the soil-tuff interface, whichever is shallower. Soil will be sampled at locations judged to be most likely to contain contaminants. All samples will be analyzed in the analytical laboratory for explosives, radionuclides, metals, and semivolatile organics. In addition, the subsurface samples will be analyzed for volatile organics. The number of samples will be sufficient to detect contaminants above SALs with at least an 80% certainty if the contaminants cover half or more of the area being sampled.

5.5.3.1.2 Environmental Setting

No data are needed for Phase I decisions. If contaminants of concern are found to be present in soil, tuff, or sediments, Phase II may require data to characterize environmental migration pathways.

5.5.3.1.3 Potential Receptors

No data are needed for Phase I decisions.

5.5.3.2 Data Needs for Evaluating Other Impacts

No other impacts are expected. No other data are needed to make a Phase I decision.

5.5.4 Sampling and Analysis Plans

Specifications are given here for minimum numbers of samples to be collected. These are listed in Table 5-12. Justification for these numbers is discussed in Section 5.5.3.1.1 and details are given below. If additional locations for sampling are identified in the field survey or during sampling, additional samples will be collected from these locations. Indicators of additional locations for sampling include all findings that may indicate the presence of contaminants, including the results of field screening tests, discoloration, and the presence of deposits.

Engineering drawings and a preliminary field survey will be used to determine the locations of surface debris. Locations for sampling will be identified and mapped.

Radiation surveys of the disposal areas plus a 10-ft-wide perimeter area will be conducted on a 5-ft grid. Containers such as cans and bottles that may have held explosives or that contain materials that may be explosives will be tested with the M-1 explosives test kit (Baytos 1991, 0741).

TABLE 5-12

ANALYTICAL SAMPLES FOR AGGREGATE 5

		Field Surveys			Samples			Field Screening			Field Lab. Measr.		Laboratory Analysis													
SWMU or AOC	SWMU Type	Land Survey	Gross Gamma	Geophysics	Sampled Media	Samples	Duplicate	Gross Gamma	High Explosives (M-1 Kit)	Lithological Logging	Gamma Spectrometry	Volatile Organics (SW 8240)	Gamma Spectrometry	Isotopic Uranium	Strontium-90	Cesium-137	Metals (SW 6010)	Volatile Organics (SW 8240)	Semivolatile Organics (SW 8270)	High Explosives (LANL Method)	PCB (SW 8080)	Sulfates/Chromates/Copper Salts	Nitrates and Nitrites	Fluoride	Cyanide	Phosphate
6-007(f)	Surface Disposal	X	X		Soil	6	1	X	X		X		X				X	X	X	X						
6-007(g)	Surface Disposal	X	X		Soil	6		X	X		X		X				X	X	X	X						
40-010	Surface Disposal	X	X		Soil	6		X	X		X		X				X	X	X	X						

In each surface disposal area, soil samples will be collected at three locations at the surface and at the soil-tuff interface or at 3 ft, whichever is shallower. All locations will be under debris or where contaminants are judged most likely to be present by such indicators as screening results. If no results indicate the likely presence of contaminants, the samples will be widely spaced in the areas covered by debris.

5.6 Aggregate 6, Septic Systems

The following SWMUs are included in this aggregate.

- 6-001(a)
- 6-001(b)
- 22-010(a)
- 22-010(b)
- 22-016
- 40-001(b)
- 40-001(c)

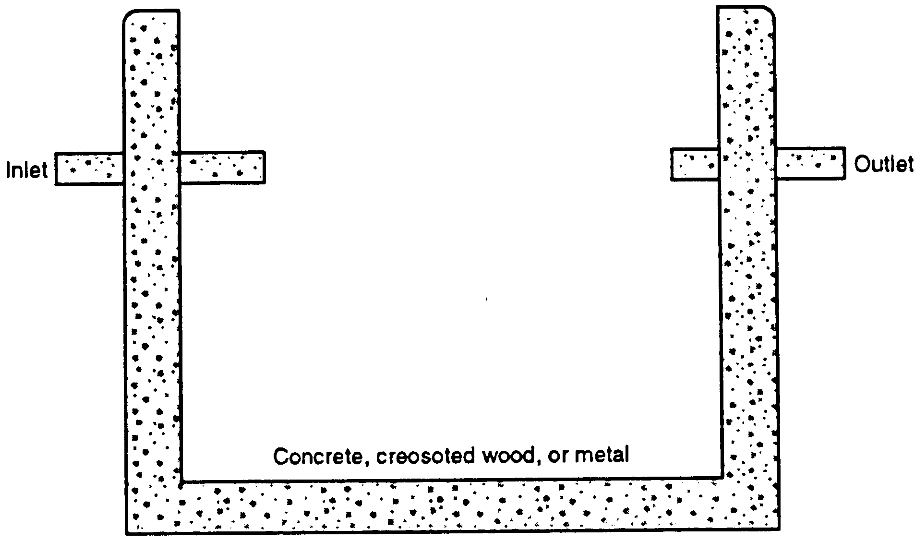
5.6.1 Background

5.6.1.1 Description and History

OU 1111 includes seven septic systems. Four of these systems are active and three are inactive. Components of each septic system include drain lines from buildings, a septic tank, an outflow drain line, and an outflow area (outfall and the related run-off area, sand filter, filter trench, leach field, or seepage pit). Some of the systems include more than one outflow area. Figure 5-22 shows the structure of a typical septic tank; the tank retains solids while allowing liquid to flow through. The liquid may flow directly to an outfall, or it may flow to one of several types of structures designed to retain solids that pass through the tank and allow percolation of the liquid into the soil. Sand filters and filter trenches are sand beds emplaced in the ground. The outflow is distributed across the sand bed by a system of pipes. A leach field typically has a distribution system and may contain buried clay tile to further distribute the flow. Seepage pits are deeper than the other structures and are typically filled with gravel.

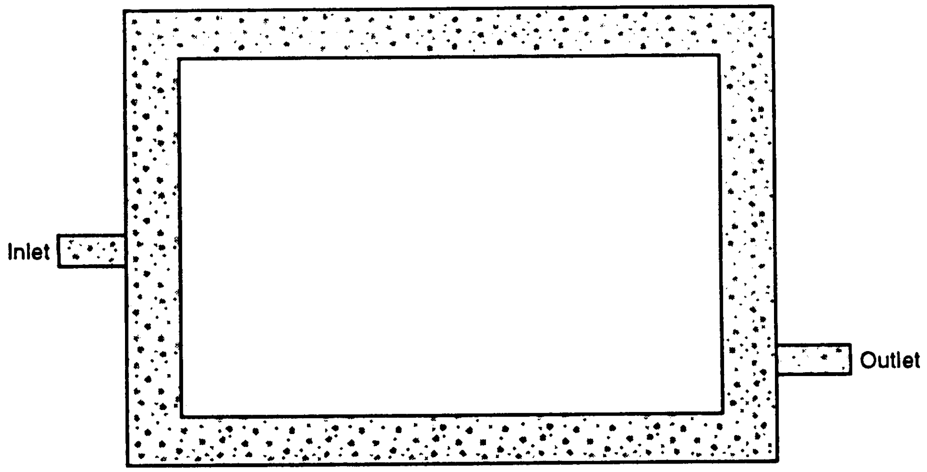
TA-6, -22, and -40 have hosted activities related to the processing, manufacture, and testing of devices containing explosives. These activities included the use of solvents and other hazardous materials. Photography has been an integral part of operations, and several darkrooms have been operated. Wastes from all operations may have been disposed of in the septic systems. The septic systems at TA-40 and TA-22 were designated for sanitary waste, but disposal of hazardous wastes cannot be ruled out. Early practice at TA-6 allowed disposal of both hazardous and sanitary waste in the septic systems. In 1973, septic systems at Laboratory sites were upgraded; industrial flows going to septic tanks were separated from sewage flows and the surfacing of sewage was discontinued (LASL 1973, 0846).

Table 5-13 gives SWMU designations and operational information on the septic systems. Table 5-14 gives a physical description of each system. Detailed histories follow.



Source: LASL 1950, 19-0110
LASL 1949, 19-0118

CROSS SECTION



PLAN VIEW

Figure 5-22. Diagram of a typical septic tank.

SWMU 6-001(a). Figure 5-23 shows the location of 6-001(a). Building TA-6-1, which 6-001(a) served, was built in the summer of 1944; it housed a laboratory (LASL 1944, 19-0001) and a carpenter shop (Creamer 1993, 19-0035). The laboratory was used during 1944 to develop analytical procedures for nonradioactive cobalt tracer shots fired at the asphalt pad [6-003(c), Section 5.4] (Creamer 1992, 19-0003). An acid-resistant workbench containing a lead sink that connected to the septic system (LASL 1944, 19-0001) suggests that chemical wastes may have been discharged from this laboratory into the septic system. No further information exists on the use of this laboratory; it is possible that the carpenter shop expanded into this space. During the late 1950s, silver soldering may have been done in this shop (H-Division 1955, 0762). The

TABLE 5-13

SEPTIC SYSTEMS

Current SWMU Number	HSWA Module SWMU Number	Structure Number	Operational Status	Period of Use
6-001(a)	6-001(a)	TA-6-40	Inactive	1944-1980s
6-001(b)	6-001(b)	TA-6-43	Inactive	1945-1980s
22-010(a)	22-010(a)	TA-22-50	Active*	1952-present
22-010(b)	22-010(b)	TA-22-51	Active*	1952-present
22-016		TA-22-42	Inactive	1945-1952
40-001(b)	40-001(b)	TA-40-24	Active	1950-present
40-001(c)		TA-40-25	Active	1949-present

*Will become inactive when SWSC connections are made.

building has not been used since the carpenter shop closed in the early 1980s (Creamer 1993, 19-0035).

Building TA-6-3, which 6-001(a) also served, was under construction in May 1944 (LASL 1944, 19-0002) and contained a rest room, a darkroom, and a laboratory with a lead-lined sink (LASL 1944, 19-0036). The building was first used as a control bunker for explosives shots (Creamer 1992, 19-0003) fired at a sand pad located about 0.5 mi. east of the building (LASL 1944, 19-0002). In the summer of 1944, the laboratory was remodeled with explosion-proof fixtures (LASL 1944, 19-0004) because diethyl ether was to be used in the analysis of the cobalt tracer shots; this activity ended by 1945 (Creamer 1992, 19-0003). The building housed offices from 1945 to 1948. From 1948 until the early 1950s, the building contained a firing control panel and a bridgewire-testing laboratory (Griffin 1992, 19-0037). Testing involved the use of industrial chemicals such as alcohol, acetone, carbon tetrachloride, and dilute acids. The darkroom was used until 1957 (Schott 1993, 19-0125). Detonators were fired inside containment apparatus in TA-6-3. In 1972, it was remodeled into a printed circuit shop with a darkroom (LASL 1972, 19-0038; LASL 1972, 19-0039; LASL 1972, 19-0040; LASL 1972, 19-0041; LASL 1972, 19-0042). The printed circuit operation used solvents and etching chemicals. The building was later used as a silk-screen facility; that operation continued until the mid 1980s (LANL 1990, 0145). Paints, inks, and solvents were probably used. Since then, the building has been used for storage.

Septic system 6-001(a) was not in use in December 1986 (DOE 1987, 0264), and the drain line was plugged in 1988 (HSE-8 1989, 0752). Inspection of the septic tank in July 1992 showed that it was empty (Rofer and Guthrie 1992, 19-0006). Possible contaminants in this septic system are silver, darkroom chemicals, paint, ink, diethyl ether, acids, lead, etching chemicals, explosives and their residues, and solvents (alcohol, acetone, and carbon tetrachloride).

SWMU 6-001(b). Figure 5-23 shows the location of 6-001(b). Building TA-6-6, which 6-001(b) served, was built during the summer of 1945 (LASL 1945, 19-0030). It originally housed laboratory operations relating to detonator assembly,

TABLE 5-14

PHYSICAL DESCRIPTION OF THE SEPTIC SYSTEMS

SWMU Number	Drain Lines	Septic Tank		Septic Tank Outflow	Field Reconnaissance
		Construction	Size		
6-001(a)	From TA-6-1 and TA-6-3 to tank, from tank to outflow	No drawings found but the tank may be similar to 6-001(b)	500 gal.[a] or 840 gal.[b]	Outflow drain line extended to canyon, outflow to Tributary A of Two-Mile Canyon	Located tank[c]
6-001(b)	From TA-6-6 to tank, from tank to filter trench	Primarily concrete with wood hot dipped in creosote, preformed concrete cover, top of walls painted with Interol Standard Black or similar coating, 2-in. plank baffles at ends of tank[d]	960 gal., dimensions are 5 ft x 9 ft x 5 ft 9 in. deep[d]	In 1967, had a field that was daylighting;[d] new filter trench added after 1973;[e] outflow to Tributary A	
22-010(a)	From TA-22-34 to tank, from tank to leach field	Concrete[f]	1365 gal.[b]	Outflow to 800 ft^2 leach field (north of TA-22-34) with drain tile,[b] drains into Pajarito Canyon	
22-010(b)	From TA-22-1, -4, -5, -32, -52, -90, -91, and -93 to tank; from tank to inactive leach field and from tank to sand filter; from sand filter to outflow	Concrete[g]	8775 gal.[g]	Outflow originally was to a large two-tier leach field (south of TA-22-1),[h] each tier was approximately 30 ft by 200 ft,[h] outflow changed to subsurface sand filter during the late 1970s[e]	Located surface structures for tank, abandoned drain field, sand filter, plugged outflow to Pajarito Canyon[c]
22-016	From TA-22-1 to tank, from tank to outflow	Reinforced concrete,[b] replaced by 22-010(b) in 1958[f]	6 ft x 9 ft x 5 ft[b]	Outflow through 50-ft-long VCP pipe to daylight[i]	Located surface structures for tank, did not locate outflow pipe[c]
40-001(b)	From TA-40-1, -19, and -23 to tank; from tank to seepage pits	Reinforced concrete[j]	1215 gal.[j]	Outflow originally went to leach field;[b] in 1973, outflow connected to 2 seepage pits with estimated input of 420 gal./day[k] and sampling box[e]	Located surface structures for tank, possibly seepage pits or leach field[c]
40-001(c)		Reinforced concrete[j]	540 gal.[j]	Outflow originally went to the canyon, new leach field connected in 1988	

[a] LASL 1944, 19-0017
[b] LANL 1990, 0145
[c] Rofer and Guthrie 1992, 19-0006
[d] LASL 1945, 19-0018
[e] LASL 1973, 0846
[f] (LASL 1950, 19-0110)
[g] LASL 1950, 19-0011
[h] (LASL 1948, 19-0033)
[i] (LASL 1945, 19-0012)
[j] LASL 1949, 19-0015
[k] DOE 1987, 0264

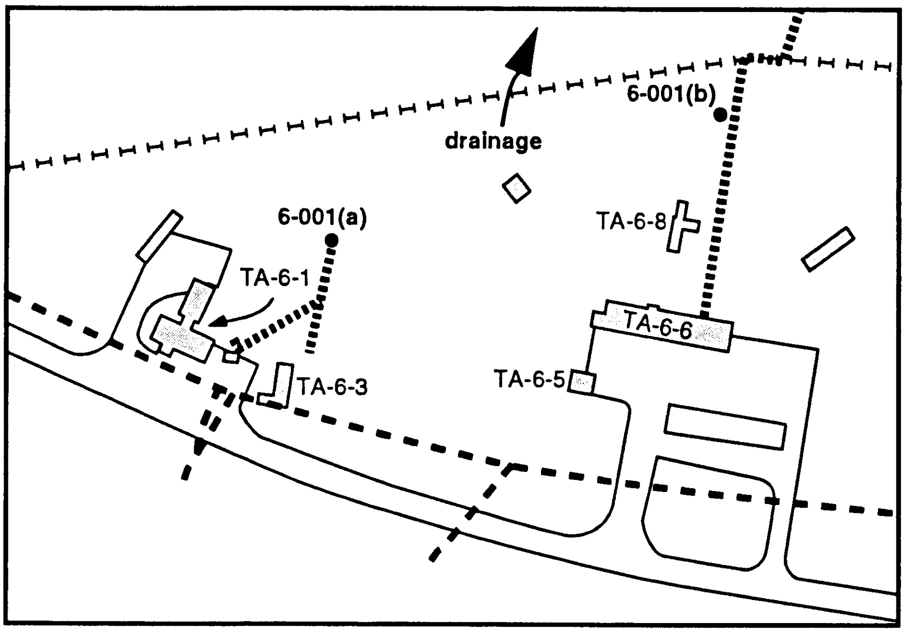
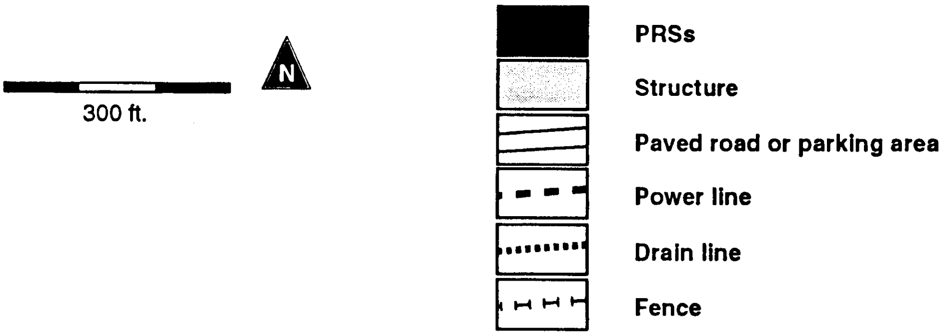


Figure 5-23. Locations of 6-001(a, b).



an electronics work room, a chemistry laboratory, darkrooms, and rest rooms (LASL 1945, 19-0030; LASL 1945, 19-0031). Detonator assemblies to be test fired were prepared in this building until 1950 (Creamer 1993, 19-0035). Detonator assembly may have used carbon tetrachloride and other solvents. Soldering and metal cleaning with nitric acid also took place in TA-6-6 (Schott 1993, 19-0125). During the late 1950s, the building was used by a section of GMX-7 as offices. It was used as a cable shop by E Division in the 1970s and early 1980s (Creamer 1993, 19-0035). Acetone, alcohol, and dilute acids may have been used in the shop. The building is currently unused.

Sinks in Buildings TA-6-5 and TA-6-8 also drained to 6-001(b) (Schott 1993, 19-0125). From 1972 through 1976, UF_6 was used in experiments at TA-6-8 (Schott 1993, 19-0125).

In 1989, the drain line from the septic tank was plugged (HSE-8 1989, 0752). Possible contaminants in this septic system include darkroom chemicals, acids, metals, carbon tetrachloride, and solvents. Explosives were present in partial assemblies. However, it is unlikely any releases of explosives occurred because they were present as pressed pellets and subject to careful handling and accountability procedures.

SWMU 22-010(a). Figure 5-24 shows the location of 22-010(a). Building TA-22-34, served by 22-010(a), was constructed between 1950 and 1952 as an explosives laboratory (LASL 1950, 19-0011). In 1972, the septic tank was checked for explosives; none was found (DOE 1987, 0264). Explosives operations continue in TA-22-34. Possible contaminants from the laboratory are acetone, alcohol, and explosives.

SWMUs 22-010(b) and 22-016. Figure 5-24 shows the locations of 22-010(b) and 22-016. Buildings TA-22-1 and TA-22-4 were served by 22-016; this system consisted of Septic Tank TA-22-42 and an outflow (LASL 1945, 19-0012). The septic tank was replaced by Septic Tank TA-22-51 [22-010(b)] in 1948, and an additional building (TA-22- 5) and a large leach field were added (LASL 1948, 19-0033). Buildings TA-22-32 and -52 were added to the system when they were built in the early 1950s, and Buildings TA-22-90, -91, and -93 were added when they were built in 1984. During the late 1970s or early 1980s, the leach field was disconnected and probably abandoned in place, and a sand filter east of the leach field was connected.

TA-22-1 was built in 1945 for the assembly of explosives for full-scale implosion devices (LASL 1945, 19-0043). Because the process involved only the assembly of already fabricated explosives components, no hazardous wastes are likely to have resulted from these operations. In 1948, TA-22-1 was remodeled as an explosives fabrication facility (Meyers 1993, 19-0044). Room 109 was used for the recrystallization of PETN from September 1948 to September 1950, but it had a separate drain for waste from this operation [22-014(d), Section 5.4]. A laundry facility for Laboratory-supplied protective clothing for workers to wear during explosives operations was added in 1951 (LASL 1951, 19-0034). The washing machines discharged into Septic Tank TA-22-51. The explosives fabrication and laundry facilities were used until 1984 (Creamer 1993, 19-0035). The building is no longer used.

Building TA-22-4, built in 1945, was used as an office building and for fabrication of parts that contained inert material instead of explosives until 1985 when it was demolished (Creamer 1993, 19-0035). Solvents may have been used in this operation. Building TA-22-5, built before the late 1940s, has housed a machine shop, a plastics shop, a potting laboratory, a vapor deposition laboratory, and an electronics laboratory (Creamer 1993, 19-0035). It is now a warehouse. Solvents, non-PCB machine oil, and metals were used in these operations. Building TA-22-32, built in the early 1950s, was a guard shack and is now an office. Building TA-22-52, built in the early 1950s, has housed electroplating and metal-etching operations and a darkroom (Creamer 1993, 19-0035). It is now used as a conventional machine shop. Buildings TA-22-90, which contains offices; TA-22-91, which is used for assembly of parts not containing explosives; and TA-22-93, which houses the major explosives operations for detonator development, were built in 1984 and continue to be used for these operations (Creamer 1993, 19-0035).

Separate industrial and explosives drains have been available for disposal of hazardous materials, but acids, photographic chemicals, non-PCB machine oil, magnesium chips, solvents (acetone and alcohol), and explosives are possible contaminants of this septic system. Because the vapor deposition process was self-enclosed, metals from this operation did not enter the septic system.

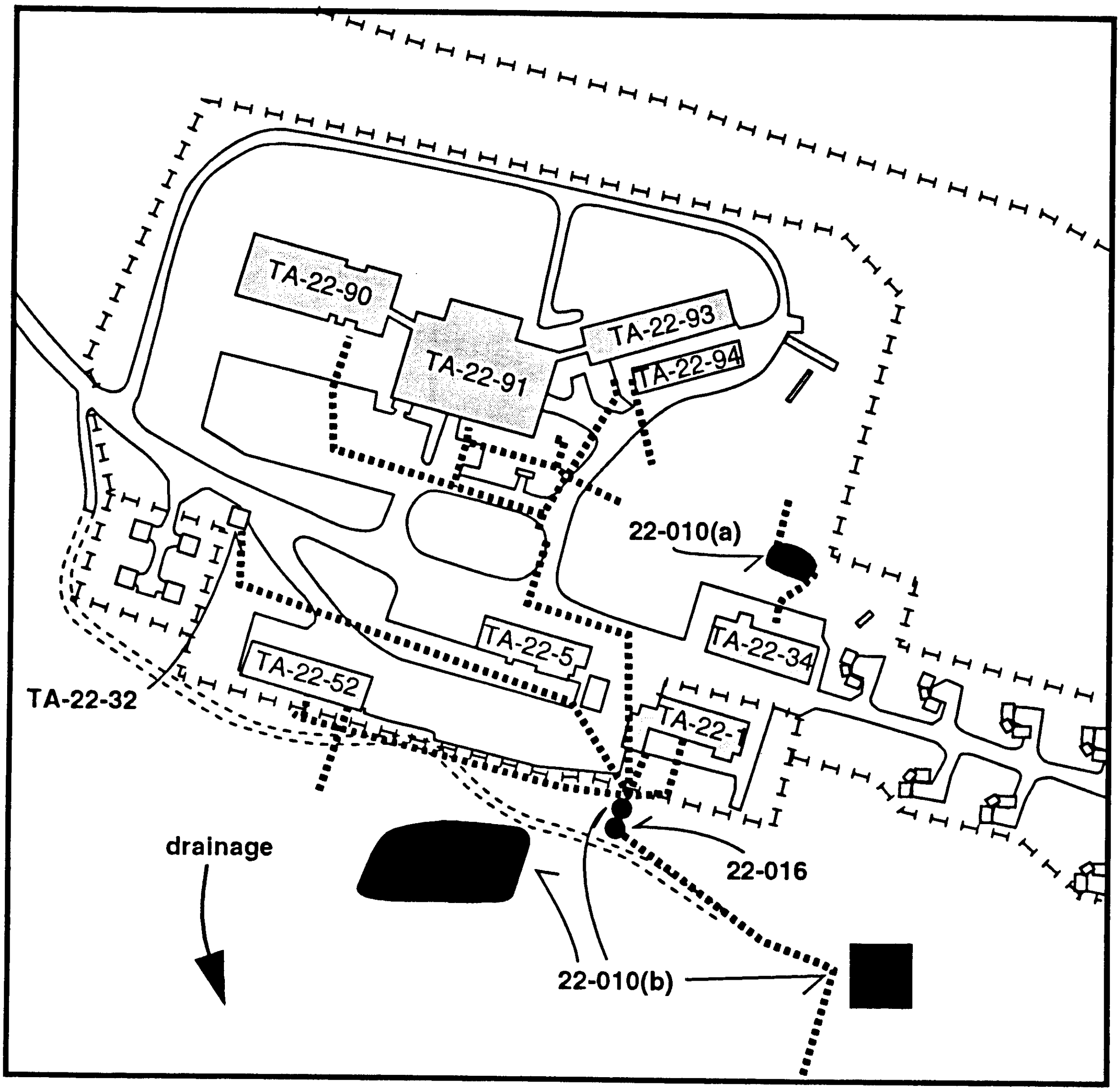


Figure 5-24. Locations of 22-010(a, b) and 22-016.

300 ft.

N

■ PRSs

▨ Structure

Paved road or parking area

Unpaved road

Drain line

Fence

SWMU 40-001(b). Figure 5-25 shows the location of 40-001(b). Buildings TA-40-1, -19, and -23, which were built in the early 1950s, are served by 40-001(b). TA-40-1 has contained offices, a darkroom, and an explosives laboratory (Creamer 1993, 19-0035). In the early 1980s, the explosives laboratory was removed and the building was converted into office space. The building is still in use. TA-40-19 was a guard shack (Creamer 1993, 19-0035); it is not in use. TA-40-23 has contained a cable shop, a warehouse, and an electronics laboratory and now contains offices, a laser laboratory, a carpenter shop, and a staff shop (Creamer 1993, 19-0035). Acetone, alcohol, and dilute acids may have been used in these facilities. Possible contaminants of this septic system include explosives, photoprocessing chemicals, solvents, and acids.

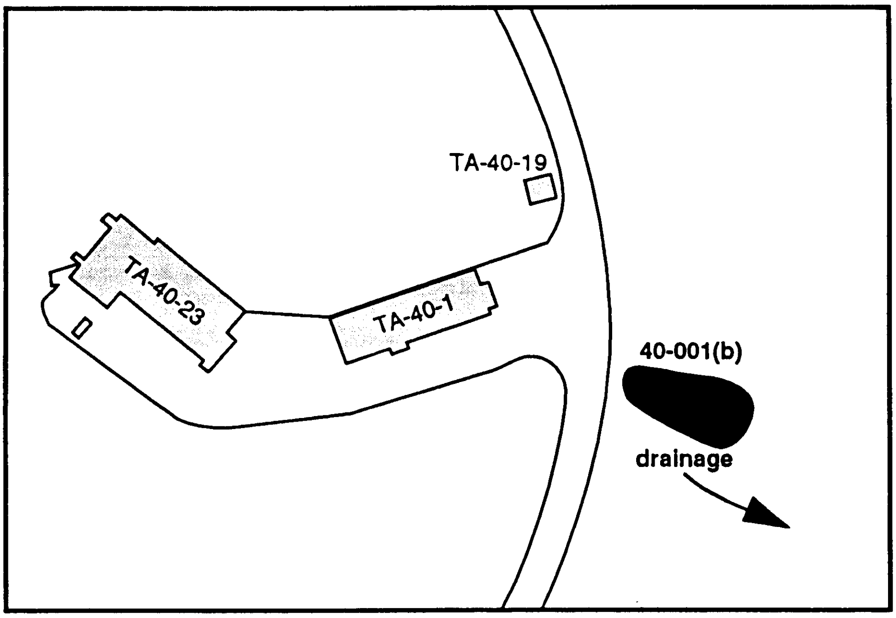
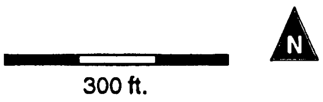


Figure 5-25. Location of 40-001(b).



■ **PRS**

▨ **Structure**

▤ **Paved road or parking area**

SWMU 40-001(c). Figure 5-26 shows the location of 40-001(c). This septic system has served Building TA-40-11 since 1950. The building contains change rooms and rest rooms. Operators at the TA-40 firing sites change into Laboratory-provided clothing in this building. The clothing protects against small amounts of explosives, metals, and other hazardous materials in the form of dust and other residues that may be present at firing sites. No activities in this building have involved production of hazardous wastes, but hazardous material carried on clothing or skin may have been washed down sink drains. Possible contaminants of this system include solvents, metals, and explosives.

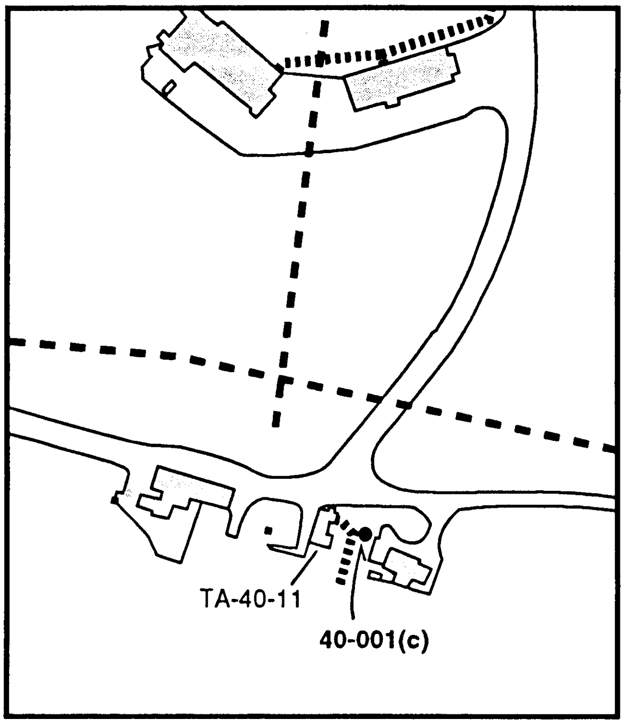
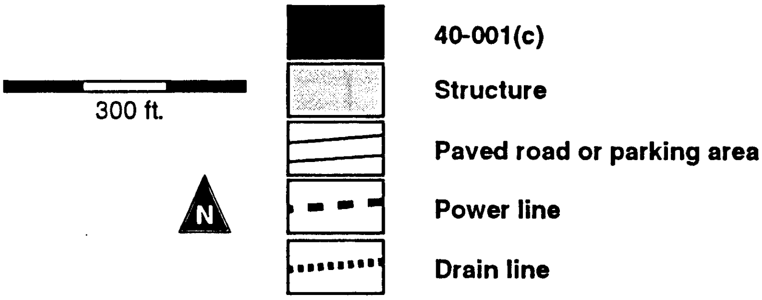


Figure 5-26. Location of 40-001(c).



5.6.1.2 Conceptual Exposure Model

5.6.1.2.1 Nature and Extent of Contamination

The archival information suggests that contaminants may be present in the TA-6 septic systems but are less likely to be present in the TA-22 and TA-40 septic systems. In all cases, the archival information suggests that levels of contaminants are likely to be low because total amounts of hazardous materials used in operations are low. The most probable contaminants in these septic systems are several types of explosives, acids, solvents, metals, creosote, nitrates, explosives decomposition products, and darkroom chemicals. The explosive most often used is PETN; the upper limits on the amounts that may have been discharged to SWMUs in this aggregate have been estimated and are given in Table 4-5 (Meyers 1993, 19-0044).

There are no records of sampling of the SWMUs in this aggregate; therefore, whether contaminants are present in them is unknown.

5.6.1.2.2 Potential Pathways and Exposure Routes

Septic tanks, drain lines, outfalls and related run-off areas, leach fields, sand filters, sand filter trenches, and seepage pits could be primary sources of possible contaminants. If contaminants were deposited in the septic systems, secondary sources could include soils, tuff, air, surface water, sediments, or plants. The outflow areas (outfall and the related run-off area, sand filter, filter trench, leach field, or seepage pit) are the most likely parts of the system to contain contaminants because they have received outflow from the septic tanks since their installation. Septic tanks and drain lines are less likely to contain contaminants because solids are removed periodically from the tanks, and the drain lines are flushed by continued flow. At some outfalls, the soil has been scoured away and only tuff remains. Contaminants may have been carried downstream with sediments. Because the septic tank is designed to allow solids to settle out, the constituents most likely to have been carried to the outflow areas are those that are soluble in water, lighter than water, or fine particulates that could have been entrained in the water flow. Thus, soluble metal salts and solvents that are lighter than water or soluble in water are the constituents most likely to have been carried into the outflow areas. Although the explosives used are very insoluble in water, particulates may have been carried to the outflow areas. Solvents are expected to have at least partially evaporated from these areas; however, a portion may have migrated downward with water and be present in the subsurface regions of the outflow areas. Explosives can be expected to remain in place and may have decomposed by oxidation in air or by bacterial action. Thus, decomposition products may also be present.

The direction of drainage is indicated on Figures 5-23, 5-24, 5-25, and 5-26. The systems drain into Pajarito Canyon and Tributaries A and B of Two-Mile Canyon. Transport mechanisms include overland flow and associated sediment transport, infiltration, percolation, wind erosion, and uptake by plants. Receptors include plants, animals, and humans. Exposure routes to receptors include direct skin contact with contaminated soils or sediments, ingestion, and inhalation when a contaminated area is disturbed. Herbivores living on site may be exposed by eating plants that grow in contaminated soils. Discussion of particular aspects of the SWMUs follows.

SWMUs 6-001(a) and 6-001(b) served small numbers of people and small operations for a short period of time. Drainage from the septic tanks was originally to outfalls, with a sand filter added to 6-001(a) later.

The septic system that includes SWMUs 22-010(b) and 22-016 is the largest in OU 1111 and serves most of TA-22. This system includes two tanks (one inactive and one active but scheduled to become inactive), an abandoned outfall, a large abandoned leach field, and a sand filter.

SWMU 22-010(a) drains into a marshy area in Tributary B of Two-Mile Canyon. Sampling of the marshy area is discussed in Section 5.3.

SWMU 40-001(b) has served a significant number of people since 1950. Because the seepage pits were constructed as gravel-filled holes in the tuff

(LASL 1949, 19-0015), soils and tuff may be contaminated to a greater depth than for the other septic systems in this OU. The depth of the pits (tens of ft), however, is small compared to the depth of the drinking-water aquifer (more than 1000 ft). No perched aquifers have been observed in OU 1111 (Section 3.5.2.3). Direct exposure to receptors is unlikely because most of the material drained into these pits will probably be absorbed by the tuff.

SWMU 40-001(c) originally had an outfall but is now connected to a leach field. It has relatively light use with little probability of hazardous materials present.

5.6.2 Remediation Decisions and Investigation Objectives

Remediation alternatives differ for inactive and active septic systems. The preferred remediation alternative for inactive septic tanks appears to be concurrent removal and sampling. The cost of sampling around the tank without removal may be higher than the cost of removing the tank while sampling (Den-Baars 1991, 19-0021). If both radioactive and hazardous components are present in the septic tanks, they must be disposed of in an appropriate mixed-waste facility. Therefore, sampling of inactive systems will first determine whether tank disposal can be in existing disposal facilities. If tank disposal must be in a mixed-waste facility, removal and sampling of the tank will be deferred until such a facility is available. Two systems that are active now [22-010(a, b)] will become inactive when connections are made to the Sanitary Wastewater Consolidation System (SWCS). Because connections are planned for Fiscal Year 1993, these systems are expected to be inactive when sampling begins. If no contaminants of concern are found, no further action will be recommended. If remediation is required, alternatives include removal of contaminated structures, removal or *in situ* treatment of contaminated soil in the outflow area and surrounding the tank and drain lines, and capping contaminated soil and structures and monitoring the stabilized areas.

Two active septic systems, 40-001(b) and 40-001(c), will not be connected to the SWCS; no plans exist for decommissioning these systems or the buildings they serve. The probable remediation alternatives for these systems are removal at decommissioning and no further action. These systems will be sampled during Phase I to determine whether contaminants of concern are present. If no contaminants of concern are found, further action will be deferred until decommissioning. If remediation is required, alternatives include removal of contaminated structures, removal or *in situ* treatment of contaminated soil in the outflow area and surrounding the tank and drain lines, and capping of contaminated soil and structures and monitoring the stabilized areas.

The objective of the Phase I investigation of the septic systems is to determine whether the septic systems contain contaminants of concern.

RFI Phase I data will be collected to answer these questions:

- Are contaminants of concern present in the outflow areas of septic systems? The areas receiving outflow are the most likely component to retain hazardous materials that may have been discharged into the septic system. This information will be used to make decisions on whether a Phase II investigation is necessary. If contaminants of concern are present in the outflow area of an active septic system, the media surrounding the tank will be investigated during Phase II.

- Are contaminants of concern present in the septic tank and in the media surrounding the tank in inactive systems? This information is required to decide whether the inactive septic tanks must be disposed of as mixed waste. If mixed waste is found, the removal and sampling operation will be deferred until a suitable mixed-waste disposal site is available. If no mixed waste is found but contaminants of concern are present, a Phase II investigation will be recommended. If no contaminants of concern are found, the tank will be removed and no further action will be recommended.

Decisions on remediation alternatives for drain lines will be based on the results of sampling of outflow areas and septic tanks. If contaminants of concern are found in the outflow areas, a Phase II investigation of drain lines from the septic tank to the outflow areas will be recommended. If contaminants of concern are found in the septic tank, a Phase II investigation of drain lines from buildings to the septic tank will be recommended. If no contaminants of concern are found in these components of the septic system, no further action will be recommended for the drain lines.

5.6.3 Data Needs and Data Quality Objectives

5.6.3.1 Data Needs for Evaluating Health and Safety Risks

5.6.3.1.1 Source Characterization

Each septic system will be field mapped. The septic tank, the present and historical outflow areas, and the present and historical drain lines to and from the septic tank and the outflow area will be included on the map.

Reconnaissance sampling (Appendix H) (LANL 1992, 0768) at each SWMU will determine whether contaminants of concern are present and whether a Phase II investigation is necessary. Results from the analysis of samples will produce data for decisions on remediation alternatives. If no samples are found to contain contaminants of concern, no further action will be recommended. If contaminants of concern are found, a Phase II investigation will be recommended.

In outflow areas, results from the analysis of samples will produce data for decisions on remediation alternatives for the outflow area and the drain lines from the septic tank to the outflow area. If no contaminants of concern are found in an outflow area, it will be concluded that the extent of contamination does not include that outflow area and drain lines serving it. If contaminants of concern are found, a Phase II investigation will be recommended for that outflow area and for drain lines serving it. At a minimum, samples will be analyzed for explosives and for possible contaminants listed in Section 5.6.1.1. The number of samples will be sufficient to detect contaminants above SALs with at least an 80% certainty if the contaminants cover half or more of the area being sampled. Sampling will take place where contaminants are judged most likely to be present.

For active septic systems (systems in use), only the outflow areas and media near the septic tank outlet will be sampled during Phase I. The number of samples in the media surrounding the tank will be sufficient to detect contaminants above SALs with at least an 80% certainty if the contaminants cover half or more of the area being sampled. Sampling will take place where contaminants are judged most likely to be present. If no contaminants of concern are found, further action will be deferred until decommissioning. If contaminants of concern are found, a Phase II investigation will be recommended.

Inactive septic tanks will be removed. Before removal, the tank contents will be sampled, and cores outside the tank will be analyzed to guide removal and disposal of the tank. Results of the analyses will help determine where to dispose of the tank. More than one sample will be taken from the contents of the tank for the following reasons: it is uncertain whether each layer is homogeneous, statistical analysis is not possible with just one sample, and three samples provide a check for laboratory analysis. The number of samples in the media surrounding the tank will be sufficient to detect contaminants above SALs with at least an 80% certainty if the contaminants cover half or more of the area being sampled. Sampling will take place where contaminants are judged most likely to be present. If contaminants of concern implying the presence of mixed waste are found, removal will be deferred; otherwise, the tank will be removed.

After the tank is removed, samples will be collected where there are signs of leakage, such as tank structural flaws or staining. The number of samples placed around the excavation will be sufficient to detect contaminants above SALs with at least an 80% certainty if the contaminants cover 20% or more of the area being sampled. Sampling will take place where contaminants are judged most likely to be present. If no contaminants of concern are found in the excavation and none were found in the associated outflow areas, the excavation will be filled and no further action will be recommended. If contaminants of concern are found, a Phase II investigation will be recommended for the media surrounding the tank and the drain lines.

The logic of Phase I sampling is summarized in flow diagrams for active (Figure 5-27) and inactive (Figure 5-28) septic systems.

5.6.3.1.2 Environmental Setting

No data are needed for Phase I decisions. If contaminants of concern are found to be present in soil, tuff, or sediments, Phase II may require data to characterize environmental migration pathways.

5.6.3.1.3 Potential Receptors

No data are needed for Phase I decisions.

5.6.3.2 Data Needs for Evaluating Other Impacts

The primary use for some of the source characterization data will be to determine constraints on the scheduling and budgeting of a combined sampling and VCA

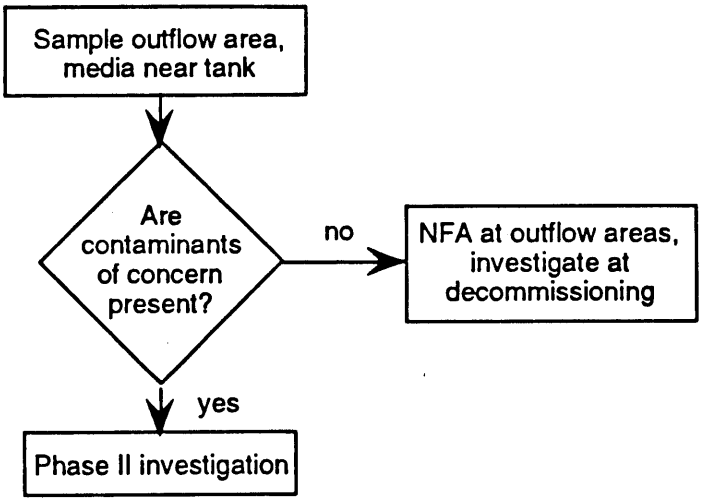


Figure 5-27. Logic flow diagram for Phase I sampling of active septic system SWMUs.

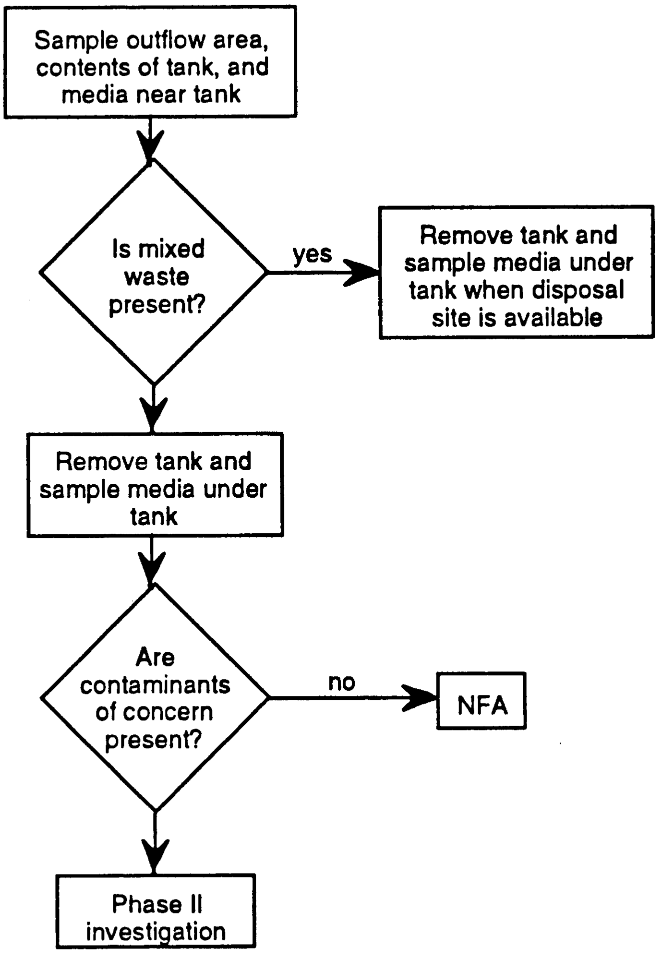


Figure 5-28. Logic flow diagram for Phase I sampling of inactive septic system SWMUs.

for the inactive septic tanks. If no hazardous constituents or only hazardous constituents are found during the source characterization, combined removal and sampling of inactive septic tanks may proceed. If mixed waste is present, removal of contaminated soil or structures may be deferred until suitable waste disposal capacity is available.

5.6.4 Sampling and Analysis Plans

Specifications are given here for minimum numbers of samples to be collected. If additional locations for sampling are identified in the field survey or during sampling, additional samples will be collected from those locations. Indicators of additional locations for sampling include all findings that may indicate the presence of contaminants, including the results of field screening tests, discoloration, structural flaws in the tank, the presence of deposits, and geomorphic structures that may trap contaminants.

Engineering drawings and preliminary field investigations (field surveys, geophysical surveys, and/or trenching) will be used to determine the locations of drain lines, septic tanks, and their outflow areas. All locations that have not been mapped will be mapped. Locations for sampling, including outflow channels and sediment accumulations within those channels, will be identified and mapped.

Sampling plans for the septic system components are given below. The outflow area and the septic tank outlet will be sampled in inactive and active systems. Figure 5-29 shows sampling locations around a septic tank. Sampling plans are summarized in Tables 5-15 and 5-16; numbers of samples given in those tables are derived from the discussions in the sampling plans below. The recommended chemical analyses are derived from the information in Section 5.6.1.2.1. All samples will be submitted to the analytical laboratory except for samples taken from excavations resulting from the removal of septic tanks. Those samples will be submitted to a field laboratory or other laboratory that can provide quick turnaround times so that the excavation can be filled as soon as possible to minimize safety hazards.

Outfalls and Related Run-off Areas. Soil samples will be collected at three locations: one as close as practicable to the outfall pipe but no farther away than 6 ft and two at a distance of more than 15 ft from the outfall pipe but before the bottom of the major canyon into which the outfall drains. All locations will be in sediment accumulations identified in the field survey or along the outfall channel if no sediment accumulations are available. Samples will be taken at the surface and at a 12-in. depth.

Leach Fields. Three sampling locations will be determined during the field survey: one as close as practicable to the outflow pipe but no farther away than 6 ft, one at the point of lowest elevation within the field, and one at the center of the field, unless other locations are judged more likely to have trapped contaminants. Samples will be taken of drainage tiles and of soil at a depth of 3 ft below the depth of the tiles or at the depth of the soil-tuff interface, whichever is shallower. If there are no drainage tiles, soil samples will be collected at the depth of the outflow pipe.

Sand Filters. Soil samples will be collected from three locations determined during the field survey: one as close as practicable to the outflow drain line but

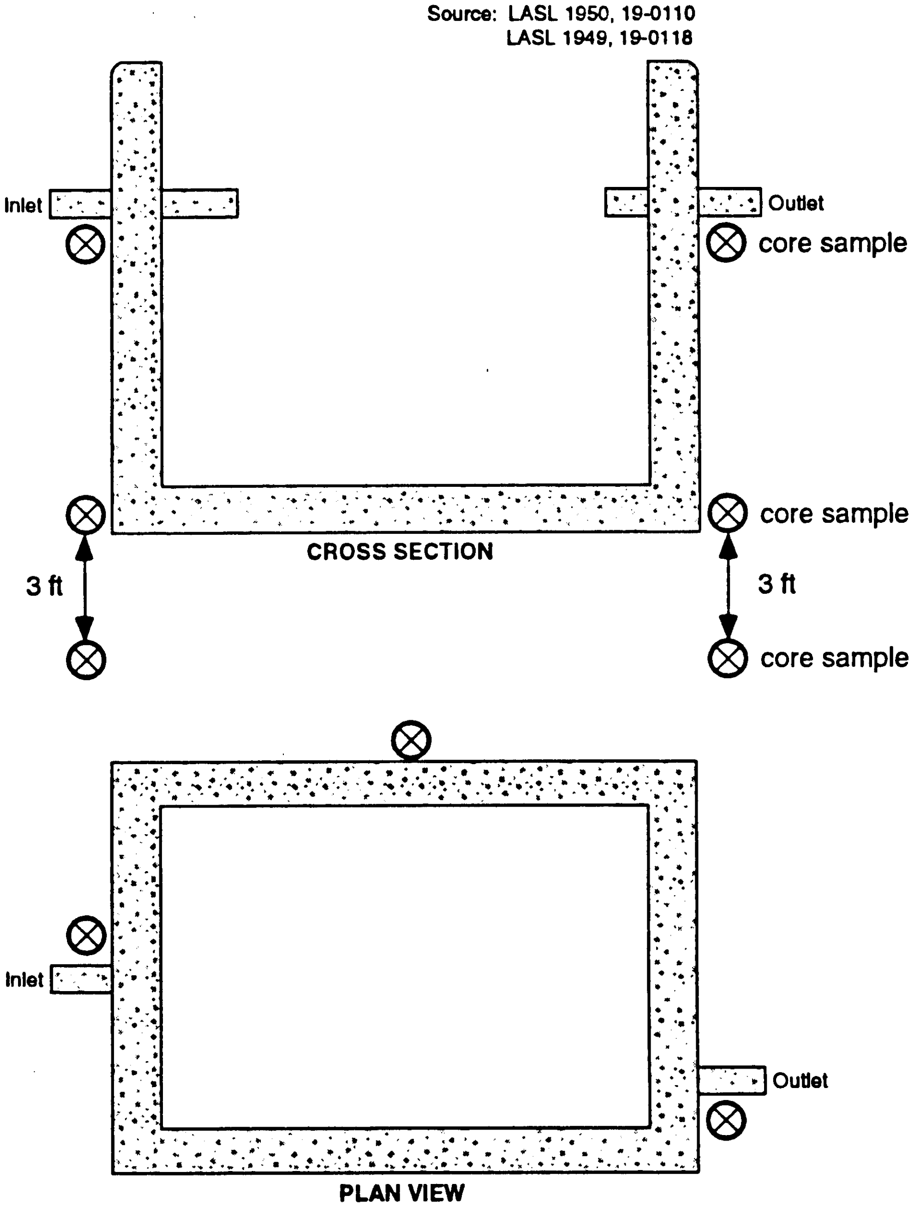


Figure 5-29. Diagram of approximate locations of cores around a septic tank. At least eight additional sampling locations will be sited upon removal of inactive septic tanks.

no farther away than 6 ft, one at the point of lowest elevation within the filter, and one at the center of the filter, unless other locations are judged more likely to have trapped contaminants. Samples will be taken at the surface and at 3 ft below the depth of the outflow drain line or at the soil-tuff interface, whichever is shallower.

Filter Trenches. Soil samples will be collected at three locations determined during the field survey: one as close as practicable to the outfall pipe but no farther away than 6 ft, one at the center of the trench, and one at the point of lowest elevation within the trench. Samples will be taken at the surface and at 3 ft below the depth of the outflow drain line or at the soil-tuff interface, whichever is shallower.

TABLE 5-15

COMPONENTS OF SEPTIC SYSTEM SWMUs TO BE SAMPLED

	Outflow Areas					Tank			
SWMU Number	**Outfall and Run-off Area**	**Leach Field**	**Sand Filter**	**Filter Trench**	**Seepage Pit**	**Outlet**	**Outside Tank**	**Inside Tank**	**Excavation**
6-001(a)	6 sand filter outfall 6 inactive outfall					1 core[a]	2 cores[a]	3 contents	16 soil
6-001(b)	6 filter trench outfall 6 inactive outfall			6 soil		1 core[a]	2 cores[a]	3 contents	16 soil
22-010(a)		6 soil				1 core[a]	2 cores[a]	3 contents	16 soil
22-010(b)	6 sand filter outfall	6 soil	6 soil			1 core[a]	2 cores[a]	3 contents	16 soil
22-016	6 inactive outfall					1 core[a]	2 cores[a]	3 contents	16 soil
40-001(b)		6 soil			3 cores[b] 3 contents	1 core[a]			
40-001(c)	6 inactive outfall	6 soil				1 core[a]			

[a] Three analytical samples to be removed.
[b] Four analytical samples to be removed.

Seepage Pits. Three evenly spaced intact cores to 3 ft below the depth of the pit will be taken as close as practicable to the pit but no farther away than 6 ft. Samples will be removed from each core at the surface, at the middle depth of the pit, at the bottom depth of the pit, and 3 ft below the bottom depth of the pit. One sample each of sludge, liquid, and any other media that may be present will be taken from the contents of the pit at three levels: the top, middle, and bottom of the height of the contents. Sampling of the pit contents will be done by appropriate methods for liquids, sediments, or other materials, depending on the nature of the contents of the pit.

Septic Tank Outlet. Concurrent with the sampling of the outflow area, an intact core to a depth 4 ft below the depth of the bottom of the tank will be taken as close as practicable to the outlet of the septic tank but no farther away than 6 ft. Samples will be removed from the core at the depth of the outlet, at the depth of the bottom of the tank, and at 3 ft below the bottom of the tank.

Inactive Septic Tank. Before the septic tank can be removed for disposal, three widely spaced samples will be collected from each layer of sludge or liquid present or, if the tank is empty, three scrape or swipe samples will be collected from inside the tank on the side and bottom where contaminants are judged most likely to be present. Such a judgment might be based on coloration of the tank or the presence of deposits.

Intact cores will be collected at two locations: one at the tank inlet and one at another side of the tank judged most likely to contain contaminants. Both cores will be located as close as practicable to the tank but no farther away than 6 ft. The depth of the cores and the samples removed will be as described above for the septic tank outlet.

If no contaminants indicating the presence of mixed waste are found in the tank contents or in the adjacent cores, removal of the tank and sampling of the media surrounding the tank may proceed. The tank will be inspected for flaws, and the tank and excavation will be inspected for signs of leaks. Samples will be

TABLE 5-16

ANALYTICAL SAMPLES FOR AGGREGATE 6

		Field Surveys			Samples			Field Screening			Field Lab. Measr.		Laboratory Analysis													
SWMU or AOC	SWMU Type	Land Survey	Gross Gamma	Geophysics	Sampled Media	Samples	Duplicate	Gross Gamma	High Explosives (M-1 Kit)	Lithological Logging	Gamma Spectrometry	Volatile Organics (SW 8240)	Gamma Spectrometry	Isotopic Uranium	Strontium-90	Cesium-137	Metals (SW 6010)	Volatile Organics (SW 8240)	Semivolatile Organics (SW 8270)	High Explosives (LANL Method)	PCB (SW 8080)	Sulfates/Chromates/Copper Salts	Nitrates and Nitrites	Fluoride	Cyanide	Phosphate
6-001(a)	Septic System	X			Soil	12	1	X	X								X		X	X						
					Soil/Tuff	9	1	X	X								X	X	X	X						
					Contents	3	1	X	X								X		X	X						
					Soil	16	1	X	X		X	X					X		X	X						
6-001(b)	Septic System	X			Soil	12		X	X								X		X	X						
					Soil/Tuff	9		X	X								X	X	X	X						
					Contents	3		X	X								X		X	X						
					Soil	16	1	X	X		X	X					X		X	X						
22-010(a)	Septic System	X			Soil	6		X	X										X	X						
					Soil/Tuff	9	1	X	X									X	X	X						
					Contents	3		X	X										X	X						
					Soil	16	1	X	X		X	X							X	X						
22-010(b)	Septic System	X			Soil	18	1	X	X								X		X	X						
					Soil/Tuff	9		X	X								X	X	X	X						
					Contents	3		X	X								X		X	X						
					Soil	16		X	X		X	X					X		X	X						
22-016	Septic System	X			Soil	6		X	X								X		X	X						
					Soil/Tuff	9	1	X	X								X	X	X	X						
					Contents	3		X	X								X		X	X						
					Soil	16	1	X	X		X	X					X		X	X						
40-001(b)	Septic System	X			Soil	6		X	X								X		X	X						
					Soil/Tuff	15	1	X	X								X	X	X	X						
					Contents	3	1	X	X								X		X	X						
40-001(c)	Septic System	X			Soil	12	1	X	X								X		X	X						
					Soil/Tuff	3		X	X								X	X	X	X						

collected where flaws or leaks indicate liquid may have escaped from the tank. At least eight sample locations will be used, including the areas selected for leaks and other samples dispersed about the excavation to obtain wide coverage. Samples will be collected at depths of 6 in. and 3 ft or at the soil-tuff interface, whichever is shallower.

If no contaminants of concem are present, the excavated area will be backfilled and no further action will be recommended. If contaminants of concern are present, the excavated area will be backfilled and a Phase II investigation will be recommended.

5.7 Aggregate 7, Active Firing Sites

The following PRSs are included in this aggregate.

- 40-006(a) (TA-40-15)
- 40-006(b) (TA-40-8)
- 40-006(c) (TA-40-5)
- 40-009

The following firing sites are also included in this aggregate.

- TA-40-4
- TA-40-9
- TA-40-12

5.7.1 Background

5.7.1.1 Description and History

In 1950, TA-40 was constructed to replace the detonator firing sites at Two-Mile Mesa Site South (TA-6). Six firing sites are active at TA-40; these include the three firing sites [40-006(a, b, c)] listed in the SWMU Report (LANL 1990, 0145) and three other firing sites (Buildings TA-40-4, -9, and -12). All six firing sites are used only for testing and development of small explosive devices and not for waste disposal. They, therefore, are probably not Hazardous and Solid Waste Amendments SWMUs (RCRA proposed Subpart S) (EPA 1990, 0432) but will be investigated to determine whether they are sources of contaminants. SWMU 40-009, a landfill adjacent to TA-40-9, is also included in this aggregate.

The firing sites at TA-40 are located on the north edge of Pajarito Canyon (Figure 5-30). Each site consists of a reinforced concrete and steel building from which a shot is observed with various types of optical diagnostics, a partially protected area adjacent to the building where the shot is set up, and an open area covered with sand where larger shots are fired. After each shot, large pieces of debris are removed and disposed of, the open area is graded, and sand and debris are pushed to the edge of the canyon. This practice has led to the development of sand berms extending along the edge of the canyon.

These firing sites have been used for detonator development tests since they were constructed. Tests have included detonator booster tests, which use 2 lb. of explosives, and large open-air shots, which can use up to 50 lb. of explosives.

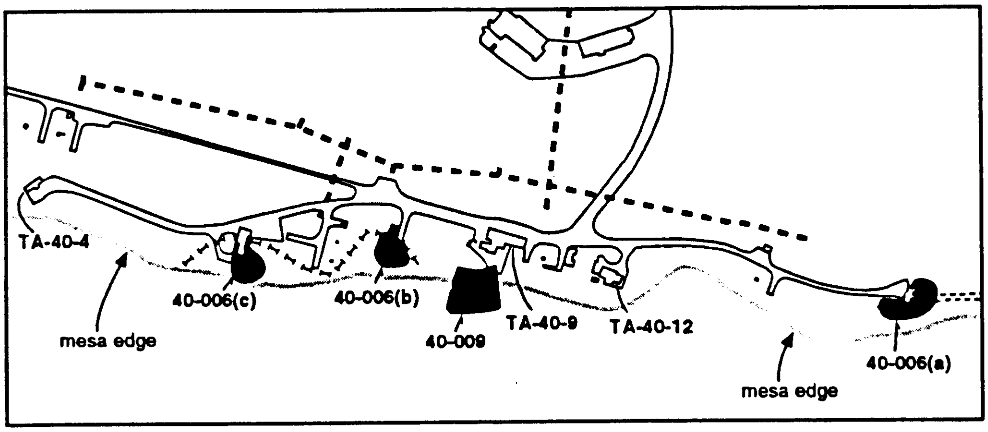


Figure 5-30. Locations of active firing sites and Landfill 40-009 at TA-40.

All Laboratory-approved explosives, including PETN, RDX, HMX, HNS, TATB, Baratol, TNT, nitroguanidine, and combinations of these materials, are authorized for firing and probably have been used. Thallium azide was used for a short time (Milford 1956, 19-0100). Lead bricks were commonly used as components of test setups and were broken into fragments during the shots. Short-term experimental tests have also been carried out at the firing sites [e.g., with diethanolamine in 1960 (Campbell 1960, 19-0083) and with ClF_3 in 1964 and 1965 at TA-40-4 (Burch 1964, 19-0084; Burch 1964, 19-0085; Wackerle 1965, 19-0086)]. Up to 85 lb. of explosives per shot were used in a series of shots in 1967 (Wackerle 1967, 19-0082).

Although TA-40-8 and -9 are now contained operations, they originally had the same configuration as the other sites. TA-40-9 was used for detonator tests during the 1950s and was later enclosed to contain a gas gun. TA-40-8 was extended, and a containment system consisting of a large vessel with a high-efficiency air particulate filtration system for gaseous emissions was installed in 1992. Excavation of the existing firing pad was necessary for this renovation. A reconnaissance survey was done for contaminants in the firing pad soil before excavation (Fresquez 1991, 19-0089; Fresquez 1991, 19-0087; Fresquez 1991, 19-0088). Samples were tested for explosives residues; gross alpha, beta, and gamma radioactivity; total beryllium; total uranium; RCRA target volatile and semivolatile organic compounds; and PCBs. The toxicity characteristic leaching procedure for metals (silver, arsenic, barium, cadmium, chromium, mercury, lead, and selenium) was also performed. Lead was found in concentration up to 450 ppm, and uranium was found in concentrations up to 26.5 ppm. The highest concentrations were found just in front of the chamber. Before construction began, the top 6 in. of soil on the firing pad was removed from the area and deposited on plastic sheeting to confine contaminants that might be leached from it (Bailey 1991, 19-0096). This soil and the plastic sheeting have not been removed.

SWMU 40-009 is a landfill that contains debris from decommissioning of buildings at TA-15. The debris was monitored for radioactivity before it was disposed between TA-40-15 and TA-40-5 (LANL 1990, 0145). This SWMU is included in this aggregate because it is close to the firing site at TA-40-9.

5.7.1.2 Conceptual Exposure Model

5.7.1.2.1 Nature and Extent of Contamination

Explosives are mostly consumed in tests, but may leave residues. Residues may consist of the explosives themselves, polycyclic aromatic hydrocarbons, and other organic compounds. Occasionally a test fails and disperses explosives fragments around the firing pad. Safety practices require that these fragments be recovered and disposed of at an approved disposal site. However, small particles of explosives may have been dispersed around the firing pad and into Pajarito Canyon and may still remain. Residues from oxidation and bacterial degradation of the explosives may also be present. Fragments of lead and other metals may be present in and around the firing pads. Soil samples were collected at TA-40-15 during the DOE Environmental Survey (LANL 1989, 19-0097; DOE 1991, 0857) (Table 5-17). No explosives were found, but barium, copper, and zinc were detected. Lead (up to 450 ppm) and uranium (up to 26.5 ppm) were detected in sampling done in 1991 at TA-40-8. Thallium compounds are known to have been used in detonators for a short time. Diethanolamine has probably evaporated or decomposed. ClF_3 is a gas and is highly reactive with atmospheric water. It is probably no longer present, but fluoride may be present as a decomposition product at TA-40-4.

The soil stored on plastic sheeting at TA-40-8 contains uranium concentrations that are probably less than 26.5 ppm (Fresquez 1991, 19-0087) and lead concentrations that are probably less than 450 ppm (Fresquez 1991, 19-0088). The plastic sheeting confines contaminants that may be leached from this soil.

Little information is available about the building debris from TA-15 deposited in 40-009, but TA-15 is primarily used for explosives testing, and the contaminants expected in this debris are, therefore, similar to those expected in the firing sites.

5.7.1.2.2 Potential Pathways and Exposure Routes

The primary sources of possible contaminants are hazardous material that may be contained in the soil and sand of the firing pads and large debris (shrapnel) and particulates that may have been deposited outside the pads. The firing sites are located on the edge of the mesa, and the blasts are directed toward Pajarito Canyon. In an explosion, shrapnel may be thrown into the canyon, and a dust cloud is formed that may contain hazardous constituents. Generally, particulates from the dust cloud will be deposited in decreasing concentrations with increasing distance from the explosion site as the cloud moves away from the detonation area. Blast debris is bulldozed off the pad and onto the canyon wall. Secondary sources could include soils, tuff, air, surface water, sediments, or plants.

Water flows throughout most years in the part of Pajarito Canyon that is adjacent to the firing sites. Spring run-off may provide flow as far east as State Road 4 in

TABLE 5-17

RESULTS OF DOE SAMPLING AT TA-40-15[a]

Sample Number	LA20101	LA20102	LA20103
Medium	Surface soil	Surface soil	Surface soil
Depth (ft)	0-0.5	0-0.5	0-0.5
Analytes			
High explosives	ND[b]	ND	ND
Antimony (mg/kg)	ND	ND	ND
Arsenic (mg/kg)	ND	ND	ND
Barium (mg/kg)	435	657	396
Beryllium (mg/kg)	ND	ND	ND
Cadmium (mg/kg)	ND	ND	ND
Chromium (mg/kg)	ND	ND	ND
Copper (mg/kg)	47.6	151	32.2
Lead (mg/kg)	ND	ND	ND
Nickel (mg/kg)	ND	ND	ND
Selenium (mg/kg)	ND	ND	ND
Silver (mg/kg)	ND	ND	ND
Thallium (mg/kg)	ND	ND	ND
Zinc (mg/kg)	47.3	61.4	78.4
Thorium-232 (pCi/kgW)[c]	<6200±1800	<7200±1100	<8400±2500
Uranium-234 (pCi/kgW)	ND	ND	ND
Uranium-235 (pCi/kgW)	ND	ND	ND
Uranium-238 (pCi/kgW)[d]	ND	ND	ND
Aluminum-26 (pCi/kgW)	ND	ND	ND
Potassium-40 (pCi/kgW)	19800±4400	17300±2600	19400±6500
Cobalt-56 (pCi/kgW)	ND	ND	ND
Cesium-137 (pCi/kgW)	ND	ND	ND

[a] (LANL 1989, 19-0097)
[b] ND = Not detected
[c] Radionuclide results are from screening only.
[d] Activity in excess of uranium-238 natural chain.

White Rock. During the summer and fall, the flow of surface water stops west of the intersection of Pajarito Canyon with Pajarito Road, about 3 miles west of State Road 4. Constituents deposited on canyon slopes, debris that has landed near the stream, and contaminated soils that have been washed down the side of the canyon may be carried into the stream and out of the OU during intense summer thunderstorms.

Receptors include plants, animals, and humans. Exposure routes to receptors include direct skin contact with contaminated soils or sediments, ingestion, and inhalation when a contaminated area is disturbed. Herbivores living on site may be exposed by eating plants that grow in contaminated soils. Exposure to humans may be through direct skin contact during occupational events and during recreational use and by ingestion of hunted game animals that have foraged in contaminated areas.

5.7.2 Remediation Decisions and Investigation Objectives

Remediation alternatives for active firing sites include deferral of further investigation until decommissioning, if no contaminants of concern are found. Remediation alternatives for 40-009 include no further action, if no contaminants of concern are found. If remediation is required, testing will be suspended during remediation. Remediation alternatives include removal or *in situ* treatment of contaminated soil and capping of contaminated soil and monitoring the stabilized area if the cap will not be disturbed by subsequent test activities.

The top 6 in. of soil has been removed from the firing pad area at TA-40-8 and is stored on plastic sheeting. Because this soil has been adequately sampled and because the firing pad area is under the newly constructed building, no further sampling of the firing pad area of TA-40-8 is proposed at this time. The stored soil will be appropriately disposed of by M-7, the operating group.

The objective of the Phase I investigation of the active firing sites is to determine whether the firing sites and surrounding media contain contaminants of concern and whether contaminants of concern could move off site. This will be accomplished by sampling 40-006(a) and the surrounding area. Explosives and materials used in the tests conducted at 40-006(a) were similar in composition to those at the other sites, but tests were more numerous and some included larger amounts of explosives. Results of sampling at this site should indicate the maximum levels of contaminants likely to have been dispersed by testing activities at any of the other sites.

RFI Phase I data will be collected to answer these questions.

- Is shrapnel present around the firing site? If so, in approximately what quantities and to what distance is it present? This information will be used to make decisions on whether a Phase II investigation is necessary.

- Are contaminants of concern present in the firing pad? Firing pads are most likely to contain contaminants directly under the firing position and at close radii. This information will be used to make decisions on whether a Phase II investigation is necessary.

- Are contaminants of concern present in media outside the firing pad? This information will be used to make decisions on whether contaminants of concern could move off site and whether a Phase II investigation is necessary.

5.7.3 Data Needs and Data Quality Objectives

5.7.3.1 Data Needs for Evaluating Health and Safety Risks

5.7.3.1.1 Source Characterization

SWMUs 40-006(a) and 40-009 (landfill) will be field mapped. The extent of the landfill including drainage, erosion, and deposition features will be documented. Included on the map of 40-006(a) will be the extent of the firing pad area, the debris berm, and other features that may be part of a potential contaminant source. Instrumental measurements, sample locations, and sediment or contaminant accumulations will be included on the map. Alluvium deposits and stream channels adjacent to the firing site will also be mapped.

Two transects will be shown on the map. They will be situated along lines judged to include the area of maximum deposition of explosion debris and will be based on the site operator's recommendations. The transects will originate at the firing bunker and extend to the upper edge of the south wall of Pajarito Canyon. One transect will be about 870 ft long positioned at about 200° and the other will be about 990 ft long at about 160°. Figure 5-31 shows the approximate location of the transects.

Metal detectors will be used to survey along and between the two transects to determine the presence of shrapnel. The same area will be monitored for radioactivity resulting from the presence of depleted uranium; x-ray fluorescence will be used to monitor for metals.

The distribution of metal fragments will be used to estimate total amounts of metal deposited as shrapnel. Action levels will be developed for depleted uranium and lead shrapnel for a scenario in which the present uses of this site continue.

Reconnaissance sampling (Appendix H, IWP) (LANL 1992, 0768) for the firing site and surrounding areas where deposition may have taken place and for the landfill will determine whether contaminants of concern are present and whether a Phase II investigation is necessary. Results from the analysis of samples will produce data for decisions on remediation alternatives. If no samples are found to contain contaminants of concern, deferral of further investigation until decommissioning (for all firing sites) or no further action (for the landfill) will be recommended. If contaminants of concern are found, a Phase II investigation will be recommended.

For the firing pad, debris berm, north canyon wall below the debris berm, and canyon alluvium, intact soil cores will be collected. Surface samples will be collected on the south canyon wall. The number of samples for each area and depth will be sufficient to detect contaminants above SALs with at least an 80% certainty if the contaminants cover 20% or more of the area being sampled. Sampling will take place where contaminants are judged most likely to be present. Sampling locations on the north canyon wall, canyon alluvium, and stream channel will include areas where potentially contaminated eroded materials may have accumulated.

Soil cores will be collected from within the apparent boundary of the landfill (40-009) and below the landfill in areas representing accumulation of eroded debris.

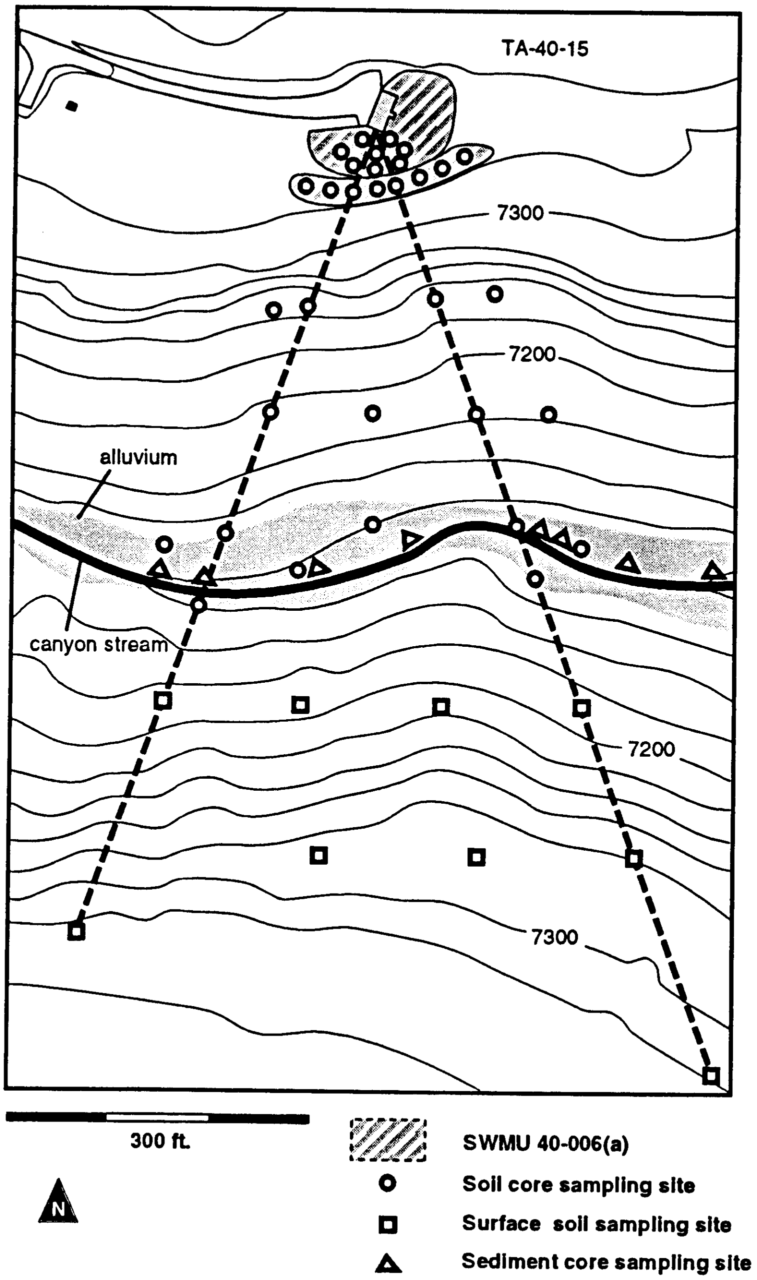


Figure 5-31. Sampling locations for 40-006(a). Locations are approximate.

The number of samples will be sufficient to detect contaminants above SALs with at least an 80% certainty if the contaminants cover half or more of the area being sampled. Sampling will take place where contaminants are judged most likely to be present.

5.7.3.1.2 Environmental Setting

No data are needed for Phase I decisions. If contaminants of concern are found to be present in soil, tuff, or sediments, Phase II may require data to characterize environmental migration pathways.

5.7.3.1.3 Potential Receptors

No data are needed for Phase I decisions.

5.7.3.2 Data Needs for Evaluating Other Impacts

No other impacts are expected. No other data are needed to make a Phase I decision.

5.7.4 Sampling and Analysis Plans

Specifications are given here for minimum numbers of samples to be collected. The minimum numbers of samples to be collected are listed in Table 5-18. Justification for these numbers is discussed below. Figure 5-31 shows the approximate location of proposed sampling locations. If additional locations for sampling are identified in the field survey or during sampling, additional samples will be collected from those locations. Indicators of additional locations for sampling include all findings that may indicate the presence of contaminants, including pieces of shrapnel, the results of field screening tests, discoloration, the presence of deposits, and geomorphic structures that may trap contaminants.

Engineering drawings and a preliminary field survey will be used to determine the shape and location of the firing pad and debris berm and other deposits associated with the firing site and the shape and location of Landfill 40-009. Locations for sampling, including flow channels and sediment accumulations, will be identified and mapped. The site operator's recommendations will be used to estimate the most probable direction of debris throw for the site; that direction and the sampling area derived from it will be included on the map.

All samples will be submitted to the analytical laboratory for metals and explosives analysis.

Shrapnel and Radiological Survey. Two transects, each 6 ft wide and extending from the firing bunker across the canyon, will be surveyed for shrapnel with a metal detector, for depleted uranium with a radiation counter, and for metals with an x-ray fluorescence detector. Spots producing positive metal detector response will be marked in the field and mapped. If shrapnel is noted outside the 6-ft width, it may also be marked and mapped. A hand-held radiation counter will be used to survey the metal and areas around the metal. A field portable x-ray fluorescence detector will be used to detect concentrations of metal elements at one-third of the locations at which radiation measurements are made. If fragments of explosives are found during this survey, they will be flagged and their positions mapped. Explosives fragments will be removed by explosives safety personnel as a VCA.

Soil Sampling. Eight intact soil cores will be taken to the soil-tuff interface in each of four areas: the firing pad area, the berm on the canyon edge, the north canyon wall between the berm and the alluvium, and the alluvium area on both sides of the stream channel. Eight surface soil samples will be collected from the south wall of the canyon. Four intact soil cores will be collected from within Landfill 40-009 and two from the drainages below it on the canyon wall. Approximate locations for sampling are shown in Figures 5-31 and 5-32.

TABLE 5-18

ANALYTICAL SAMPLES FOR AGGREGATE 7

		Field Surveys			Samples			Field Screening			Field Lab. Measr.		Laboratory Analysis													
SWMU or AOC	SWMU Type	Land Survey	Gross Gamma	Geophysics	Sampled Media	Samples	Duplicate	Gross Gamma	High Explosives (M-1 Kit)	Lithological Logging	Gamma Spectrometry	Volatile Organics (SW 8240)	Gamma Spectrometry	Isotopic Uranium	Strontium-90	Cesium-137	Metals (SW 6010)	Volatile Organics (SW 8240)	Semivolatile Organics (SW 8270)	High Explosives (LANL Method)	PCB (SW 8080)	Sulfates/Chromates/Copper Salts	Nitrates and Nitrites	Fluoride	Cyanide	Phosphate
40-006(a)	Active Firing Pad	X	X	X	Soil	24	2	X	X				X	X			X		X	X						
	Berm	X	X	X	Soil	24	2	X	X				X	X			X		X	X						
	North Canyon Wall	X	X	X	Soil	24	2	X	X				X	X			X		X	X						
	Canyon Bottom Floodplain	X	X	X	Soil	24	2	X	X				X	X			X		X	X						
	Stream Channel Sediment	X	X	X	Sediment	8	1	X	X				X	X			X		X	X						
	South Canyon Wall	X	X	X	Soil	8	1	X	X				X	X			X			X						
40-009	Landfill	X	X	X	Soil	18	1	X	X				X	X			X		X	X						

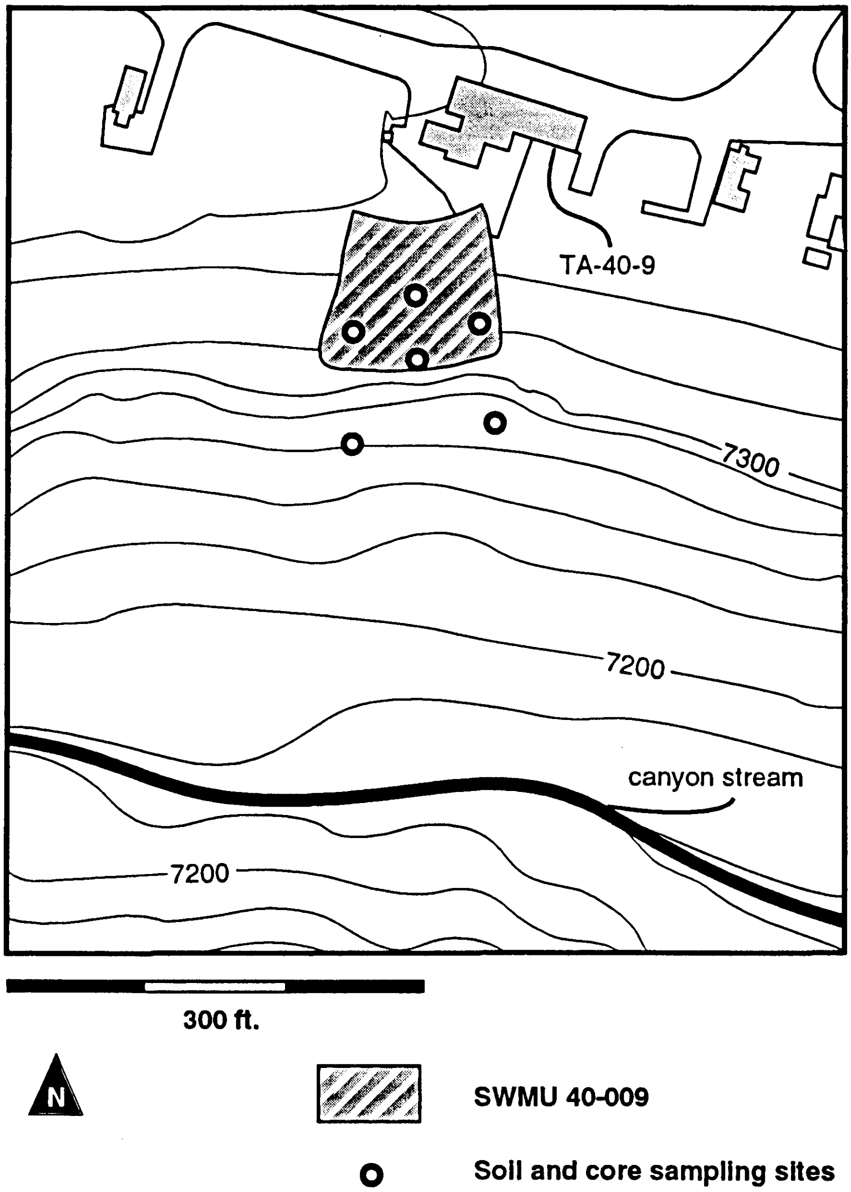


Figure 5-32. Sampling locations for 40-009. Locations are approximate.

Cores from the firing pad will be evenly spaced to cover the area judged most likely to contain contaminants. Cores from the berm will be evenly spaced along the full length of the berm. Most of the cores from the north canyon wall will be widely spaced between the transects, but two may be located outside the transects within 50 ft. Cores in the canyon alluvium will be widely spaced on both sides of the stream channel between the transects.

Three samples will be removed from each core at the surface, at the soil-tuff interface, and at a feature intermediate in the core judged most likely to contain contaminants. Such judgement might be based on discoloration or the presence of fractures or lenses of material. If no such feature is evident, a sample will be taken at a depth of 2 ft or at the middle depth of a core that is less than 3 ft long.

Locations for surface samples on the south canyon wall will be evenly spaced between the two transects.

Stream Channel Sampling. Evenly spaced cores will be collected in the stream channel to the depth of the sediment-tuff interface. The majority of the cores will be located between the two transects, but two samples may be located outside the transects within 50 ft. Each core will be collected as one sample, including any entrained fluid present at the time of sampling, and will be considered a single sample for analysis. The samples will be dried and homogenized before analysis.

Procedures will be designed to provide adequate safety for working on the canyon wall and in the presence of fragments of explosives.

5.8 Aggregate 8, Former Structure Sites

The following PRSs are included in this aggregate.

- 6-002
- C-6-001
- C-6-003
- C-6-005
- C-6-006
- C-6-007
- C-6-008
- C-6-009
- C-6-010
- C-6-011
- C-6-012
- C-6-013
- C-6-014
- C-6-015
- C-6-016
- C-6-017
- C-6-018
- C-6-021

5.8.1. Background

5.8.1.1 Description and History

The PRSs in this aggregate are TA-6 sites from which structures were removed or destroyed. Table 5-19 summarizes their histories and Figure 5-33 shows their locations.

5.8.1.2 Conceptual Exposure Model

5.8.1.2.1 Nature and Extent of Contamination

Based on archival evidence, possible contaminants in these PRSs are primarily explosives. SWMU 6-002 may contain acetone and carbon tetrachloride. The

TABLE 5-19

HISTORIES OF PRSs IN AGGREGATE 8

PRS Number	Structure Number	Type of Structure	Operations	Date Removed	Possible Contaminants	Comments
6-002	TA-6-41	Septic tank	PETN recrystallization; rest house, 1940s[a]	1965[b]	PETN, solvents	Drain lines remain in place[b]
C-6-001	TA-6-4	Magazine	Explosives storage, 1940s[a]	1972[c]	Explosives	Removed[d]
C-6-003	TA-6-11	Building	Control building for explosives shots, detonator loading, 1940s[a]	8/8/1955[d]	Explosives	Removed to MDA C[d]
C-6-005	TA-6-13	Building	Detonator assembly, chemistry laboratory, storage, 1940s[a]	1/16/1960[d]	Explosives, solvents	Contained a sink with a drain to daylight,[e] removed by burning[d]
C-6-006	TA-6-14	Building	Explosives pressing, storage, 1940s[a]	1/16/1960[d]	Explosives	Removed by burning[d]
C-6-007	TA-6-15	Boiler house	Steam generation, 1940s[a]	1/16/1960[d]	Explosives	Removed by burning[d]
C-6-008	TA-6-16	Magazine	Explosives processing, 1940s[a]	1/16/1960[d]	PETN	Removed by burning[d]
C-6-009	TA-6-17	Magazine	Shake testing of explosives, 1940s[a]	1/16/1960[d]	Explosives	Removed by burning[d]
C-6-010	TA-6-21	Magazine	Explosives storage, 1940s[a]	1/16/1960[d]	Explosives	Removed by burning[d]
C-6-011	TA-6-22	Magazine	Explosives processing, 1940s[a]	1/16/1960[d]	Explosives	Removed by burning[d]
C-6-012	TA-6-23	Magazine	Detonator storage, 1940s[a]	1/16/1960[d]	Explosives	Removed by burning[d]
C-6-013	TA-6-24	Magazine	Explosives storage, 1940s[a]	1/16/1960[d]	PETN	Removed by burning[d]
C-6-014	TA-6-25	Magazine	Explosives storage, 1940s[a]	1/16/1960[d]	Explosives	Removed by burning[d]
C-6-015	TA-6-27	Magazine	Explosives storage, 1940s[a]	1/16/1960[d]	Tetryl	Removed by burning[d]
C-6-016	TA-6-28	Magazine	Detonator storage, 1940s[a]	1/16/1960[d]	Explosives	Destroyed[d]
C-6-017	TA-6-29	Magazine	Detonator storage, 1940s[a]	1/16/1960[d]	Explosives	Removed by burning[d]
C-6-018	TA-6-30	Magazine	Explosives storage, 1940s[a]	1/16/1960[d]	PETN	Removed by burning[d]
C-6-021	TA-6-26	Magazine	Explosives storage, 1940s[a]	1/16/1960[d]	Explosives	Removed by burning[d]

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[a] (LASL 1945, 19-0005)
[b] (Courtright 1965, 19-0009)
[c] (Parker 1971, 19-0104)
[d] (LANL 1944— , 19-0115)
[e] (LASL 1947, 19-0014)

maximum estimated amount of PETN that may be present in SWMU 6-002 and the drain line leading to it from former Building TA-6-10 is 0.03 lb. (Table 4-5). The PRSs have not been sampled, and thus, the extent of contamination is unknown.

Destruction of the magazines and other buildings with protective soil berms appears to have involved redistribution of the soil berms. Building foundations and debris from burning may have been covered by this soil.

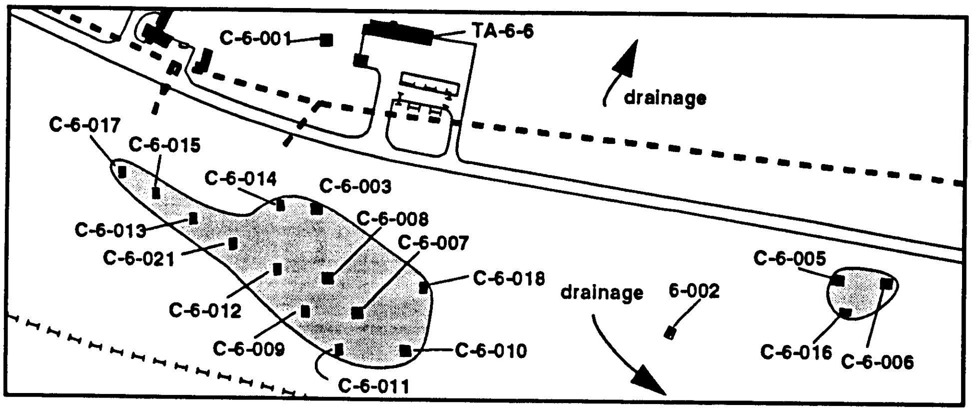

Figure 5-33. Locations of PRSs in Aggregate 8.

5.8.1.2.2 Potential Pathways and Exposure Routes

The structures on these sites may have been contaminated. These possible primary sources of contamination have been removed, with the exception of the drain lines connecting Buildings TA-6-10 and TA-6-19 to Septic Tank 6-002. If hazardous materials were released from the primary sources, secondary sources of contamination could include soils, tuff, air, surface water, sediments, or plants. Contaminants may have been redistributed by water and sediment transport.

The direction of drainage is indicated on Figure 5-33. The systems drain into Tributaries A and B of Two-Mile Canyon. Transport mechanisms include overland flow and associated sediment transport, infiltration, percolation, wind erosion, and uptake by plants. Receptors include plants, animals, and humans. Exposure routes to receptors include direct skin contact with contaminated soils or sediments, ingestion, and inhalation when a contaminated area is disturbed. Herbivores living on site may be exposed by eating plants that grow in contaminated soils.

5.8.2 Remediation Decisions and Investigation Objectives

Historical information suggests that no contaminants of concern are present and that no further action will be necessary. If risks are above acceptable levels and remediation is required, alternatives include removal, *in situ* treatment, and capping of contaminated soil or other media.

The objective of the Phase I investigation of the PRSs in this aggregate is to determine whether the soil in the sites of former structures contains contaminants of concern.

RFI Phase I data will be collected to answer this question.

- Are contaminants of concern present in the soil of the sites of former structures? This information will be used to make decisions on whether a Phase II investigation is necessary.

Decisions on the drain line from the rest house, TA-6-19, will be based on the results of sampling the drain line from the PETN processing building, TA-6-10.

5.8.3 Data Needs and Data Quality Objectives

5.8.3.1 Data Needs for Evaluating Health and Safety Risks

5.8.3.1.1 Source Characterization

Each PRS in this aggregate will be field mapped. Former structure locations and manmade features such as foundations will be included on the map.

Reconnaissance sampling (Appendix H, IWP) (LANL 1992, 0768) at each PRS will determine whether contaminants of concern are present and whether a Phase II investigation is necessary. Results from the analysis of samples will produce data for decisions on remediation alternatives. If no samples are found to contain contaminants of concern, no further action will be recommended. If contaminants of concern are found, a Phase II investigation will be recommended.

Soil samples will be collected at two depths at each former structure site. The number of samples will be sufficient to detect contaminants above SALs with at least an 80% certainty if the contaminants cover half or more of the area being sampled. Sampling will take place where contaminants are judged most likely to be present.

The drain line from TA-6-10 will be located and its internal contents screened for the presence of PETN. If no PETN is found in the screening, no further action will be recommended for this drain line and the drain line from TA-6-19. If PETN is found, a Phase II investigation will be recommended for both drain lines.

5.8.3.1.2 Environmental Setting

No data are needed for Phase I decisions. If contaminants of concern are found to be present in soil, tuff, or sediments, Phase II may require data to characterize environmental migration pathways.

5.8.3.1.3 Potential Receptors

No data are needed for Phase I decisions.

5.8.3.2 Data Needs for Evaluating Other Impacts

No other impacts are expected. No other data are needed to make a Phase I decision.

5.8.4 Sampling and Analysis Plans

Specifications are given here for minimum numbers of samples to be collected. These are listed in Table 5-20. Justification for these numbers is discussed in Section 5.8.3.1.1 and details are given below. If additional locations for sampling are identified in the field survey or during sampling, additional samples will be collected from these locations. Indicators of additional locations for sampling include all findings that may indicate the presence of contaminants, including the results of field screening tests, discoloration, the presence of deposits, areas of disturbed soil, and vegetation patterns.

Aerial photographs, engineering drawings, and field surveys will be used to determine the probable former locations of the septic tank and the buildings. The location of the drain pipe from the sink in TA-6-13 (C-6-005) will be determined from engineering drawings. The drain line connecting Building TA-6-10 will be located at the existing foundation of TA-6-10. All locations that have not been mapped will be mapped.

The sampling area for all former building sites will include the building site and an area extending 5 ft from the outer boundaries of the building. All samples will be submitted to the analytical laboratory for explosives and metals analysis.

Former Building Sites. Soil cores will be collected at each site at three widely spaced locations to a 3-ft depth or the depth of the soil-tuff interface, whichever is shallower. Samples will be taken from the surface and the bottom of each core. One sampling location at C-6-005 will be at the location of the sink outflow pipe.

Decommissioned Septic System (6-002). Soil cores will be collected at three evenly spaced locations at the site where the septic tank was located. Samples will be taken from each core at the surface and at a depth of 3 ft or the soil-tuff interface, whichever is shallower. In addition to explosives and metals analysis, the subsurface samples will be analyzed for acetone and carbon tetrachloride. A metal snake will be inserted into the drain pipe at TA-6-10 and a metal detector will be used to locate the drain pipe for at least 50 ft. When the snake is withdrawn, it will be tested for the presence of PETN with the M-1 explosives field test kit (Baytos 1991, 0741).

5.9 Aggregate 9, Former Container Storage Areas

The following SWMUs are included in this aggregate.

- 6-006
- 40-004

5.9.1. Background

5.9.1.1 Description and History

SWMU 6-006 includes a concrete pad and asphalt parking lot near TA-6-6 (Figure 5-34) where containers and electrical equipment were stored during the 1980s (LANL 1990, 0145). The containers and equipment are no longer present,

TABLE 5-20

ANALYTICAL SAMPLES FOR AGGREGATE 8

SWMU or AOC	SWMU Type	Field Surveys: Land Survey	Field Surveys: Gross Gamma	Field Surveys: Geophysics	Samples: Sampled Media	Samples: Samples	Samples: Duplicate	Field Screening: Gross Gamma	Field Screening: High Explosives (M-1 Kit)	Field Screening: Lithological Logging	Field Lab. Measr.: Gamma Spectrometry	Field Lab. Measr.: Volatile Organics (SW 8240)	Laboratory Analysis: Gamma Spectrometry	Laboratory Analysis: Isotopic Uranium	Laboratory Analysis: Strontium-90	Laboratory Analysis: Cesium-137	Laboratory Analysis: Metals (SW 6010)	Laboratory Analysis: Volatile Organics (SW 8240)	Laboratory Analysis: Semivolatile Organics (SW 8270)	Laboratory Analysis: High Explosives (LANL Method)	Laboratory Analysis: PCB (SW 8080)	Laboratory Analysis: Sulfates/Chromates/Copper Salts	Laboratory Analysis: Nitrates and Nitrites	Laboratory Analysis: Fluoride	Laboratory Analysis: Cyanide	Laboratory Analysis: Phosphate
6-002	Decommissioned Septic System	X			Soil	6	1	X	X								X			X						
C-6-001	Former Building Site	X			Soil	6		X	X								X			X						
C-6-003	Former Building Site	X			Soil	6		X	X								X			X						
C-6-005	Former Building Site	X			Soil	6	1	X	X																	
C-6-006	Former Building Site	X			Soil	6		X	X								X			X						
C-6-007	Former Building Site	X			Soil	6		X	X								X			X						
C-6-008	Former Building Site	X			Soil	6	1	X	X								X			X						
C-6-009	Former Building Site	X			Soil	6		X	X								X			X						
C-6-010	Former Building Site	X			Soil	6		X	X								X			X						
C-6-011	Former Building Site	X			Soil	6	1	X	X								X			X						
C-6-012	Former Building Site	X			Soil	6		X	X								X			X						
C-6-013	Former Building Site	X			Soil	6		X	X								X			X						
C-6-014	Former Building Site	X			Soil	6		X	X								X			X						
C-6-015	Former Building Site	X			Soil	6	1	X	X								X			X						
C-6-016	Former Building Site	X			Soil	6		X	X								X			X						
C-6-017	Former Building Site	X			Soil	6		X	X								X			X						
C-6-018	Former Building Site	X			Soil	6	1	X	X								X			X						
C-6-020	Former Building Site	X			Soil	6		X	X								X			X						
C-6-021	Former Building Site	X			Soil	6		X	X								X			X						

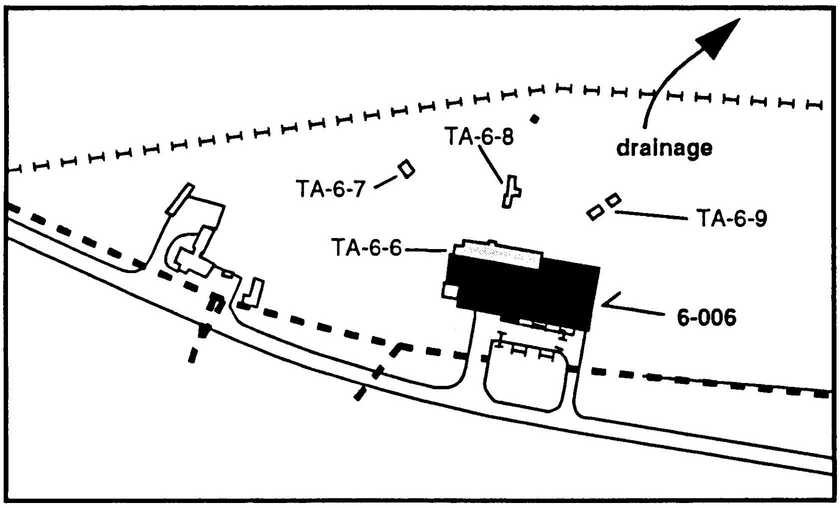

Figure 5-34. Location of 6-006.

but stains can be seen on the asphalt and nearby soil. The contents of the containers are unknown.

SWMU 40-004 is an area where containers of chloroethane and pump oil were stored (LANL 1990, 0145). Building TA-40-9 now covers this area (Figure 5-35).

5.9.1.2 Conceptual Exposure Model

5.9.1.2.1 Nature and Extent of Contamination

Volatile and semivolatile organics may be present. Because electrical equipment was stored at 6-006, PCBs may be present. There are no records of sampling of the SWMUs in this aggregate; therefore, whether contaminants are present in them is unknown.

5.9.1.2.2 Potential Pathways and Exposure Routes

Containers and equipment stored in these areas may have held hazardous materials. These possible primary sources of contamination have been removed. Contaminants that may have been released from containers could be in or near the storage areas. If hazardous materials were released, secondary sources of contamination could include soils, tuff, air, surface water, sediments, or plants. Because both areas were paved at the time of container storage, contaminants may have washed into drainage channels adjacent to the paved

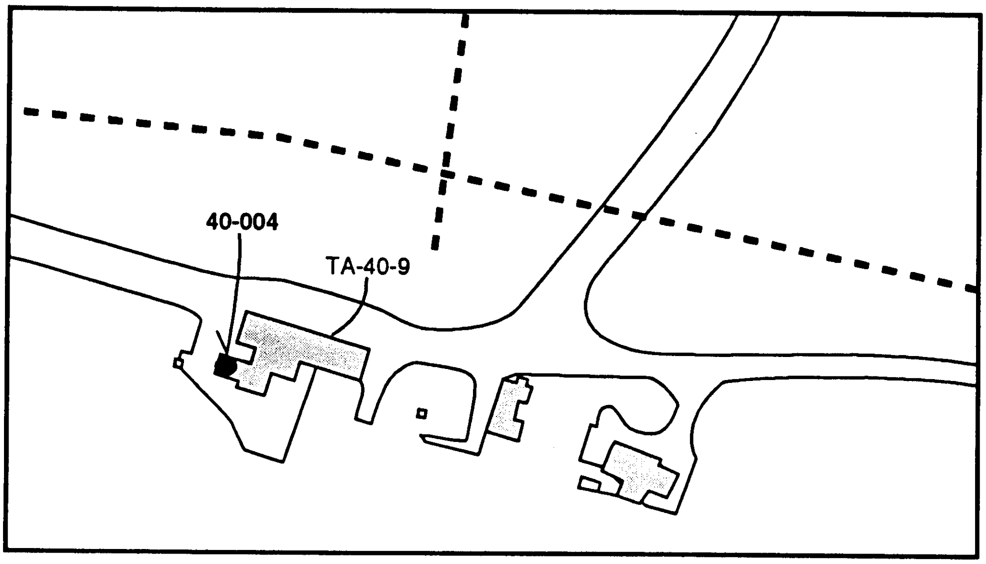

Figure 5-35. Location map of 40-004.

areas. Contaminants may have been redistributed by water and sediment transport. Contaminants may have been removed during the excavation for the expansion of TA-40-9. In any case, the former container storage site now lies under the building.

SWMU 6-006 drains into Tributary A of Two-Mile Canyon, and 40-004 drains into Pajarito Canyon. Transport mechanisms include overland flow and associated sediment transport, infiltration, percolation, wind erosion, and uptake by plants. Receptors include plants, animals, and humans. Exposure routes to receptors include direct skin contact with contaminated soils or sediments, ingestion, and inhalation when a contaminated area is disturbed. Herbivores living on site may be exposed by eating plants that grow in contaminated soils.

5.9.2 Remediation Decisions and Investigation Objectives

Possible remediation alternatives include no further action and removal, *in situ* treatment, and capping of contaminated soil or other media. If no contaminants of concern are found, no further action will be recommended. If remediation is required, alternatives include removal, *in situ* remediation, or capping the contaminated soil and monitoring the stabilized area.

The objective of the Phase I investigation of the PRSs in this aggregate is to determine whether the asphalt and soil in the former storage areas or nearby drainage channels contain contaminants of concern.

RFI Phase I data will be collected to answer these questions.

- Are contaminants of concern present in the asphalt and soil in 6-006? This information will be used to make decisions on whether a Phase II investigation is necessary.
- Are contaminants of concern present in the media in drainage channels leading from the storage sites? This information will be used to make decisions on whether a Phase II investigation is necessary.

5.9.3 Data Needs and Data Quality Objectives

5.9.3.1 Data Needs for Evaluating Health and Safety Risks

5.9.3.1.1 Source Characterization

SWMU 6-006 will be field mapped. Drainage channels leading from 6-006 will be included on the map. Drainage channels adjacent to the location of 40-004 will be field mapped.

Reconnaissance sampling (Appendix H, IWP) (LANL 1992, 0768) at 6-006 and the drainage channels at both SWMUs will determine whether contaminants of concern are present and whether a Phase II investigation is necessary. Results from the analysis of samples will produce data for decisions on remediation alternatives. If no samples are found to contain contaminants of concern, no further action will be recommended. If contaminants of concern are found, a Phase II investigation will be recommended.

Surface asphalt samples will be collected at 6-006, and soil and sediment samples will be collected in drainage channels at both SWMUs in this aggregate. The number of samples will be sufficient to detect contaminants above SALs with at least an 80% certainty if the contaminants cover half or more of the area being sampled. Sampling will take place where contaminants are judged most likely to be present.

5.9.3.1.2 Environmental Setting

No data are needed for Phase I decisions. If contaminants of concern are found to be present in soil, tuff, or sediments, Phase II may require data to characterize environmental migration pathways.

5.9.3.1.3 Potential Receptors

No data are needed for Phase I decisions.

5.9.3.2 Data Needs for Evaluating Other Impacts

No other impacts are expected. No other data are needed to make a Phase I decision.

5.9.4 Sampling and Analysis Plans

Specifications are given here for minimum numbers of samples to be collected. These are listed in Table 5-21. Justification for these numbers is discussed in Section 5.9.3.1.1, and details are given below. If additional locations for sampling are identified in the field survey or during sampling, additional samples will be collected from these locations. Indicators of additional locations for sampling include all findings that may indicate the presence of contaminants, including the results of field screening tests, discoloration, the presence of deposits, and geomorphic structures that may trap contaminants.

Engineering drawings and field surveys will be used to determine the locations of the SWMUs and drainage channels from them. All locations that have not been mapped will be mapped. Sampling locations will also be identified and mapped.

All soil samples will be analyzed in the analytical laboratory for semivolatile organics. Subsurface samples will be analyzed for volatile organics. All samples from 6-006 will be analyzed for PCBs.

SWMU 6-006. Three widely spaced samples will be removed from the asphalt and the soil just under the asphalt.

Drainage Channels. Soil samples will be collected at three locations at the surface and at a 12-in. depth. The locations will be in sediment accumulations identified in the field survey, or along the drainage channel if no sediment accumulations are available Locations will be no more than 100 ft from the former container storage areas.

5.10 Aggregate 10, Storage Areas

The following SWMUs are included in this aggregate.

- 40-007(a) (TA-40-3)
- 40-007(b) (TA-40-6)
- 40-007(c) (TA-40-11)
- 40-007(d) (TA-40-14)
- 40-007(e) (TA-40-41)

5.10.1. Background

5.10.1.1 Description and History

The SWMU Report describes these buildings (Figures 5-36, 5-37) as having been used between 1950 and 1980 for storage of waste contaminated by explosives (LANL 1990, 0145). The buildings are now used for preparation of explosives tests at the TA-40 firing sites (Section 5.7). Each building contains a satellite waste storage area, which is regulated under RCRA generator requirements.

TABLE 5-21

ANALYTICAL SAMPLES FOR AGGREGATE 9

		Field Surveys			Samples			Field Screening			Field Lab. Measr.		Laboratory Analysis													
SWMU or AOC	SWMU Type	Land Survey	Gross Gamma	Geophysics	Sampled Media	Samples	Duplicate	Gross Gamma	High Explosives (M-1 Kit)	Lithological Logging	Gamma Spectrometry	Volatile Organics (SW 8240)	Gamma Spectrometry	Isotopic Uranium	Strontium-90	Cesium-137	Metals (SW 6010)	Volatile Organics (SW 8240)	Semivolatile Organics (SW 8270)	High Explosives (LANL Method)	PCB (SW 8080)	Sulfates/Chromates/Copper Salts	Nitrates and Nitrites	Fluoride	Cyanide	Phosphate
6-006	Former Container Storage	X			Asphalt	3	1	X	X												X					
					Soil	3		X	X												X					
					Sediments	6		X	X									X	X		X					
40-004	Former Container Storage	X			Sediments	6		X	X									X	X							

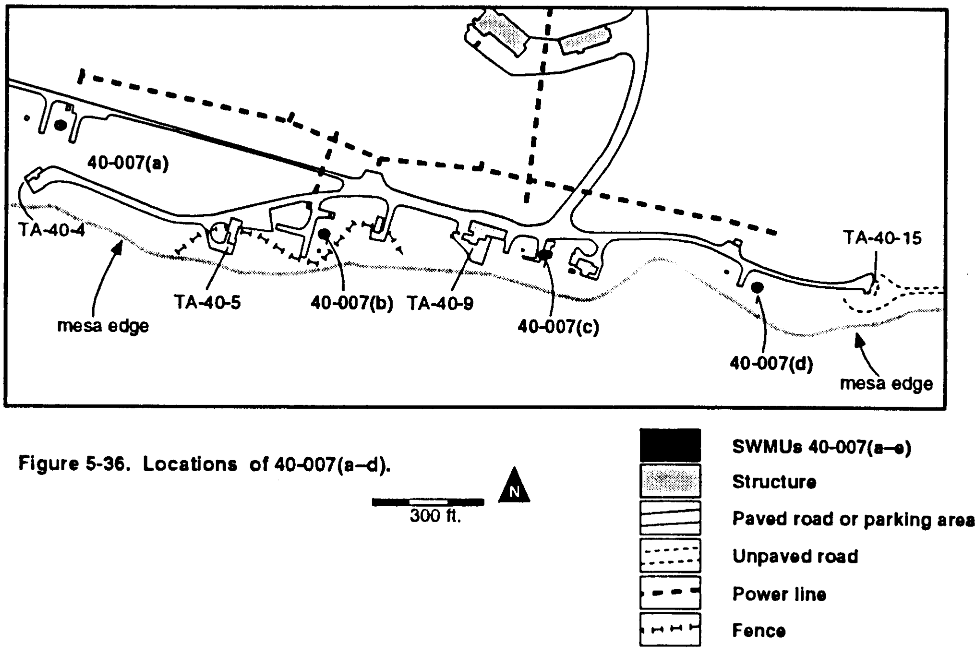

Figure 5-36. Locations of 40-007(a–d).

5.10.1.2 Conceptual Exposure Model

5.10.1.2.1 Nature and Extent of Contamination

Based on archival evidence, the possible contaminants in these SWMUs are explosives. The extent of any contamination is unknown. Customary housekeeping practices for explosives storage since TA-40 was built have been characterized by minimization of residues and accountability of material (Section 2.3). Releases to the environment are unlikely.

5.10.1.2.2 Potential Pathways and Exposure Routes

Drainage from these buildings is into Pajarito Canyon. Containment of explosives within the buildings appears to be the most likely scenario. Exposure to contaminants that may be present is limited to workers in these buildings.

5.10.2 Remediation Decisions and Investigation Objectives

Remediation alternatives for SWMUs in this aggregate include deferral of action until decommissioning, cleaning of the building, and soil removal or capping. Historical information suggests that no contamination is present and deferral of action until decommissioning is the preferable alternative. Possible contaminants resulting from the current use of these areas are the same as those resulting from the use of these areas during the 1950s to the 1980s. Therefore, information on possible contamination of these storage areas will not be collected as part of this RFI. We recommend that all characterization will be deferred until the storage areas are decommissioned.

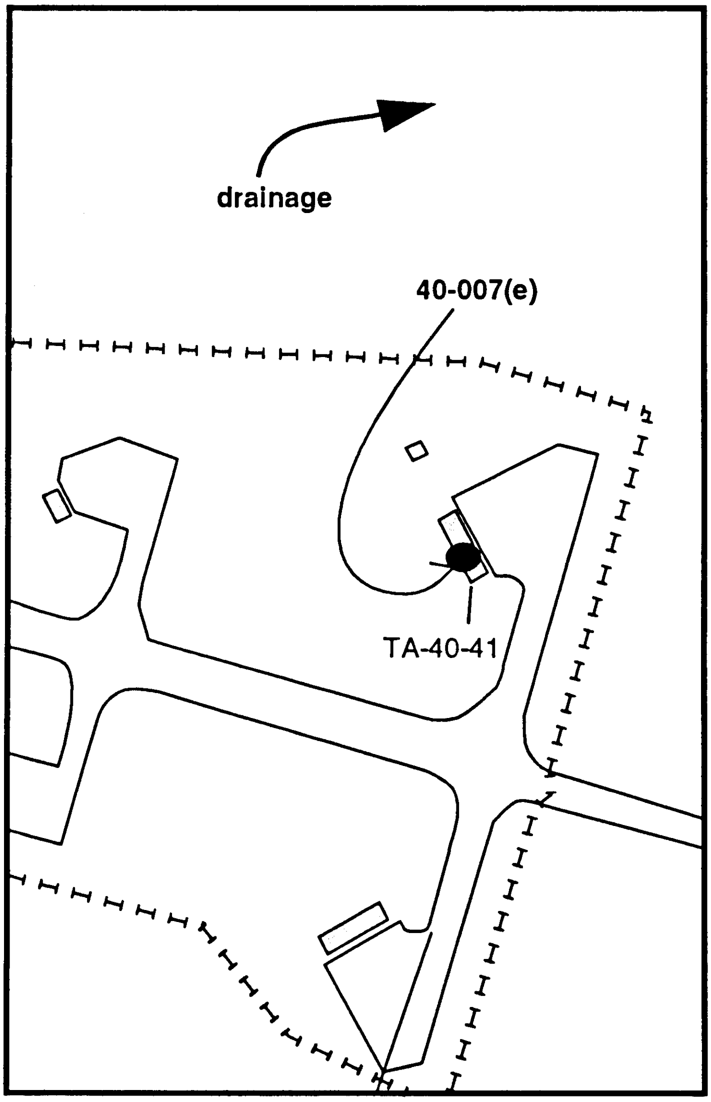

Figure 5-37. Location of 40-007(e).

200 ft.

N

■ **Structure**

▨ **Permanent structure**

▤ **Paved road or parking area**

⊢⊣ **Fence**

5.10.3 Data Needs and Data Quality Objectives

5.10.3.1 Data Needs for Evaluating Health and Safety Risks

5.10.3.1.1 Source Characterization

No data will be collected during this RFI.

5.10.3.1.2 Environmental Setting

No data are needed.

5.10.3.1.3 Potential Receptors

No data are needed.

5.10.3.2 Data Needs for Evaluating Other Impacts

No data are needed.

5.10.4 Sampling and Analysis Plans

No sampling and analysis will be done for the storage areas, as indicated in Section 5.10.2.

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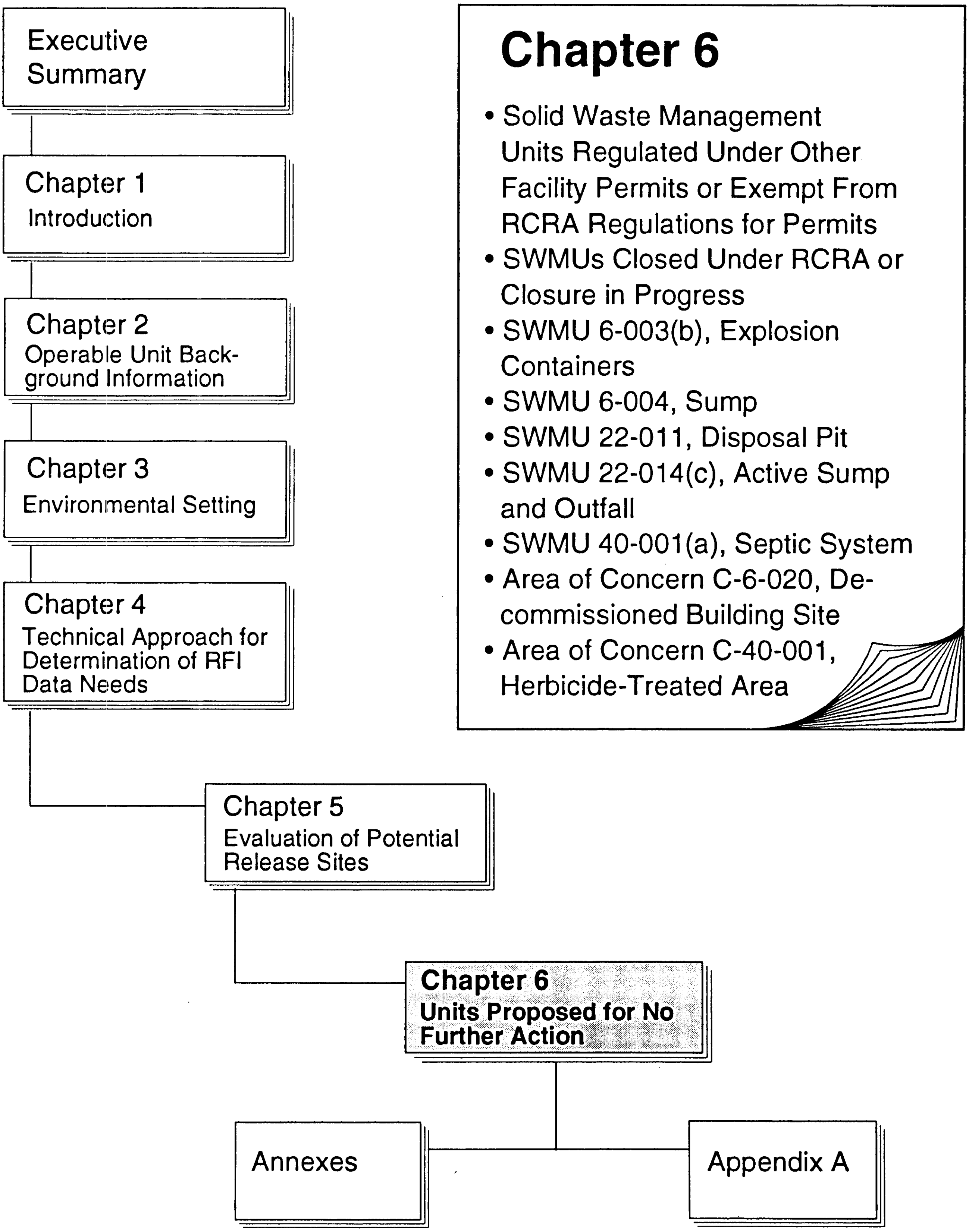

Chapter 6

- Solid Waste Management Units Regulated Under Other Facility Permits or Exempt From RCRA Regulations for Permits
- SWMUs Closed Under RCRA or Closure in Progress
- SWMU 6-003(b), Explosion Containers
- SWMU 6-004, Sump
- SWMU 22-011, Disposal Pit
- SWMU 22-014(c), Active Sump and Outfall
- SWMU 40-001(a), Septic System
- Area of Concern C-6-020, Decommissioned Building Site
- Area of Concern C-40-001, Herbicide-Treated Area

6.0 UNITS PROPOSED FOR NO FURTHER ACTION

The following criteria are used in this investigation for recommending no further action. Potential release sites (PRSs) meeting any of these criteria are recommended for no further action.

1. The PRS was misidentified, and sampling will proceed under the correct PRS.
2. The PRS was never constructed, installed, or used.
3. The PRS was never the location of solid or radioactive waste generation, treatment, storage, or disposal.
4. No release has been observed or documented at the PRS, and the design, construction, and/or institutional controls of the PRS are such that a release to the environment and transport to off-site receptors is highly unlikely.
5. The PRS is operating and has always operated under other regulations, such as the Resource Conservation and Recovery Act (RCRA) generator requirements or the National Pollutant Discharge Elimination System (NPDES), or is a treatment unit exempt from RCRA requirements for permits.
6. The PRS has undergone or is scheduled to undergo remediation.
7. Existing data indicate that contaminants at the PRS are not present in concentrations that exceed screening action levels and present no risk to persons on site or off site.

PRSs recommended for no further action are summarized in Table 6-1. Locations of PRSs are shown in Figure 1-3. Detailed discussions follow.

6.1 Solid Waste Management Units Regulated Under Other Facility Permits or Exempt From RCRA Regulation for Permits

22-003(a-g)
22-013
40-002(a-c)

6.1.1 Description and History

Solid waste management units (SWMUs) 22-003(a-g) and 40-002(a-c) are satellite solid waste storage areas. They are posted as such and are regulated by RCRA generator requirements. The locations of the areas are moved short distances as necessary for proper management of building space. Therefore, present locations are not necessarily those given in the SWMU Report (LANL 1990, 0145).

Two 1000-gal. tanks (22-013) in Building TA-22-91 receive liquid wastes from etching operations. The liquid wastes are neutralized in these tanks to produce a

TABLE 6-1

PRSs RECOMMENDED FOR NO FURTHER ACTION

Current PRS Number	HSWA Module SWMU Number	Type of PRS	Building Structure Number	Criterion for No Further Action[a]
6-003(b)		Explosion containers		7
6-004		Sump		1
22-001		Explosives waste storage area	TA-22-24	6
22-003(a)	22-002(a)	Satellite waste storage area	TA-22-05	5
22-003(b)		Satellite waste storage area	TA-22-96	5
22-003(c)		Satellite waste storage area	TA-22-34	5
22-003(d)		Satellite waste storage area	TA-22-91	5
22-003(e)		Satellite waste storage area	TA-22-95	5
22-003(f)		Satellite waste storage area	TA-22-93	5
22-003(g)		Satellite waste storage area	TA-22-52	5
22-011	22-011	Disposal pit		1
22-013		Liquid waste treatment/storage	TA-22-91	5
22-014(c)		Active sump and outfall		1
40-001(a)	40-001(a)	Septic system	TA-40-22[b]	3
40-002(a)		Container storage area	TA-40-23	5
40-002(b)		Container storage area		5
40-002(c)		Container storage area	TA-40-05	5
40-003(a, b)	40-003(a, b)	Burning area/open detonation		6
40-008		Decommissioned explosives storage	TA-40-02	6
C-6-020		Decommissioned building site	TA-6-49	3
C-40-001		Herbicide area	TA-40-02	3

[a] Criteria for no further action are listed in Section 6.0.

[b] Structure number of the septic system.

liquid and a sludge. The sludge is picked up and disposed of by the Laboratory's Waste Management Group (EM-7). The treated liquid is discharged through NPDES Outfall 128 (LANL 1990, 0145)

6.1.2 Rationale for Recommendation of No Further Action

SWMUs 22-003(a-g) and 40-002(a-c) are regulated by RCRA generator requirements. No past or current releases have been recorded at these units. The neutralization tanks (22-013) are exempt from RCRA requirements for permits.

6.2 SWMUs Closed Under RCRA or Closure in Progress

22-001
40-003(a and b)
40-008

6.2.1 Description and History

SWMU 22-001, a concrete and soil magazine, was used from the 1950s until 1982 for the storage of solid waste contaminated by explosives (LANL 1990, 0145). The unit was closed under an approved RCRA closure plan in 1988 (LANL 1990, 0145).

SWMUs 40-003(a and b) are adjacent areas that were used for disposal of scrap explosives and detonators from the late 1950s through 1985; they are located about 450 ft east of Firing Chamber TA-40-15 (LANL 1990, 0145). Explosives and their residues, lead, barium, nitrate, cyanide, and organic compounds may be present. These areas are being closed under an approved RCRA closure plan (LANL 1991, 19-0116), as described in the installation work plan (IWP) in Section 3.6.1 (LANL 1992, 0768). Characterization of these SWMUs is now in progress. An amendment to the closure plan was submitted to the New Mexico Environmental Department in May 1993. The Department of Energy and the University of California will complete closure activities according to the approach laid out in the closure plan (IWP, Section 3.6.1) (LANL 1992, 0768).

SWMU 40-008, a magazine, was used for a short time during the 1980s to store scrap waste contaminated by explosives (LANL 1990, 0145). This storage area has been closed under an approved RCRA closure plan (LANL 1990, 0145).

6.2.2 Rationale for Recommendation of No Further Action

SWMUs 22-001 and 40-008 have been closed under approved RCRA closure plans. SWMUs 40-003(a and b) are being closed under an approved RCRA closure plan. Because the closure plans specify that these SWMUs will be cleaned to acceptable risk-based criteria, no further action beyond that specified in or carried out under the closure plan is recommended.

6.3 SWMU 6-003(b), Explosion Containers

6.3.1 Description and History

The recovery effort during the Manhattan Project (Section 2.2) was directed toward finding a means of recovering the fissionable material from the Trinity test in case the conventional explosives detonated but the fissionable material did not (Hoddeson et al., in preparation, 0851; Goldberg 1991, 0852). As part of the effort, scale-model steel explosion containers were tested during 1944 and 1945. The objective was to test the strength of different container designs. Explosives were used in these tests (Schaffer 1945, 19-0027), but no fissionable materials were used. Spherical containers tested were called Model I Jumbinos (sometimes Jumbos); cylindrical containers were called Model II Jumbinos. The total number of containers produced and tested at Technical Area 6 is not known.

A Model I Jumbino, about two feet in diameter, was located south of the concrete bowl [6-003(a)], and parts of three Model II Jumbinos were located in a disposal area [6-007(f)] north of Buildings TA-6-1 and -3. Because these objects have historical value, the Bradbury Science Museum at the Laboratory wishes to acquire them for their collection. Personnel from the museum have had the three Model II Jumbinos tested for explosives residues and found them to be free of explosives contamination (Turner 1992, 19-0105). Museum personnel also plan to test and acquire the Model I Jumbino container.

6.3.2 Rationale for Recommendation of No Further Action

The known uses of these explosion containers indicate that the only hazardous contaminants to be expected are explosives and their residues. The parts of containers that have been located and tested for explosives have been found free of explosives contamination. Other containers that may be found will be tested for contamination and may be collected by the museum. Because many of these containers were tested to destruction, they may have been disposed of in landfills and other disposal areas, or they may have been recycled as scrap steel. All known containers have been or will be tested for explosives contamination, and landfill and disposal areas will be investigated as part of the RCRA facility investigation process.

6.4 SWMU 6-004, Sump

6.4.1 Description and History

No documentation of a sump, separate from Septic Tank TA-6-41 (6-002), has been found for wastewater from Buildings TA-6-19 and TA-6-10. No construction drawings of a sump have been found, but an engineering drawing does show a septic tank in this area (LASL 1944, 19-0017). Memorandums describing the decommissioning of Septic Tank TA-6-41 (6-002) (Courtright 1965, 19-0009) do not mention a separate sump. A single memorandum refers to a sump (Reider 1950, 19-0007), but this is probably a reference to the septic tank rather than to a separate structure.

6.4.2 Rationale for Recommendation of No Further Action

The archival information is consistent with the conclusion that the only structure in this area was Septic Tank TA-6-41, which was removed in 1965 (Courtright 1965, 19-0009). No evidence has been found that a sump ever existed as a separate structure. Sampling for any residual contamination in this area is discussed in Section 5.8.

6.5 SWMU 22-011, Disposal Pit

6.5.1 Description and History

The SWMU Report (LANL 1990, 0145) describes 22-011 as a pit prepared in 1946 for the disposal of discarded objects and shapes and associates this pit with a disturbed area south of Building TA-22-1. The disturbed area is posted with signs warning of explosives. The documentation referred to for this SWMU in the SWMU Report appears to be a 1946 memorandum from Norris Bradbury (Bradbury 1946, 19-0048). The memorandum refers to TD Site, but our best current information is that all disposal pits on Two-Mile Mesa were dug in the area of Material Disposal Area (MDA) F (Section 5.1) (Van Vessem 1992, 19-0045). Therefore, sampling of the area referred to in the memo is described in Section 5.1.

A disturbed area south of Building TA-22-1, which has signs warning of explosives, was located during a field survey (Rofer and Guthrie 1992, 19-0006). W. H. Meyers (1993, 19-0102) states that this pit was filled with gravel to filter solid explosives from contaminated wash water from Room 108 of TA-22-1 and to allow the water to percolate into the soil. This drain outfall from Room 108 is listed in the SWMU Report as 22-015(d) (LANL 1990, 0145). Therefore, sampling of the disturbed area is described under 22-015(d) (Section 5.3).

6.5.2 Rationale for Recommendation of No Further Action

The documentation of a disposal pit is being investigated under MDA F [7-001(a), Section 5.1], and the disturbed area south of Building TA-22-1 is being investigated under 22-015(d) (Section 5.3). No independent documentation or features exist for 22-011.

6.6 SWMU 22-014(c), Active Sump and Outfall

6.6.1 Description and History

The SWMU Report states, under "Notes" for 22-014, that "SWMU Nos. 22-014(a) and (b) were formerly SWMU Nos. 22-004(a) and (b), respectively. SWMU No. 22-014(c) was formerly SWMU No. 22-005" (LANL 1990, 0145). The section for 22-004 states that 22-004(a and b) were renumbered to 22-014(a), and the section for 22-005 states that it was renumbered to 22-014(b) (LANL 1990, 0145). No other references to 22-014(c) appear in the SWMU Report, and it is not identified with a structure number.

6.6.2 Rationale for Recommendation of No Further Action

On the basis of this lack of description, we conclude that the single reference to 22-014(c) is a typographical error.

6.7 SWMU 40-001(a), Septic System

6.7.1 Description and History

The SWMU Report lists a septic tank, TA-40-22, but it also indicates that no structure number appears on original drawings (LANL 1990, 0145). A septic tank or this structure number are not listed on specific drawings of septic tanks. Drawing ENG-C-12275 (LASL 1949, 19-0118) shows a pipe from the TA-40-1 roof drains going to the area where the structure sign for TA-40-22 is now located. Drawings ENG-C-12174 (LASL 1949, 19-0120) and ENG-C-12179 (LASL 1949, 19-0119) also show vitreous clay pipe, apparently fed by the roof drains, going to this area. Field reconnaissance found a drain pipe but no septic system (Rofer and Guthrie 1992, 19-0006). Recent drain tracing indicates that this outlet is fed only by drains from the roof of Building TA-40-1 (Santa Fe Engineering 1991, 19-0109).

6.7.2 Rationale for Recommendation of No Further Action

We have found no evidence in the archives or in the field that a septic system ever existed in this area.

6.8 Area of Concern C-6-020, Decommissioned Building Site

6.8.1 Description and History

The SWMU Report lists TA-6-49 as a building and ramp destroyed by burning in 1960 (LANL 1990, 0145). No other information on this building has been found. We conjecture that this building and ramp may have been a concrete batch plant located just south of the concrete bowl (TA-6-37). A ramp-like structure still exists in this location.

6.8.2. Rationale for Recommendation of No Further Action

No information has been found to substantiate the location of this building or the storage, treatment, or release of hazardous materials from it. If TA-6-49 was the concrete batch plant south of the concrete bowl, it is unlikely that hazardous waste was managed there.

6.9 Area of Concern C-40-001, Herbicide-Treated Area.

6.9.1 Description and History

The SWMU Report states that herbicide was used to remove vegetation from a 50-ft radius around structures TAs-40-3, -6, -11, and -14 in 1961 (LANL 1990, 0145). No further information on this area of concern has been found, and plants are now growing in these areas.

6.9.2 Rationale for Recommendation of No Further Action

We have found no evidence that these areas were subject to any action beyond normal application of herbicides. No information has been found to indicate that herbicides were stored in these buildings.

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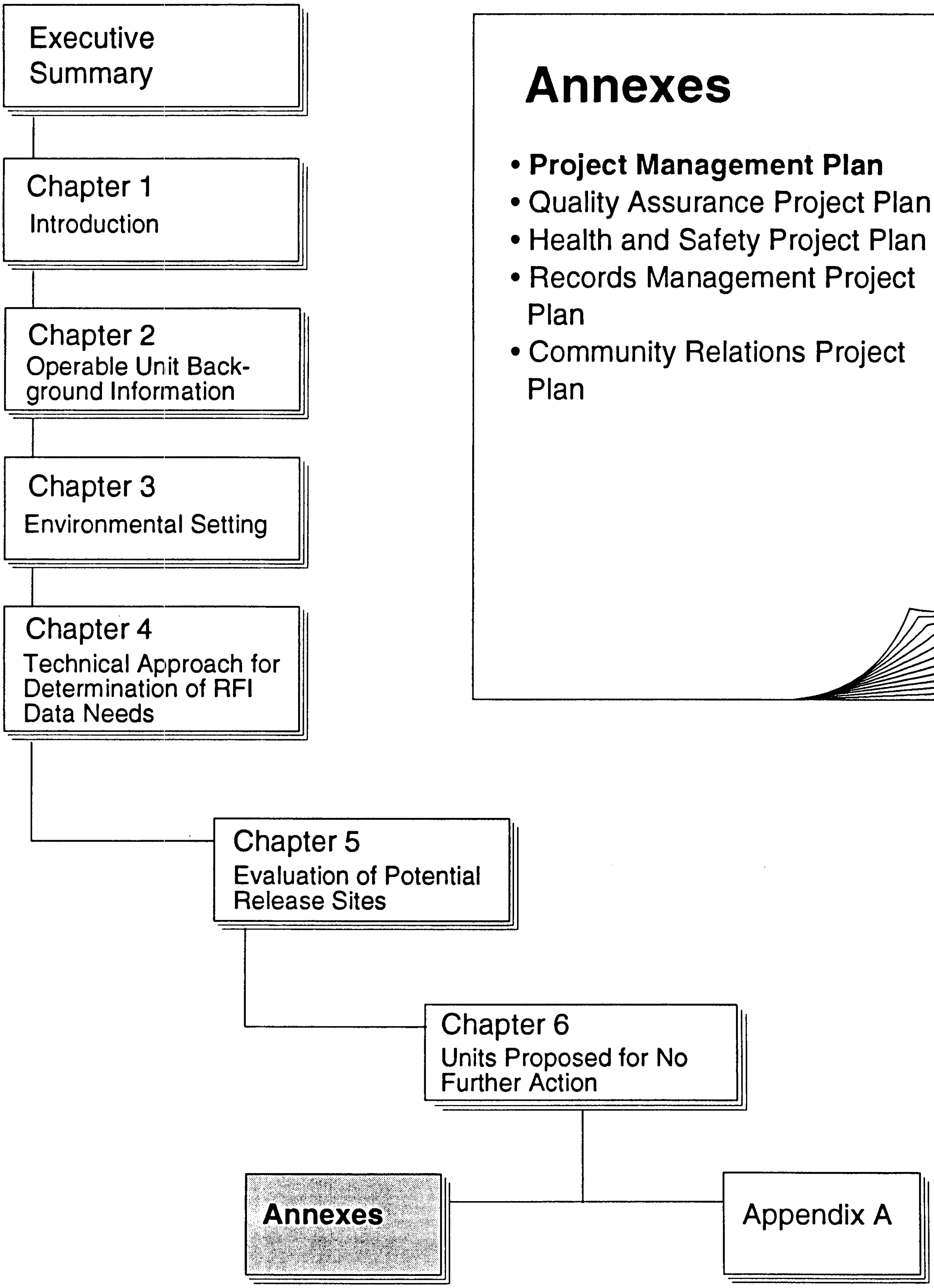


Annexes

- **Project Management Plan**
- Quality Assurance Project Plan
- Health and Safety Project Plan
- Records Management Project Plan
- Community Relations Project Plan

1.0 Technical Approach

The technical approach employed for the Operable Unit (OU) 1111 Resource Conservation and Recovery Act facility investigation (RFI) work plan follows the approach described in Chapter 4 of the installation work plan (IWP) and is presented in Chapter 4 of this work plan.

2.0 Schedule and Budget

A schedule and budget for the RFI/corrective measures studies process at OU 1111 is given in the Executive Summary. This information is included in Appendix N and Annex I, Section 4.0, of the IWP (LANL 1992, 0768).

3.0 Reporting

Results of RFI field work will be presented in three principal documents: quarterly technical progress reports, RFI phase reports/work plan modifications, and the RFI report. Table I-1 gives reporting requirements. A schedule for submission of these reports for OU 1111 is presented in Table I-2.

4.0 Organization and Responsibilities of Project Management

The organizational structure for the ER Program is presented in Section 3.0, Annex I, of the IWP (LANL 1992, 0768). A list of contributors to the OU 1111 RFI work plan is in Appendix A.

TABLE I-1

REPORTING REQUIREMENTS FOR OU 1111

Document	EPA	DOE	Due Date
Monthly	X	X	End of following month
Quarterly	X		End of following quarter
Phase Reports	X	X	As in baseline, DOE milestones

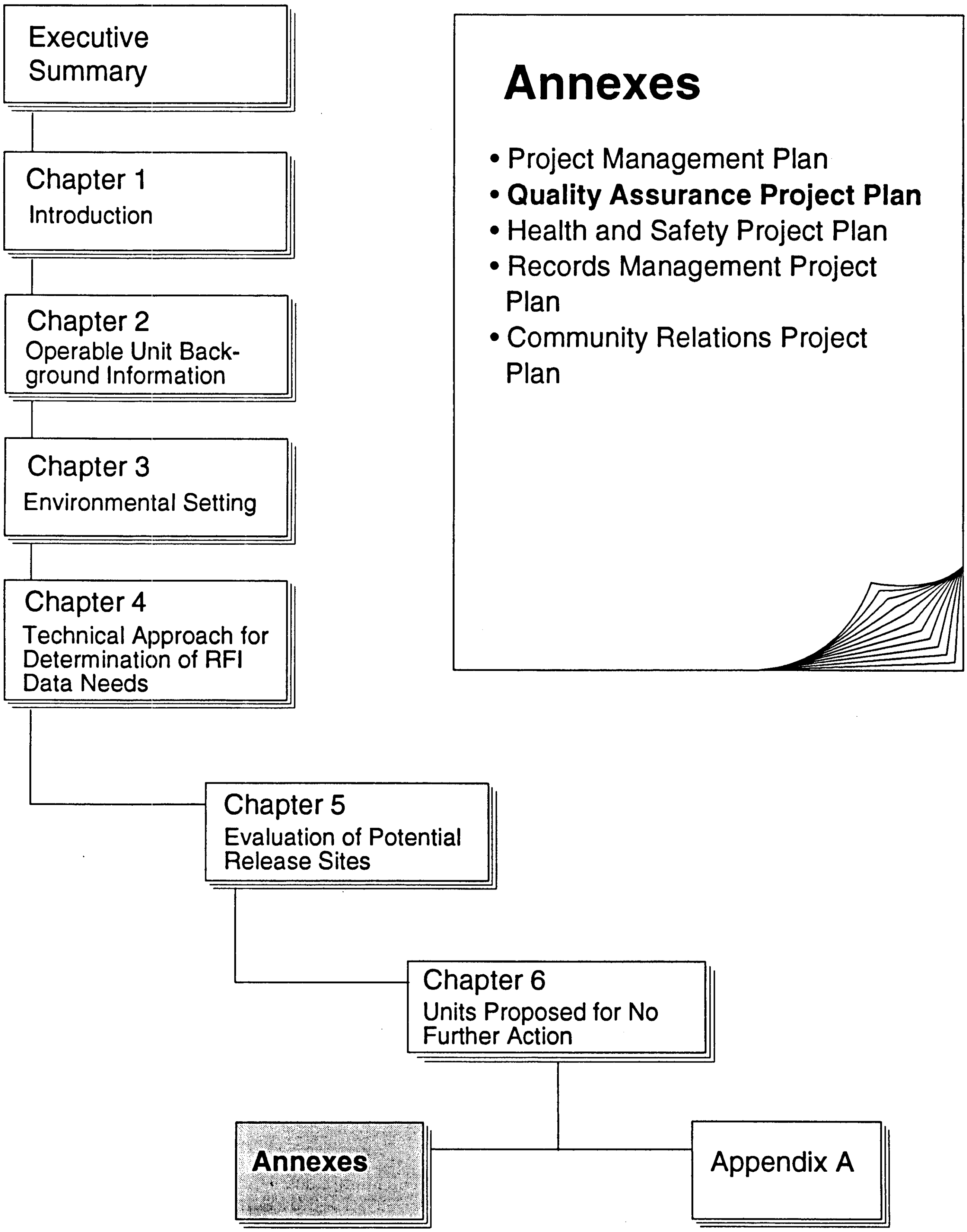
TABLE I-2

SCHEDULE FOR SUBMISSION OF OU 1111 REPORTS

Report	Date
RFI Work Plan	August 27, 1993
Phase I Report	February 16, 1995
RFI Report	September 23, 1996
CMS Plan	May 2, 1997
CMS Report	April 16, 1999

REFERENCES

LANL (Los Alamos National Laboratory), November 1992. "Installation Work Plan for Environmental Restoration," Revision 2, Los Alamos National Laboratory Report LA-UR-92-3795, Los Alamos, New Mexico. (LANL 1992, 0768)



Annexes

- Project Management Plan
- **Quality Assurance Project Plan**
- Health and Safety Project Plan
- Records Management Project Plan
- Community Relations Project Plan

SIGNATURE PAGE

Approval for Implementation

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TITLE: ER Program Manager, Los Alamos National Laboratory

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INTRODUCTION

This Quality Assurance Project Plan (QAPjP) for the Resource Conservation and Recovery Act facility investigation work plan for Operable Unit (OU) 1111 was written as a matrix report (Table II-1). It is based on the Generic QAPjP in the Los Alamos National Laboratory Environmental Restoration (ER) Program Quality Program Plan (LANL 1991, 0843).

The Generic QAPjP describes the format for the OU QAPjPs. Section 1.0, Signature Page, of the Generic QAPjP is included in the front of this annex. Section 2.0, Table of Contents, was omitted from this annex because the OU 1111 QAPjP is presented as a matrix. Section 3.0 of the Generic QAPjP is the project description, and Section 3.1 is the introduction. This introduction will serve as the equivalent of Section 3.1 and the matrix (Table II-1) will begin with Section 3.2, Facility Description.

In Table II-1, the Generic QAPjP criteria are listed in the first column; these criteria correspond to the sections of the Generic QAPjP. The second column lists the specific requirements of the Generic QAPjP that the OU 1111 QAPjP must meet; the section titles and numbers in the second column correspond to those contained in the Generic QAPjP. Sections of the Generic QAPjP that do not contain specific requirements are not included in the matrix. The third column lists the location of information that fulfills the requirements in the ER Program's installation work plan and/or the OU 1111 work plan. If OU 1111 is to follow the requirements in the Generic QAPjP and no further information is necessary, the column contains the phrase "Generic QAPjP accepted." In some cases, a standard operating procedure and/or a clarification note is included.

TABLE II-1

OU 1111 QAPjP MATRIX

Generic QAPjP Criteria	Generic QAPjP Requirements by Section	OU 1111 Incorporation of Generic QAPjP Requirements
Project Description	3.2 Facility Description	IWP, Chapter 2, and OU 1111 work plan, Chapter 3
	3.3 ER Program	IWP, Chapter 3
	3.4 Project Description	OU 1111 work plan, Executive Summary, Chapters 1, 2, and 4
Project Organization	4.0 Project Organization	IWP, Section 3.3
Quality Assurance	5.1 Level of Quality Control	Generic QAPjP accepted
Objectives for Measurement of Data in Terms of	5.2 Precision, Accuracy, and Sensitivity of Analyses	Generic QAPjP accepted
Precision, Accuracy, Representativeness,	5.3 Quality Assurance Objectives for Precision	Generic QAPjP accepted
Completeness, and Comparability	5.4 Quality Assurance Objectives for Accuracy	Generic QAPjP accepted
	5.5 Representativeness, Completeness, and Comparability	Generic QAPjP accepted
	5.6 Field Measurements	Generic QAPjP accepted
	5.7 Data Quality Objectives	OU 1111 work plan, Chapter 5

Table II-1 (continued)

Generic QAPjP Criteria	Generic QAPjP Requirements by Section	OU 1111 Incorporation of Generic QAPjP Requirements
Sampling Procedures	6.0 Sampling Procedures	OU 1111 work plan, Section 4.5
	6.1 Quality Control Samples	Generic QAPjP accepted, including ER-SOP-01.05*
	6.2 Sample Preservation During Shipment	Generic QAPjP accepted, including ER-SOP-01.02*
	6.3 Equipment Decontamination	Generic QAPjP accepted, including ER-SOP-01.06*
	6.4 Sample Designation	Generic QAPjP accepted, including ER-SOP-01.04*
Sample Custody	7.1 Overview	Generic QAPjP accepted, including ER-SOP-01.04*
	7.2 Field Documentation	Generic QAPjP accepted, including ER-SOP-01.04*
	7.3 Sample Control Facility	Generic QAPjP accepted
	7.4 Laboratory Documentation	Generic QAPjP accepted
	7.5 Sample Handling, Packaging, and Shipping	Generic QAPjP accepted, including ER-SOP-01.03*
	7.6 Final Evidence File Documentation	Generic QAPjP accepted
Calibration Procedures and Frequency	8.1 Overview	Generic QAPjP accepted
	8.2 Field Equipment	Generic QAPjP accepted
	8.3 Laboratory Equipment	Generic QAPjP accepted
Analytical Procedures	9.1 Overview	Generic QAPjP accepted
	9.2 Field Testing and Screening	OU 1111 work plan, Chapter 5
	9.3 Laboratory Methods	OU 1111 work plan, Chapter 5
Data Reduction, Validation, and Reporting	10.1 Data Reduction	Generic QAPjP accepted
	10.2 Data Validation	Generic QAPjP accepted
	10.3 Data Reporting	Generic QAPjP accepted
Internal Quality Control Checks	11.1 Field Sampling Quality Control Checks	Generic QAPjP accepted
	11.2 Laboratory Analytical Activities	Generic QAPjP accepted
Performance and System Audits	12.0 Performance and System Audits	Generic QAPjP accepted
Preventive Maintenance	13.1 Field Equipment	Generic QAPjP accepted
	13.2 Laboratory Equipment	Generic QAPjP accepted
Specific Routine Procedures Used to Assess Data Precision, Accuracy, Representativeness, and Completeness	14.1 Precision	Generic QAPjP accepted
	14.2 Accuracy	Generic QAPjP accepted
	14.3 Sample Representativeness	Generic QAPjP accepted
	14.4 Completeness	Generic QAPjP accepted
Corrective Action	15.1 Overview	Generic QAPjP accepted
	15.2 Field Corrective Action	Generic QAPjP accepted
	15.3 Laboratory Corrective Action	Generic QAPjP accepted

Table II-1 (concluded)

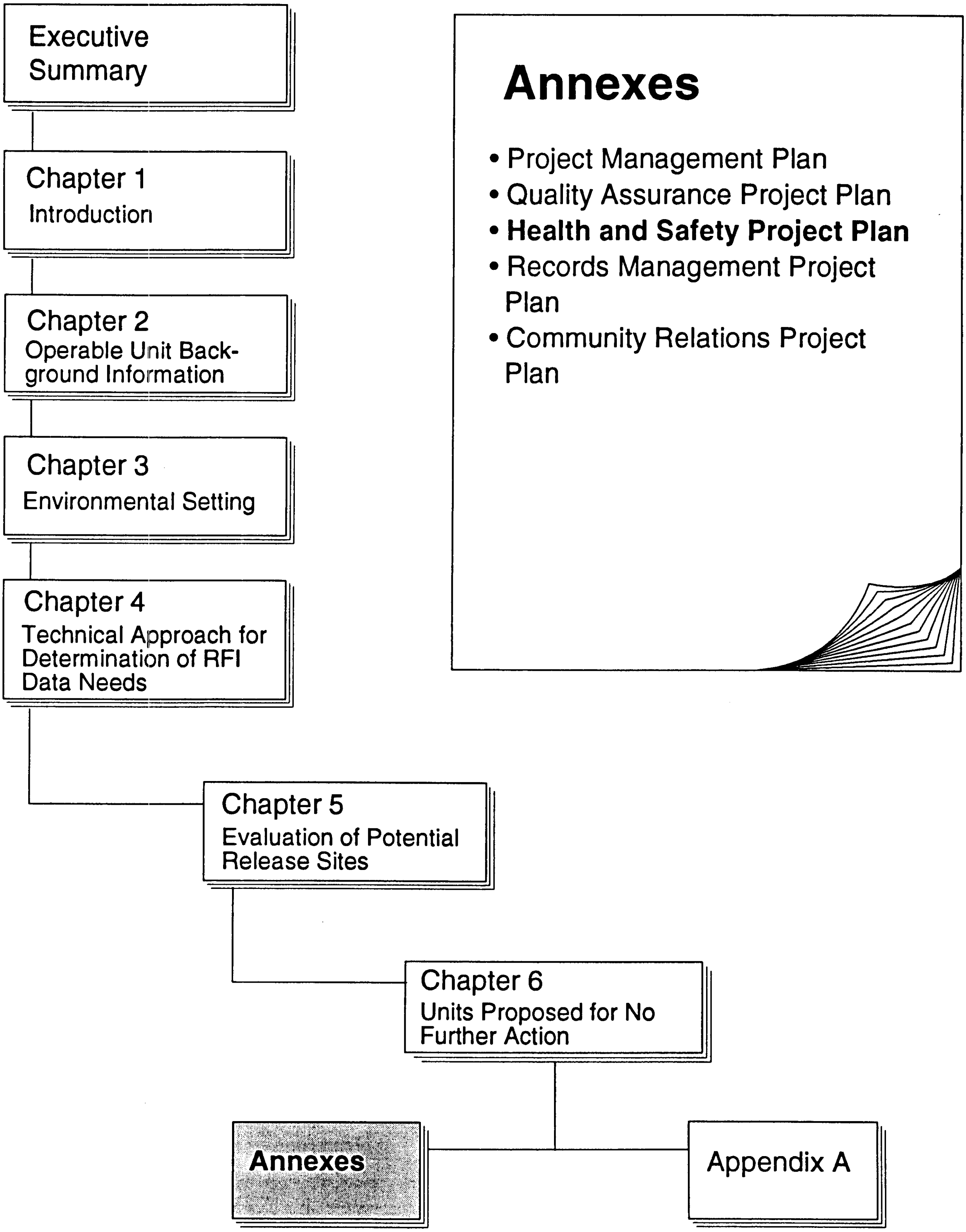
Generic QAPjP Criteria	Generic QAPjP Requirements by Section	OU 1111 Incorporation of Generic QAPjP Requirements
Quality Assurance Reports to Management	16.1 Field Quality Assurance Reports to Management	Generic QAPjP accepted
	16.2 Laboratory Quality Assurance Reports to Management	Generic QAPjP accepted
	16.3 Internal Management Quality Assurance Reports	Generic QAPjP accepted

[a] LANL 1993, 0875

REFERENCES

LANL (Los Alamos National Laboratory), May 1991. "Generic Quality Assurance Project Plan for RCRA Facility Investigations for the Los Alamos National Laboratory Environmental Restoration Program," Rev. 0, Los Alamos National Laboratory Report ____, Los Alamos New Mexico. (LANL 1991, 0843)

LANL (Los Alamos National Laboratory), January 1993. "Los Alamos National Laboratory Environmental Restoration Program Standard Operating Procedures," Los Alamos National Laboratory report, Los Alamos, New Mexico. (LANL 1993, 0875)



Annexes

- Project Management Plan
- Quality Assurance Project Plan
- **Health and Safety Project Plan**
- Records Management Project Plan
- Community Relations Project Plan

1.0 INTRODUCTION

1.1 Purpose and Scope

This Health and Safety Project Plan for Operable Unit (OU) 1111 enumerates potential safety and health hazards, describes techniques for their evaluation, and identifies control methods. The goals are to eliminate injuries and illness; minimize exposure to physical, chemical, biological, and radiological agents during environmental restoration (ER) activities; and provide contingencies for events that may occur while these efforts are under way.

This plan provides information about health and safety programs and procedures as they relate to OU 1111. Site-specific health and safety plans and procedures will be prepared for specific activities during the Resource Conservation and Recovery Act facility investigation (RFI).

The hierarchy of health and safety documents for the Los Alamos National Laboratory (the Laboratory) ER Program is as follows: (1) the Health and Safety Program Plan in the installation work plan (LANL 1992, 0768), (2) the Health and Safety Project Plan, and (3) the site-specific health and safety plan. The first document is the most general; the others become increasingly detailed. Each document can stand alone, but other relevant documents should always be considered when making decisions.

1.2 Applicability

The requirements set out in this plan apply to all individuals at OU 1111 ER sites, including Laboratory employees, supplemental work force personnel, regulators, and visitors.

1.3 Regulatory and Policy Requirements

Government-owned, contractor-operated facilities must comply with Occupational Safety and Health Administration (OSHA) regulations, Environmental Protection Agency (EPA) regulations, and Department of Energy (DOE) orders. The regulatory basis for the RFI is discussed in Chapter 1.

Health and safety risks to workers engaged in ER operations are addressed in the Superfund Amendments and Reauthorization Act of 1986 (SARA). Under SARA, the Secretary of Labor is required to promulgate worker protection regulations. After consulting with many organizations, including EPA, OSHA, the US Coast Guard, and the National Institute for Occupational Safety and Health, a set of regulations was published in March 1989. This is the Code of Federal Regulations (CFR), Title 29, Part 1910.120, Hazardous Waste Operations and Emergency Response (DOL 1989, 0952).

DOE orders 5480.4 (DOE 1984, 0059) and 5483.1A (DOE 1983, 0058) require DOE employees, contractors, and subcontractors to comply with federal OSHA regulations. DOE Order 5480.11 (DOE 1990, 0732) sets radiation protection standards for all DOE activities. The DOE Radiological Control Manual established practices for the conduct of radiological control activities at all DOE sites and is used by DOE to evaluate contractor performance.

Laboratory director's policies "Environment, Safety, and Health" and "Environmental Protection and Restoration," both dated September 1991, require compliance with federal regulations, DOE orders, and state and local laws. These policies can be found in the Laboratory's Environment, Safety, and Health (ES&H) manual, which is updated regularly.

1.4 Variances From Health and Safety Requirements

When special conditions exist, the site safety officer (SSO) may submit to the health and safety project leader (HSPL) a written request for a variance from a specific health and safety requirement. If the HSPL agrees with the request, it will be reviewed by the OU project leader (OUPL) or a designee. Higher levels of management may be consulted, as appropriate. The condition of the request will be evaluated, and if appropriate, the HSPL will grant a written variance specifying the conditions under which the requirements may be modified. The variance will become part of the site-specific health and safety plan.

1.5 Review and Approval

This document will be effective after it has been reviewed and approved by the appropriate Laboratory subject matter experts. Signatures of approval are required. It will be revised at least annually. Revisions will reflect changes in the scope of work, site conditions, work procedures, site data, monitoring or visual information technology, policies, or procedures. Changes must be approved by the HSPL and OUPL. A complete review will be conducted if feasibility studies or remediation are necessary.

2.0 ORGANIZATION, RESPONSIBILITY, AND AUTHORITY

2.1 General Responsibilities

The Health and Safety Division Hazardous Waste Operations Program (HAZWOP) establishes laboratory policies for health and safety activities at ER sites. The 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 for ER activities are summarized in the Health and Safety Program Plan (LANL 1992, 0768). Line management is responsible for implementing health and safety requirements.

Any individual observing an operation that presents a clear and imminent danger to the environment or to the safety and health of others has the responsibility to initiate a stop-work action. The requirements, responsibilities, and basis for stop-work actions and for restarting activities are established in Laboratory Procedure (LP) 116-01.0 (April 1992, ES&H manual). Any individual initiating a stop-work action will follow the procedural steps, as described in LP 116-01.0. Upon initiation of stop-work actions, related activities are documented on the

Stop-Work Report Form and the log for Stop-Work Reports. ER Program personnel will also notify the SSO, the ER Program HSPL, and the OUPL.

2.2 Individual Responsibilities

Figure III-1 illustrates the fieldwork organizational chart.

2.2.1 Environmental Management and Health and Safety Division Leaders

The Environmental Management (EM) and Health and Safety Division leaders are responsible for addressing programmatic health and safety concerns. They will promote a comprehensive health and safety program that includes radiation protection, occupational medicine, industrial safety, industrial hygiene, criticality safety, waste management, and environmental protection and preservation.

2.2.2 ER Program Manager

The ER Program manager (EM-13) is responsible for implementing the Health and Safety Program Plan. The program manager provides for the establishment, implementation, and support of health and safety measures.

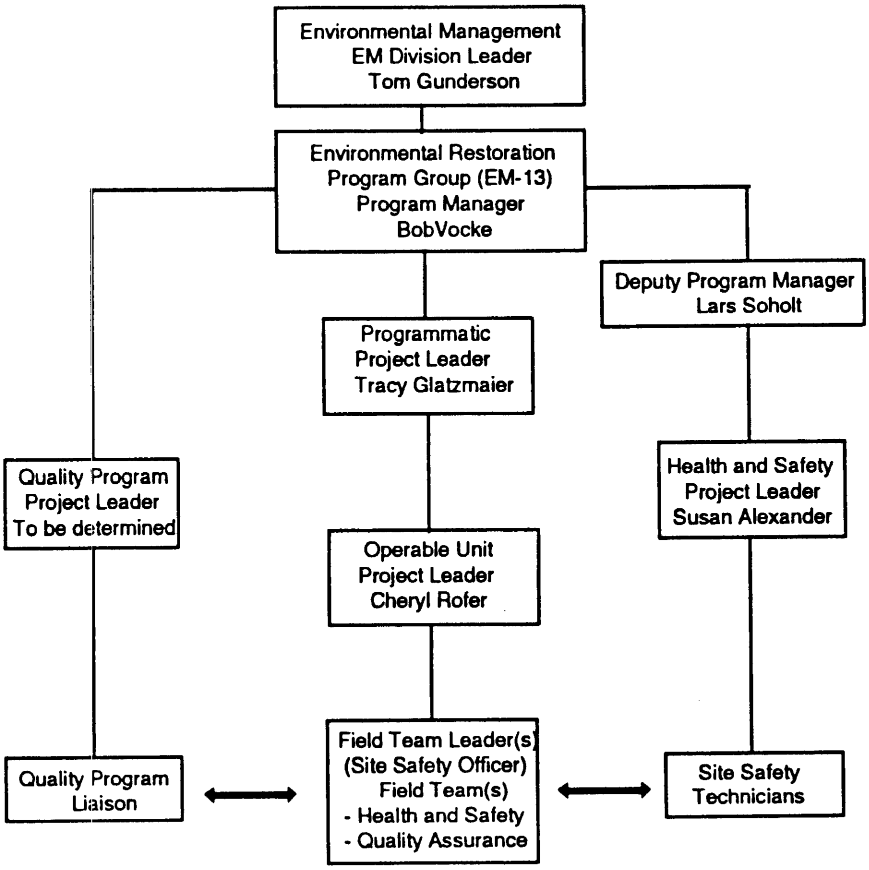


Figure III-1. OU field work organizational chart.

2.2.3 Health and Safety Project Leader

The HSPL has the following responsibilities:

- preparing and updating the Health and Safety Program Plan;
- helping the OUPL to identify resources for the preparation and implementation of the Health and Safety Project Plan;
- final approval of the Health and Safety Program Plan, the Health and Safety Project Plan, and the site-specific health and safety plan;
- reviewing subcontractor health and safety plans to ensure that they meet the requirements of the Health and Safety Project Plan;
- reviewing health and safety requirements and procedures for off-site work;
- along with field team leaders, overseeing daily health and safety activities in the field, including scheduling, tracking deliverables, and resource utilization;
- approving the health and safety section of the readiness review submitted by the OUPL;
- organizing a health and safety kickoff meeting before fieldwork begins to determine responsibility, authority, lines of communication, and scheduling; and
- establishing minimum training and competency requirements for on-site personnel to meet or exceed 29 CFR 1910.120 (DOL 1989, 0952).

2.2.4 Operable Unit Project Leader

The OUPL is responsible for all ER investigation activities for the assigned OU. Specific health and safety responsibilities include

- preparing, reviewing, implementing, and revising the Health and Safety Project Plan;
- interfacing with the HSPL to resolve health and safety concerns;
- reviewing health and safety requirements and procedures for off-site work;
- notifying the HSPL of schedule and project changes; and
- completing a field readiness review before field activities begin.

2.2.5 Field Team Leader

The field team leader is responsible for implementing the sampling and analysis plan, overseeing waste management, and implementing the Health and Safety Project Plan and the Quality Assurance Project Plan (Annex II). The leader may also serve as the SSO. Safety responsibilities include

- ensuring the health and safety of field team members,
- implementing emergency response procedures and fulfilling notification requirements, and
- notifying the HSPL of schedule changes.

2.2.6 Site Safety Officer

The SSO is responsible for ensuring that trained and competent health and safety personnel are on site. This includes industrial hygiene and health physics technicians and first aid/cardiopulmonary resuscitation responders. The SSO may fill any or all of these roles. Subcontractors must assign their own SSO.

The SSO has the following responsibilities:

- advising the HSPL and OUPL of health and safety issues;
- performing and documenting initial inspections for all site equipment;
- notifying appropriate Laboratory authorities of injuries or illnesses, emergencies, or stop-work orders;
- evaluating the results of sample screening and analysis for health and safety concerns;
- determining protective clothing requirements;
- inspecting protective clothing and equipment;
- determining personal dosimetry requirements for workers;
- maintaining a current list of telephone numbers for emergency situations;
- providing an operating radio transmitter/receiver, if necessary;
- maintaining an up-to-date copy of the site-specific health and safety plan for work at the site;
- controlling entry and exit at access control points;
- establishing and enforcing the safety requirements to be followed by visitors;
- briefing visitors on health and safety issues;
- maintaining a logbook of workers entering the site;
- determining whether workers can perform their jobs safely under prevailing weather conditions;
- monitoring work parties and conditions;
- controlling emergency situations in collaboration with other required personnel;
- ensuring that all personnel are trained in the appropriate safety procedures and are familiar with the site-specific health and safety plan and that all requirements are followed during OU activities;
- conducting daily health and safety briefings for field team members;
- stopping work when unsafe conditions develop or an imminent hazard is recognized;
- inspecting to determine whether the site-specific health and safety plan is being followed; and
- maintaining first aid supplies.

2.2.7 Field Team Members

Field team members are responsible for following safe work practices, notifying their supervisor or the SSO if unsafe conditions exist, and immediately reporting any injury, illness, or unusual event that could impact the health and safety of site personnel.

2.2.8 Visitors

Site access will be controlled. Only verified team members and previously approved visitors will be allowed in work areas or areas containing potentially hazardous materials or conditions. Special passes or badges may be issued.

Visitors who are on site to collect or split samples must meet all the health and safety requirements of a field sampling team for that site. They must comply with the provisions of the site-specific health and safety plan and sign an agreement to that effect. They will be expected to comply with relevant OSHA requirements, such as medical monitoring, training, and respiratory protection.

Site visitors who will not be collecting samples will (1) report to the SSO upon arrival at the site; (2) log in upon entry and log out upon exit; (3) receive abbreviated site training from the SSO on the following topics: site-specific hazards, site protocol, emergency response actions, and muster areas; (4) not be permitted to enter the exclusion zone or the contamination reduction zone; and (5) receive escort from SSO or another trained individual at all times.

If a visitor does not adhere to these requirements, the SSO will request the visitor to leave the site. All nonconformance incidents will be recorded in the site log.

2.2.9 Supplemental Work Force

All supplemental work force personnel performing site investigations will be responsible for developing health and safety plans that cover their specific project assignments. At a minimum, the plans will conform to the requirements of this plan. Deficiencies in health and safety plans will be resolved before a subcontractor is authorized to proceed.

Subcontractors will adhere to the requirements of all applicable health and safety plans. Laboratory personnel will monitor activities to ensure that this is done. Failure to adhere to these requirements can cause work to stop until compliance is achieved.

Subcontractors will provide their own health and safety functions unless other contractual agreements have been arranged. Such functions may include, but are not limited to, providing qualified health and safety officers for site work, imparting a corporate health and safety environment to their employees, providing calibrated industrial hygiene and radiological monitoring equipment, enrolling in an approved medical surveillance program, supplying approved respiratory and personal protective equipment (PPE), providing safe work practices, and training hazardous waste workers.

2.3 Health and Safety Oversight

The Health and Safety Division is responsible for developing and implementing an oversight program to ensure compliance with regulatory requirements. The frequency of field verifications will depend on the characteristics of the site, the equipment used, and the scope of work.

2.4 Off-Site Work

Health and safety requirements and procedures for off-site work may be different than for work within Laboratory boundaries. For example, additional notifications may be required. All modifications to health and safety requirements and procedures must be in the best interests of the public and the Laboratory. Such modifications will be determined on a case-by-case basis.

3.0 SCOPE OF WORK

3.1 Comprehensive Work Plan

Phase I of the RFI involves characterization, environmental sampling, and field assessment. This plan addresses the tasks in the Phase I study. Tasks for additional phases will be addressed in revisions to this work plan.

3.2 OU Description

OU 1111 consists of 89 potential release sites (PRSs). Descriptions and histories of these sites can be found in Chapter 5 of the work plan. Table III-1 summarizes the PRSs, the potential hazards, and the work planned at this time.

4.0 HAZARD IDENTIFICATION AND ASSESSMENT

The SSO or a designee will monitor field conditions and personnel exposure to physical, chemical, biological, and radiological hazards. If a previously unidentified hazard is discovered, the SSO will contact the field team leader and the HSPL and assess the hazard. The assessment will include identifying the potential harm, the likelihood of its occurrence, and the measures required to reduce risk. The assessment will be documented, reviewed, and approved by the HSPL and OUPL. Appropriate field team leaders and field team members will receive copies of the assessment, and it will be discussed in a tailgate meeting or another appropriate forum. The approved assessment will be added to this plan as an amendment.

4.1 Physical Hazards

The purpose of this section is to list physical hazards that may occur during ER activities. Some hazards, such as open trenches, loud noise, and heavy lifting, are easily recognized. Others, such as heat stress and altitude sickness, are less apparent. Common physical hazards are listed without discussion, and short discussions are provided for more unusual hazards. Detailed information about common hazards can be found in the Health and Safety Division HAZWOP Program documentation or other industrial hygiene reference books.

TABLE III-1

SUMMARY OF PRSs, OU 1111

Description	Tasks	Potential Chemical Contaminants	Potential Radionuclide Contaminants
Aggregate 1, Material Disposal Area F, SWMUs 6-007(a-e) and Adjacent Timbered Pit (SWMU 6-005). The contents and locations of the pits are poorly defined.	Radiological surface survey, surface soil sampling (as needed), nonintrusive geophysical surveys, shallow trenching, subsurface soil sampling, surface water sampling	Explosives and semivolatile organics	Cesium-137, depleted uranium and strontium-90
Aggregate 2, Plating and Etching Outfall and Related Run-Off Area, SMWU 22-015(c)	Surface and subsurface soil sampling	Copper, nickel, silver, chromium, chromate, zinc, cyanide, sulfates, nitrates and nitrites, fluoride, phosphate, benzene, trichloroethylene, perchloroethylene, sodium thiosulfate, sodium hydroxide, and sodium carbonate	None
Aggregate 3, Active Explosives Sump, SWMU 22-014(a)	Surface and subsurface soil sampling	Explosives	None
Aggregate 3, Active Explosives Sump and Chemical Waste Line, SWMU 22-014(b)	Surface and subsurface soil sampling	Explosives, solvents, metals, and acids	None
Aggregate 3, Inactive Explosives Sump, SWMU 22-015(b)	Surface and subsurface soil sampling and sump removal	PETN and solvents	None
Aggregate 3, Inactive Explosives Sump, SWMU 22-015(e); and Concrete Wash Pad, SWMU 22-012	Surface and subsurface soil sampling and asphalt sampling	Explosives, acetone, and other solvents	None
Aggregate 3, Inactive Explosives Drain and Seepage Pit, SWMU 22-015(d)	Surface and subsurface soil sampling	Explosives, volatiles	None
Aggregate 3, Inactive Dry Wells, SWMU 22-015(a)	Surface and subsurface soil sampling	Copper, iron, acids (sulfuric, chromic, hydrochloric, nitric, hydrofluoric, and phosphoric) or their anions, cyanide, aluminum oxide, magnesium oxide, lime, trichloroethylene, sodium hydroxide, and sodium carbonate	None
Aggregate 3, Active Explosives Sump, SWMU 40-005	Surface and subsurface soil sampling	Explosives, alcohol, and acetone	None
Aggregate 4, Inactive Firing Site, SWMU 6-003(a)	Metal detector surveys, surface and subsurface soil sampling	Explosives and metals	None expected, samples will be tested for radioactivity
Aggregate 4, Inactive Firing Site, SWMU 6-003(c)	Metal detector surveys, surface and subsurface soil sampling	Explosives and metals (cobalt)	Cesium-137 and depleted uranium
Aggregate 4, Inactive Firing Site, SWMU 6-003(d)	Structural surface samples	Explosives and metals	None expected, samples will be tested for radioactivity
Aggregate 4, Inactive Firing Site, SWMU 6-003(e)	Structural surface samples	Explosives and metals	None expected, samples will be tested for radioactivity
Aggregate 4, Inactive Firing Site, SWMU 6-003(f)	Metal detector surveys, surface and subsurface soil sampling	Explosives and metals (copper and cobalt)	None expected, samples will be tested for radioactivity

Table III-1 (continued)

Description	Tasks	Potential Chemical Contaminants	Potential Radionuclide Contaminants
Aggregate 4, Inactive Firing Site and site of a building decommissioned in 1960 by burning, SWMU 6-003(g)	Surface and subsurface core soil samples	PETN, acetone, carbon tetrachloride, and metals	None expected, samples will be tested for radioactivity
Aggregate 4, Removed Underground Storage Tank Site, SWMU 6-008	Surface and sub-surface core soil samples	None expected, samples will be tested for explosives	None expected, samples will be tested for radioactivity
Aggregate 4, Former Generator Building Site, AOC C-6-019	Surface soil sampling	None expected, samples will be tested for hydrocarbons, metals and explosives	None expected, samples will be tested for radioactivity
Aggregate 4, Inactive Firing Site, SWMU 7-001(a)	Surface and subsurface soil sampling	Explosives and metals	None expected, samples will be tested for radioactivity
Aggregate 4, Inactive Firing Site, SWMU 7-001(b)	Surface and subsurface soil sampling	Explosives and metals	None expected, samples will be tested for radioactivity
Aggregate 4, Inactive Firing Site, SWMU 7-001(c)	Surface soil sampling, and soil and metal removal as needed	Lead	None expected, samples will be tested for radioactivity
Aggregate 4, Inactive Firing Site, SWMU 7-001(d)		Explosives and metals	None expected, samples will be tested for radioactivity
Aggregate 5, Surface Disposal Area, SWMU 6-007(f)	Surface debris will be removed, surface and subsurface soil sampling	Explosives, metals, semivolatile and volatile organics	Radionuclides
Aggregate 5, Surface Disposal Area, SWMU 6-007(g)	Surface debris will be removed, surface and subsurface soil sampling	Explosives, metals, semivolatile and volatile organics	Radionuclides
Aggregate 5, Surface Disposal Area, SWMU 40-010	Surface debris will be removed, surface and subsurface soil sampling	Explosives, metals, semivolatile and volatile organics	Radionuclides
Aggregate 6, Inactive Septic System, SWMU 6-001(a)	Surface and subsurface soil sampling, contents sampling or scrape sampling if tank is empty, tank removal if not classified as mixed waste	Silver, darkroom chemicals, paint, ink, diethyl ether, etching chemicals, and solvents (alcohol, acetone, and carbon tetrachloride)	None expected, samples will be tested for radioactivity
Aggregate 6, Inactive Septic System, SWMU 6-001(b)	Surface and subsurface soil sampling, contents sampling or scrape sampling if tank is empty, tank removal if not classified as mixed waste	Darkroom chemicals, carbon tetrachloride, and solvents	None expected, samples will be tested for radioactivity
Aggregate 6, Active Septic System, SWMU 22-010(a)	Surface and subsurface soil sampling, contents sampling or scrape sampling if tank is empty	Acetone, alcohol, and explosives	None expected, samples will be tested for radioactivity
Aggregate 6, Inactive Septic System, SWMU 22-010(b)	Surface and subsurface soil sampling, contents sampling or scrape sampling if tank is empty, tank removal if not classified as mixed waste	Acids, darkroom chemicals, non-PCB machine oil, magnesium, acetone, alcohol, and explosives	None expected, samples will be tested for radioactivity
Aggregate 6, Inactive Septic System, SWMU 22-016	Surface and subsurface soil sampling, contents sampling or scrape sampling if tank is empty, tank removal if not classified as mixed waste	Acids, darkroom chemicals, non-PCB machine oil, magnesium, acetone, alcohol, and explosives	None expected, samples will be tested for radioactivity

Table III-1 (continued)

Description	Tasks	Potential Chemical Contaminants	Potential Radionuclide Contaminants
Aggregate 4, Inactive Firing Site and site of a building decommissioned in 1960 by burning, SWMU 6-003(g)	Surface and subsurface core soil samples	PETN, acetone, carbon tetrachloride, and metals	None expected, samples will be tested for radioactivity
Aggregate 4, Removed Underground Storage Tank Site, SWMU 6-008	Surface and sub-surface core soil samples	None expected, samples will be tested for explosives	None expected, samples will be tested for radioactivity
Aggregate 4, Former Generator Building Site, AOC C-6-019	Surface soil sampling	None expected, samples will be tested for hydrocarbons, metals and explosives	None expected, samples will be tested for radioactivity
Aggregate 4, Inactive Firing Site, SWMU 7-001(a)	Surface and subsurface soil sampling	Explosives and metals	None expected, samples will be tested for radioactivity
Aggregate 4, Inactive Firing Site, SWMU 7-001(b)	Surface and subsurface soil sampling	Explosives and metals	None expected, samples will be tested for radioactivity
Aggregate 4, Inactive Firing Site, SWMU 7-001(c)	Surface soil sampling, and soil and metal removal as needed	Lead	None expected, samples will be tested for radioactivity
Aggregate 4, Inactive Firing Site, SWMU 7-001(d)		Explosives and metals	None expected, samples will be tested for radioactivity
Aggregate 5, Surface Disposal Area, SWMU 6-007(f)	Surface debris will be removed, surface and subsurface soil sampling	Explosives, metals, semivolatile and volatile organics	Radionuclides
Aggregate 5, Surface Disposal Area, SWMU 6-007(g)	Surface debris will be removed, surface and subsurface soil sampling	Explosives, metals, semivolatile and volatile organics	Radionuclides
Aggregate 5, Surface Disposal Area, SWMU 40-010	Surface debris will be removed, surface and subsurface soil sampling	Explosives, metals, semivolatile and volatile organics	Radionuclides
Aggregate 6, Inactive Septic System, SWMU 6-001(a)	Surface and subsurface soil sampling, contents sampling or scrape sampling if tank is empty, tank removal if not classified as mixed waste	Silver, darkroom chemicals, paint, ink, diethyl ether, etching chemicals, and solvents (alcohol, acetone, and carbon tetrachloride)	None expected, samples will be tested for radioactivity
Aggregate 6, Inactive Septic System, SWMU 6-001(b)	Surface and subsurface soil sampling, contents sampling or scrape sampling if tank is empty, tank removal if not classified as mixed waste	Darkroom chemicals, carbon tetrachloride, and solvents	None expected, samples will be tested for radioactivity
Aggregate 6, Active Septic System, SWMU 22-010(a)	Surface and subsurface soil sampling, contents sampling or scrape sampling if tank is empty	Acetone, alcohol, and explosives	None expected, samples will be tested for radioactivity
Aggregate 6, Inactive Septic System, SWMU 22-010(b)	Surface and subsurface soil sampling, contents sampling or scrape sampling if tank is empty, tank removal if not classified as mixed waste	Acids, darkroom chemicals, non-PCB machine oil, magnesium, acetone, alcohol, and explosives	None expected, samples will be tested for radioactivity
Aggregate 6, Inactive Septic System, SWMU 22-016	Surface and subsurface soil sampling, contents sampling or scrape sampling if tank is empty, tank removal if not classified as mixed waste	Acids, darkroom chemicals, non-PCB machine oil, magnesium, acetone, alcohol, and explosives	None expected, samples will be tested for radioactivity

Table III-1 (continued)

Description	**Tasks**	**Potential Chemical Contaminants**	**Potential Radionuclide Contaminants**
Aggregate 8, Removed Building, AOC C-6-006	Surface and subsurface soil sampling	Explosives, metals	None expected, samples will be tested for radioactivity
Aggregate 8, Removed Boiler house, AOC C-6-007	Surface and subsurface soil sampling	Explosives, metals	None expected, samples will be tested for radioactivity
Aggregate 8, Removed Magazine, AOC C-6-008	Surface and subsurface soil sampling	PETN, metals	None expected, samples will be tested for radioactivity
Aggregate 8, Removed Magazine, AOC C-6-009	Surface and subsurface soil sampling	Explosives, metals	None expected, samples will be tested for radioactivity
Aggregate 8, Removed Magazine, AOC C-6-010	Surface and subsurface soil sampling	Explosives, metals	None expected, samples will be tested for radioactivity
Aggregate 8, Removed Magazine, AOC C-6-011	Surface and subsurface soil sampling	Explosives, metals	None expected, samples will be tested for radioactivity
Aggregate 8, Removed Magazine, AOC C-6-012	Surface and subsurface soil sampling	Explosives, metals	None expected, samples will be tested for radioactivity
Aggregate 8, Removed Magazine, AOC C-6-013	Surface and subsurface soil sampling	PETN, metals	None expected, samples will be tested for radioactivity
Aggregate 8, Removed Magazine, AOC C-6-014	Surface and subsurface soil sampling	Explosives, metals	None expected, samples will be tested for radioactivity
Aggregate 8, Removed Magazine, AOC C-6-015	Surface and subsurface soil sampling	Tetryl, metals	None expected, samples will be tested for radioactivity
Aggregate 8, Removed Magazine, AOC C-6-016	Surface and subsurface soil sampling	Explosives, metals	None expected, samples will be tested for radioactivity
Aggregate 8, Removed Magazine, AOC C-6-017	Surface and subsurface soil sampling	Explosives, metals	None expected, samples will be tested for radioactivity
Aggregate 8, Removed Magazine, AOC C-6-018	Surface and subsurface soil sampling	PETN, metals	None expected, samples will be tested for radioactivity
Aggregate 8, Removed Building and ramp, AOC C-6-020	Surface and subsurface soil sampling	Explosives, metals	None expected, samples will be tested for radioactivity
Aggregate 8, Removed Magazine, AOC C-6-021	Surface and subsurface soil sampling	Explosives, metals	None expected, samples will be tested for radioactivity
Aggregate 9, Former Container Storage Area, SWMU 6-006	Surface asphalt sampling and soil and sediment sampling of the drainage channels	Volatile and semivolatile organics, polychlorinated biphenyls	None expected, samples will be tested for radioactivity

Table III-1 (concluded)

Description	**Tasks**	**Potential Chemical Contaminants**	**Potential Radionuclide Contaminants**
Aggregate 9, Former Container Storage Area, SWMU 40-004	Soil and sediment sampling of the drainage channels	Volatile and semivolatile organics	None expected, samples will be tested for radioactivity
Aggregate 10, Building/Storage Area, SWMU 40-007(a)	No action	Explosives	None
Aggregate 10, Building/Storage Area, SWMU 40-007(b)	No action	Explosives	None
Aggregate 10, Building/Storage Area, SWMU 40-007(c)	No action	Explosives	None
Aggregate 10, Building/Storage Area, SWMU 40-007(d)	No action	Explosives	None
Aggregate 10, Building/Storage Area, SWMU 40-007(e)	No action	Explosives	None

Table III-2 lists some of the anticipated physical hazards inherent to ER work. It is not inclusive. If additional physical hazards are identified, they will be added to this table by the SSO.

4.1.1 Explosives

All field team members who will be working in areas that may contain explosives will be trained in explosives safety procedures, including ER standard operating procedures (SOPs) (to be written) and relevant SOPs of the explosives operating groups. All sampling procedures for areas that may contain explosives will be approved by the Explosives Review Committee. Until such guidance is fully developed, the following guidelines will be followed for work in areas that may contain explosives.

- Materials believed to be or to contain explosives will be marked in the field with a fluorescent red flag, and an explosives safety expert will assess the materials. Suspect materials, which include any material with a waxy or plastic-like texture and blue, pink, red, yellow, green, white, or orange coloration, will not be handled until authorization is given by the explosives safety expert. In addition, blasting caps, recognized as small cylinders with wires protruding from them, may be present in Technical Areas 6 and 7 from operations during the early 1940s. Small electrical components found in areas where blasting caps or detonators may have been used may contain explosives.
- Electrical equipment used in the area must be UL-approved for Class I and II hazardous locations.
- The ground will be sprayed or saturated with water before sampling to minimize the potential for sparks and particulate dispersion.
- A nonsparking sampling device will be pushed into the ground with a minimum amount of turning during surface sampling.
- All samples will contain at least 10% moisture before being sealed in containers.

TABLE III-2

POSSIBLE PHYSICAL HAZARDS, OU 1111

Hazard Description	**PPE**	**Prevention Methods**	**Monitoring Methods**
Noise	Ear plugs and muffs	Engineering controls, mufflers, noise absorbers, PPE	Sound level meter, noise dosimeter
Vibration	Gloves, absorbing materials	Prevention or attenuation, isolation, increasing distance from source, PPE	Accelerometers
Energized equipment	Gloves, safety shoes, safety glasses	Lockout/tagout of equipment, PPE	Circuit test light/meter, grounding stick
Confined space entry	Gloves, boots, full-body suit, supplied-air or self-contained breathing apparatus, safety glasses, life-line	Ventilation, oxygen, combustible gas monitoring, confined space permit, PPE	Combustible gas meter, oxygen monitors
Trenching	Hard hats, safety shoes, safety glasses	Protective shoring, proper excavation access, egress, PPE	Visual inspection, oxygen meter, determining soil type
Fire/Explosion	Hard hat, gloves, face shield, fire- resistant full-body suit	Ventilation, containment of fuel source, isolation/insulation from ignition source or heat, PPE	Combustible gas meter
Explosives	Latex gloves, safety glasses, blast shields	Identification of contaminated areas, field screening, following procedures, PPE	Visual inspection, screening tests
Welding/Cutting/ Brazing	Fire-resistant gloves and clothing (aprons, coveralls, leggings), welding helmets or goggles	Ventilation, PPE	Personal sampling for metal fumes
Compressed gas cylinders	Face shield, safety shoes, gloves	Store cylinders in areas protected from weather, secure and store cylinders with protective caps in place, do not leave regulators on stored cylinders, PPE	Visual inspection, combustible gas meter, photoionization detector
Material handling	Hard hat, safety shoes, gloves	Lifting aids, correct lifting procedure, work/rest periods, PPE	Weigh or estimate weight of typical materials and set limits for lifting
Walking/Working surfaces	Safety shoes	Clean and dry surfaces, nonskid surfacing material, PPE	Visual inspection
Pinch points/ mechanical hazards	Face shield, gloves, safety shoes	Guard interlocks, maintain guards in good condition, PPE	Visual inspection, observation of work practices
Motor vehicle accidents	Seat belt	Defensive driving training, reduced speed during adverse conditions, PPE	Observation of work practices
Heavy equipment	Hard hat, safety shoes, gloves	Operator training, stay clear of energized sources, PPE, backup alarm, orange vest	Observation of work practices
Heat stress	Hat, cooling vest	ACGIH work/rest regimens, PPE	Wet bulb globe thermometer
Cold stress	Hat, gloves, insulated boots, coat, face protection	ACGIH work/warm-up schedule, heated shelters, PPE	Thermometer and wind speed measurement, wind chill chart
Sunburn	Hat, safety sunglasses, full-body protection	Cover body with clothing or sunscreen, PPE	Solar load chart
Altitude sickness	None	Acclimatization ascent/descent schedule	Self-monitoring for symptoms
Lightning	None	Grounding all equipment, stop work during thunderstorms and seek shelter	Weather reports and visual observation
Flash floods	None	Seek shelter on high ground	Weather reports and visual observation

- All samples will be screened by trained personnel using high explosives screening procedures as described in Laboratory safety procedures for fieldwork in explosive areas. The SSO will ensure that subcontractor procedures are equivalent to Laboratory high explosives procedures.
- Sample containers will be shipped in paint cans padded with vermiculite and placed in a cooler with ice packs. The sample and exterior packaging will be properly labeled. The size of samples should be minimized.
- Samples will be handled only in well-ventilated areas, and their exposure to light and heat will be minimized.
- Latex gloves and safety glasses will be worn during sample collection.
- The skin will be washed thoroughly with soap and water immediately after accidental contact.

If noticeable surface or buried explosive residues or fragments are encountered in the immediate vicinity of ER operations, the operations will be halted. This decision will be made by the field team leader and the SSO. The HSPL and the Explosives Review Committee will be consulted before resuming field activities.

4.1.2 Altitude Sickness

Individuals coming to the Laboratory from lower elevations may experience altitude sickness. Workers who have existing conditions, such as respiratory or cardiovascular disease, and others coming from low elevations who are expected to perform heavy physical labor are at highest risk. Recognition of individual risk factors and allowance for acclimatization are the keys to prevention.

At higher altitudes, atmospheric pressure is reduced and less oxygen is available. A unit of work, whether performed at a high altitude or sea level, requires the same amount of oxygen. Oxygen flow to body tissues must remain constant to maintain that level of work. Increased respiration and cardiovascular response can only partially compensate for these factors in individuals suddenly placed at high altitude. The factors playing a part in determining working capacity at high altitudes are actual altitude (low, moderate, high), duration of exposure, and individual factors. It is not anticipated that work will require ascents of more than 200 to 300 ft at any time. Thus, too rapid ascension to high altitudes should not be a problem.

The Laboratory's moderate altitude (approximately 7,500 ft) will probably have an effect on prolonged endurance for unacclimatized individuals. However, acclimatization should be rapid (one or two weeks). Duration of exposure will dictate whether persons have an opportunity to acclimate or not. Individuals working on short-term assignments of less than two weeks will probably not acclimate.

4.2 Chemical Hazards

This section identifies and provides information on potential chemical contaminants that are known or are suspected to be present in OU 1111. When additional potential contaminants are identified, they will be added to the plan's list. The SSO will be responsible for adding chemicals to this list and notifying field personnel as needed.

The site-specific health and safety plan will provide information for known contaminants. The information will include the American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV) (ACGIH 1990, 0858), concentrations immediately dangerous to life and health, exposure symptoms, ionization potential and relative response factors for commonly used instruments (re-evaluated when a particular instrument is selected), and the best instrument for screening.

Table III-3 lists the potential chemical contaminants. This table should be used for general recognition of the chemicals to which workers may be exposed. More specific information can be obtained from Chapter 5.

4.3 Radiological Hazards

The principal pathways by which individuals may be exposed to radioactivity during field investigations include

- inhalation or ingestion of radionuclide particles or vapors,
- dermal absorption of radionuclide particulates or vapors through wounds,
- dermal absorption through intact skin, and
- exposure to direct gamma radiation from contaminated materials.

Table III-4 provides the specific properties of the radionuclides that may be present in OU 1111, including type of emission and half-life. As concentrations of these radionuclides are determined and additional radionuclides identified, the table will be updated. The SSO will be responsible for adding radionuclides to this table and notifying field personnel.

4.4 Biological Hazards

Several biological hazards found at Los Alamos are not common in other parts of the country. These include, but are not limited to, rattlesnakes, wild animals, ticks, plague, giardia lamblia, and black widow spiders. Table III-5 summarizes potential biological hazards for OU 1111.

4.5 Task-by-Task Risk Analysis

A task-by-task risk analysis, required by 29 CFR 1910.120 (DOL 1989, 0952), will be included with each site-specific health and safety plan. This process analyzes the operations and activities by task for specific hazards. Examples of some of the tasks that should be analyzed and documented in the plan are drilling, hand augering, trenching, septic system sampling, sampling in areas where explosives may be present, and canyon-side sampling.

Other tasks should be considered for inclusion by the SSO.

TABLE III-3

POTENTIAL CHEMICAL CONTAMINANTS[a, b]

Contaminant	Exposure Limit (8-hour TWA)[c]	IDLH	Symptoms of Exposure	Route(s) of Exposure	Monitoring Instrument Direct Method	Monitoring Instrument Indirect Method
Acetone	750 ppm	20,000 ppm	Irritation of eyes, nose, and throat; dermatitis; dizziness	Inhalation, ingestion, skin contact	PID, FID, detector tube	Charcoal tube, GC, NIOSH Method 1300
Alcohols	Varies	Varies	Central nervous system depression, nausea, vomiting, liver and kidney damage, skin irritation	Inhalation, absorption, ingestion, eye/skin contact	Detector tube	Varies
Aluminum and aluminum oxide	10 mg/m^3	N/A	Weakness, fatigue, respiratory distress	Inhalation, ingestion	None	MCEF, AA, NIOSH Method 7013
Barium	0.5 mg/m^3	1,100 mg/m^3	Upper respiratory irritation, gastroenteritis, muscular paralysis, eye and skin irritation	Inhalation, ingestion, skin contact	None	MCEF, AA, OSHA Method
Benzene[d]	1.0 ppm 25 ppm - ceiling 50 ppm - 10 min maximum peak	3000 ppm	Eyes, nose, and respiratory system irritation; giddiness; headache; nausea; staggered gait; fatigue; anorexia; lassitude; dermatitis; bone marrow depression; carcinogen	Inhalation, absorption, ingestion, eye/skin contact	PID, FID, detector tube	Charcoal tube, GC, NIOSH Method 1500
Calcium oxide	2 mg/m^3	N/A	Eye and upper respiratory tract irritation, ulcer, perforated nasal septum, pneumonia, dermatitis	Inhalation, ingestion, eye/skin contact	None	MCEF, AA, NIOSH Method 7020

Table III-3 (continued)

Contaminant	Exposure Limit (8-hour TWA)[c]	IDLH	Symptoms of Exposure	Route(s) of Exposure	Monitoring Instrument Direct Method	Monitoring Instrument Indirect Method
Carbon tetrachloride[d]	2 ppm 200 ppm - 5 min in any 4 hours	300 ppm	Central nervous system depression, nausea, vomiting, liver and kidney damage, skin irritation, suspect human carcinogen	Inhalation, absorption, ingestion, eye/skin contact	PID, FID, detector tube	Charcoal tube, GC, NIOSH Method 1003
Chromic acid and chromates (as CrO_3)[d]	0.1 mg/m^3 - ceiling		Respiratory system irritation, nasal septum perforation, liver and kidney damage, leukocytosis, leukopenia, monocytosis, eosinophilia, eye injury, conjunctivitis, skin ulcer, sensitization	Inhalation, ingestion, skin contact	Detector tube (chromic acid)	MCEF, AA, NIOSH Method 7024 or PVC, Visible Absorption Spectro-photometry, NIOSH Method 7600
Chromium metal[d]	0.5 mg/m^3	N/A	Histologic fibrosis of lungs	Inhalation, ingestion	None	MCEF, AA, NIOSH Method 7024
Cobalt[d]	0.05 mg/m^3	20 mg/m^3	Cough, dyspnea, decreased pulmonary function, low weight, dermatitis, diffuse nodular fibrosis, respiratory hypersensitivity	Inhalation, ingestion, eye/skin contact	None	MCEF, AA, NIOSH Method 7027
Copper	1.0 mg/m^3 (dust and mist)	None	Irritation of nasal mucus membrane, pharynx, nasal perforation, dermatitis	Inhalation, ingestion, skin contact	None	MCEF, AA, NIOSH Method 7029

Table III-3 (continued)

Contaminant	Exposure Limit (8-hour TWA)[c]	IDLH	Symptoms of Exposure	Route(s) of Exposure	Monitoring Instrument Direct Method	Monitoring Instrument Indirect Method
Diethyl ether	400 ppm 500 ppm - STEL	19,000 ppm	Dizziness, drowsiness, headache, excitedness, narcosis, nausea, vomiting, eye, skin, and upper respiratory tract irritation	Inhalation, ingestion, eye/skin contact	PID, PID, detector tube	Charcoal tube, GC, NIOSH Method 1610
Fluoride	2.5 mg/m^3	500 mg/m^3	Eye and respiratory system irritation, nausea, abdominal pain, diarrhea, excessive salivation, thirst, sweating, stiff spine, dermatitis, calcification of ligaments of ribs, pelvis	Inhalation, ingestion, skin/eye contact	None	MCEF and Na_2CO_3-treated cellulose pad, ion-specific electrode, NIOSH Method 7902
Hydrofluoric acid	3 ppm 6 ppm - STEL	30 ppm	Eyes, nose, and throat irritation; pulmonary edema; skin and eye burns; nasal congestion; bronchitis	Inhalation, absorption, ingestion, eye/skin contact	Detector tube	Silica gel tube, ion chromatography, NIOSH Method 7903
Lead	0.05 mg/m^3	700 mg/m^3	Weakness, insomnia, constipation, malnutrition, abdominal pain, tremor, anorexia, anemia, face pallor, encephalopathy	Inhalation, ingestion, skin contact	None	MCEF, AA, NIOSH Method 7082
Machine oil	5 mg/m^3	N/A	None reported	Inhalation	Aerosol photometer	Tared PVC, gravimetric, NIOSH Method 0500
Magnesium oxide fume - total particulate	10 mg/m^3	N/A	Eye and nose irritation, metal fume fever, cough, chest pain, flu-like fever	Inhalation, eye/skin contact	None	MCEF, ICP, NIOSH Method 7300

Table III-3 (continued)

Contaminant	Exposure Limit (8-hour TWA)[c]	IDLH	Symptoms of Exposure	Route(s) of Exposure	Monitoring Direct Method	Instrument Indirect Method
Nickel[d]	0.05 mg/m^3		Headache, vertigo, nausea, vomiting, epigastric pain, cough, hyperpnea, cyanosis, weakness, pneumonitis, delirium, convulsions	Ingestion, inhalation, skin contact	None	MCEF, ICP, NIOSH Method 7300
Nitric acid	2 ppm, 4 ppm - STEL	100 ppm	Irritated eyes, mucus membranes, and skin; delayed pulmonary edema; pneumonitis; bronchitis; dental erosion	Inhalation, absorption, ingestion, skin contact	Detector tube	Silica gel tube, ion chromatography, NIOSH Method 7903
Particulates not otherwise regulated (metals: zinc, iron)	15 mg/m^3, total dust 5 mg/m^3, respirable fraction	N/A	None reported	Inhalation	RAM	Total dust-tared PVC, Gravimetric, NIOSH Method 0500 respirable fraction-cyclone and tared PVC, Gravimetric, NIOSH Method 0600
Perchloroethylene	25 ppm	500 ppm	Eye, nose, and throat irritation; nausea; flush face and neck; vertigo; dizziness; incoordination; headache; somnolence; skin erythema; liver damage	Inhalation, ingestion, eye/skin contact	PID, FID, detector tube	Charcoal tube, GC, NIOSH Method 1003
Phosphoric acid	1 mg/m^3 3 mg/m^3 - STEL	10,000 mg/m^3	Eyes, skin, and upper respiratory tract irritation; skin and eye burns; dermatitis	Inhalation, ingestion, eye/skin contact	Detector tube	Silica gel tube, ion chromatography, NIOSH Method 7903

Table III-3 (continued)

Contaminant	Exposure Limit (8-hour TWA)[c]	IDLH	Symptoms of Exposure	Route(s) of Exposure	Monitoring Instrument Direct Method	Monitoring Instrument Indirect Method
Photographic processing chemicals	Varies	Varies	A variety of chemicals are used in this process (Attachment B)	Inhalation, ingestion, absorption, skin contact	Varies	Varies
Plating and etching chemical anions	Varies	Varies	A variety of chemical anions may result from these processes	Inhalation, ingestion, absorption, skin contact	Varies	Varies
Polychlorinated biphenyls[d] (Aroclor 1242)	1 mg/m^3 (skin) (Aroclor 1242), 0.5 mg/m^3 (skin) (Aroclor 1254)		Irritated eyes and skin, chloracne	Inhalation, absorption, ingestion, skin contact	None	GFF + Florisil tube, GC, NIOSH Method 5503
Silver	0.01 mg/m^3	None	Nasal septum, throat, and skin irritation; skin ulceration; gastrointestinal irritation; blue-gray eyes and patches on skin	Inhalation, ingestion, skin contact	None	MCEF, ICP, NIOSH Method 7300
Sodium cyanide	5 mg/m^3	50 mg/m^3	Asphyxiation and death, weakness, headache, confusion, nausea, vomiting, increased rate of respiration, irritated eyes and skin	Ingestion, absorption, inhalation, skin contact	Detector tube	MCEF + KOH impinger, ion-specific electrode, NIOSH Method 7904
Sodium hydroxide	2 mg/m^3 - ceiling	250 mg/m^3	Eye, nose, and throat irritation; pneumonitis; skin burns; temporary loss of hair	Inhalation, ingestion, skin contact	Detector tube	PTFE, acid-base titration, NIOSH Method 7401
Sulfuric acid	1 mg/m^3	80 mg/m^3	Eye, nose, and throat irritation; pulmonary edema; bronchitis; emphysema; conjunctivitis; stomatitis; skin and eye burns; dermatitis	Inhalation, ingestion, eye/skin contact	Detector tube	Silica gel tube, ion chromatography, NIOSH Method 7903

Table III-3 (concluded)

Contaminant	Exposure Limit (8-hour TWA)[c]	IDLH	Symptoms of Exposure	Route(s) of Exposure	Monitoring Instrument Direct Method	Monitoring Instrument Indirect Method
Tetryl	1.5 mg/m^3	N/A	Sensitization dermatitis; itch; erythema; edema on nasal folds, cheeks, and neck; keratitis; sneezing; anemia; fatigue; cough; coryza; irritability; malaise; headache; lassitude; insomnia; nausea; vomiting	Inhalation, absorption, ingestion, eye/skin contact	None	MCEF, Colorimetric, OSHA Method
Thallium[d]	0.1 mg/m^3	20 mg/m^3	Nausea, diarrhea, abdominal pain, vomiting, ptosis, strabismus, peripheral neuritis, tremors, chest pain, pulmonary edema, seizure, chorea, psychosis, liver and kidney damage, alopecia, paresthesia of legs	Inhalation, absorption, ingestion, eye/skin contact	None	MCEF, ICP, NIOSH Method 7300
Trichloro-ethylene[d]	50 ppm 100 ppm - STEL	1000 ppm	Headache, vertigo, visual disturbance, tremors, somnolence, nausea, vomiting, eye irritation, dermatitis, cardiac arrhythmias, paresthesia	Inhalation, ingestion, eye/skin contact	PID, FID, detector tube	Charcoal tube, GC, NIOSH Method 1022

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[a] Explosives will be added to this table.

[b] Acronyms and abbreviations are defined below.

[c] The most stringent of either the OSHA PEL-TWA or ACGIH TLV-TWA.

[d] Indicates potential human carcinogens

AA = atomic absorption
FID = flame ionization detector
GC = gas chromatograph
GFF = glass fiber filter
ICP = inductively coupled plasma
IDLH = immediately dangerous to life and health
MCEF = mixed cellulose ester filter
PEL = permissible exposure limit
PID = photoionization detector
PTFE = polytetrafluoroethylene
PVC = polyvinyl chloride
STEL = short-term exposure limit
TWA = time weighted average

TABLE III-4

RADIONUCLIDES THAT MAY BE PRESENT IN OU 1111

Radionuclide	Major Radiation	DAC[a] (μCi/mL)	Radioactive Half-life (years)	Monitoring Instrument
Cesium-137	Gamma	5×10^{-5}	30	Geiger-Mueller survey meter
Potassium-40	Beta	2×10^{-7}	1.26×10^{9}	Geiger-Mueller survey meter
Strontium-90	Beta	2×10^{-9}	27.7	Liquid scintillation counter
Thorium-230	Alpha, gamma	4×10^{-14}	8×10^{4}	Alpha scintillometer, FIDLER[b]
Uranium-233	Alpha, gamma	4×10^{-12}	1.6×10^{5}	Alpha scintillometer, FIDLER
Uranium-234	Alpha, gamma	4×10^{-12}	2.5×10^{5}	Alpha scintillometer, FIDLER
Uranium-235	Alpha, gamma	2×10^{-11}	7×10^{8}	Alpha scintillometer, FIDLER
Uranium-238	Alpha, gamma	2×10^{-11}	4.5×10^{9}	Alpha scintillometer, FIDLER

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[a] DAC = derived air concentration (DOE 1988, 0076)
[b] FIDLER = field instrument for the detection of low-energy radiation

TABLE III-5

POTENTIAL BIOLOGICAL HAZARDS IN OU 1111

Hazard Description	PPE	Prevention Methods
Snake bites (rattlesnake)	Long pants, snake leggings, boots	Wear PPE where footing is difficult to see, avoid blind reaches
Animal bites (dog, cat, coyote, mountain lion, bear)	Long pants, boots	Avoid wild or domestic animals, do not approach or attempt to feed
Ticks (may cause Lyme disease or tick fever)	Long pants, long-sleeved shirts, boots	Perform tick inspections of team members after working in brushy or wooded areas
Rodents (prairie dogs and squirrels may carry plague-infected fleas)	Long pants, boots	Do not handle live or dead rodents
Human sewage (may contain pathogenic bacteria)	Disposable coveralls and gloves	When sampling in septic systems, wear protective gear and dispose of properly; wash hands thoroughly after contact
Blood borne pathogens (blood, blood products, and human body fluids may contain Hepatitis B virus or HIV)	Latex gloves, mouth guards, protective eye wear	Only trained personnel should perform first aid procedures, follow laboratory blood borne pathogen control procedures
Poisonous plants (poison ivy)	Gloves, long pants, long-sleeved shirts, boots	Recognize plants, avoid contact, wash hands and garments thoroughly after contact
Waterborne infectious agents (stream water may contain giardia lamblia)	None	Drink water only from potable sources
Spiders (brown recluse, black widow)	Gloves, long pants, long-sleeved shirt, boots	Use caution when in wood piles or dark enclosed places

5.0 SITE CONTROL

5.1 Initial Site Reconnaissance

Initial site reconnaissance may involve surveyors, archaeologists, and biological resource personnel. Health and safety concerns that may be present must be addressed. The OUPL and HSPL will identify these concerns and institute measures to protect personnel.

5.2 Site-Specific Health and Safety Plans

Each ER operation (e.g., a sampling campaign) within an OU requires a site-specific health and safety plan. Planning, special training, supervision, protective measures, and oversight needs are different for each operation. The site-specific plan addresses the safety and health hazards of each ER operation and includes requirements and procedures for employee protection. All site-specific health and safety plans for OU 1111 derive from this project plan.

The standard outline for a site-specific health and safety plan follows OSHA requirements and serves as a guide for best management practice. Those performing the fieldwork are responsible for completing the site-specific plan.

Changes to the plan must be made in writing. The HSPL will approve changes, and site personnel will be notified of changes during the daily tailgate meetings. Records of plan approvals and changes will be maintained by the SSO.

5.3 Work Zones

Maps identifying work zones, which will be determined by the SSO, will be included with each site-specific health and safety plan. Markings used to designate each zone boundary (red or yellow tape, fences, barricades, and other markings) will be discussed in the plan. Work zones, defined below, are not required for every ER operation.

- **Exclusion zone.** The exclusion zone is the area where contamination is either known or likely to be present and, because of work activities, will present a potential hazard to personnel. Entry into the exclusion zone requires the use of PPE.

- **Decontamination zone.** The decontamination zone is the area where personnel and equipment are decontaminated and is a buffer between contaminated and clean areas. Activities in the decontamination zone require the use of PPE, as defined in the decontamination plan. Section 11.1.1 contains details of the decontamination plan.

- **Support zone.** The support zone is a clean area. PPE, other than safety equipment appropriate to the tasks performed (e.g., safety glasses, protective footwear, and other equipment), is not required.

Evacuation routes should be upwind or crosswind of the exclusion zone. A muster area must be designated by the SSO for each evacuation route.

5.4 Security Areas

Security areas will be shown on the site maps. Standard Laboratory security procedures will be followed for accessing security areas. All subcontractors and visitors must be processed through the badge office before entering security areas. It is the responsibility of the OUPL to see that subcontractor personnel have badges. It is the responsibility of Laboratory employees to enforce security measures.

5.5 Communications Systems

Portable telephones, CB radios, and two-way radios may be used for on-site communications. The use of transmitting equipment may be limited in areas where certain types of explosive equipment are present; hand signals and oral communications should be used in these areas.

5.6 General Safe Work Practices

Before beginning work, workers will be instructed on safe work practices to be followed when performing tasks and operating equipment needed to complete the project. Daily safety tailgate meetings will be conducted at the beginning of the shift to brief workers on recent developments and special precautions to be taken.

The following items are required to protect field workers and will be reiterated in site-specific health and safety plans. Depending on site-specific conditions, items may be added or deleted.

- The buddy system will be used. Hand signals will be established and used. Visual contact must be maintained between buddies on site.
- During site operations, each worker should be a safety backup to his/her buddy. All personnel should be aware of dangerous situations that may develop.
- Eating, drinking, chewing gum or tobacco, smoking, or any practice that increases the probability of hand-to-mouth transfer and ingestion of potentially contaminated material is prohibited in any area designated as contaminated.
- Prescription drugs should not be taken by personnel if the potential for contact with toxic substances exists, unless specifically approved by a qualified physician.
- Alcoholic beverage intake is prohibited during the work day.
- Disposable clothing will be used as necessary to minimize the risk of cross-contamination.
- The number of personnel and equipment in a contaminated area should be minimized.
- Staging areas for various operations (e.g., equipment testing, decontamination) will be established.
- Motorized equipment will be inspected to ensure that brakes, hoists, cables, and other mechanical components are operating properly.
- Procedures for leaving a contaminated area will be planned and reviewed before entering such an area.

- Proper decontamination procedures will be followed before leaving the site, except in medical emergencies.
- Any medical emergency supersedes routine safety requirements.
- Work areas and decontamination procedures will be established based on prevailing site conditions and will be subject to change.
- Wind direction indicators will be strategically located on site.
- Contact with contaminated or potentially contaminated surfaces should be avoided. Whenever possible, walking through puddles, mud, or discolored ground surface; kneeling on the ground; or leaning, sitting, or placing equipment on drums, containers, vehicles, or on the ground should be avoided.
- No personnel will be allowed to enter the site without proper safety equipment.
- Housekeeping will be emphasized to prevent injury from tripping, falling objects, and accumulation of combustible materials.
- All personnel must comply with established safety procedures. Any team member or visitor who does not comply with safety policy, as established by the SSO, will be immediately dismissed from the site.

5.7 Specific Safe Work Practices

5.7.1 Electrical Safety-Related Work Practices

The most effective way to avoid accidental contact with electricity is to de-energize the system or maintain a safe distance from the energized parts. OSHA regulations require minimum distances from energized parts. An individual working near power lines must maintain at least a 10-foot clearance from overhead lines of 50 kV or less; this clearance includes any conductive material the individual may be using. For voltages over 50 kV, the 10-foot clearance must be increased 4 inches for every 10 kV over 50 kV. For underground electrical service, the underground locator service must be contacted before digging.

Grounding is a secondary form of protection that ensures a path of low resistance to ground. A properly installed ground wire becomes the path for electrical current if the equipment malfunctions. Without proper grounding, an individual touching the equipment could become the path to ground. An assured electrical grounding program or ground fault interrupter is required.

5.7.2 Lockout/Tagout

All site workers should follow Laboratory procedures, LP 106-01.1 and LP 106-02.0, for control of hazardous energy sources. Lockout/tagout procedures are used to control hazardous energy sources, such as electricity, potential energy, thermal energy, chemical corrosivity, chemical toxicity, or hydraulic and pneumatic pressure.

5.7.3 Confined Space

Entry to confined spaces and work to be conducted in confined spaces will adhere to procedures in the Laboratory Confined Space Entry Program, Laboratory Administrative Requirement (AR) 8-1 (August 1984, ES&H manual). These procedures require that a confined space entry permit be obtained and posted at the work site. Prior to entry, the atmosphere will be tested for oxygen content, flammable vapors, carbon monoxide, and other hazardous gases. Continuous monitoring for these constituents will be performed if conditions or activities have the potential to adversely affect the atmosphere.

5.7.4 Handling Drums and Containers

Drums and containers used during cleanup will meet US Department of Transportation, OSHA, and EPA regulations. Work practices, labeling requirements, spill containment measures, and precautions for opening drums and containers will be in accordance with 29 CFR 1910.120 (DOL 1989, 0952). Drums and containers that contain radioactive material must also be labeled in accordance with AR 3-5, Shipment of Radioactive Materials, and AR 3-7, Radiation Exposure Control (January 1991, ES&H manual), and Article 412, Radioactive Material Laboratory, DOE Radiological Control Manual. Provisions for these activities will be clearly outlined in the site-specific health and safety plan, if applicable.

5.7.5 Illumination

Illumination will meet the requirements of Table H-120.1, 29 CFR 1910.120 (DOL 1989, 0952). Table III-6 lists OSHA-required illumination levels.

5.7.6 Sanitation

An adequate supply of potable water will be provided at the site. Nonpotable water sources will be clearly marked as not suitable for drinking and washing. There will be no cross-connections between potable and nonpotable water systems.

TABLE III-6

REQUIRED ILLUMINATION LEVELS

Foot-candles	Area or Operations
5	General site areas
3	Excavation and waste areas, access ways, active storage areas, loading platforms, refueling, and field maintenance areas
5	Indoors: warehouses, corridors, hallways, and exit ways
5	Tunnels, shafts, and general underground work areas. (Exception: a minimum of 10 foot-candles is required at each tunnel and shaft heading during drilling, mucking, and scaling. Cap lights approved by the Bureau of Mines are acceptable.)
10	General shops (e.g., mechanical and electrical equipment rooms, active storerooms, barracks or living quarters, locker or dressing rooms, dining areas, and indoor toilets and workrooms)
30	First aid stations, infirmaries, and offices

At remote sites, at least one toilet facility will be provided, unless the crew has transportation readily available to nearby toilet facilities.

Adequate washing facilities will be provided when personnel are in areas where they may be exposed to hazardous substances. Washing facilities will be located in areas where exposure to hazardous materials is below permissible exposure limits (PELs) and where employees may decontaminate themselves before entering clean areas. Showers and change rooms will be provided as necessary and will meet the requirements of 29 CFR 1910.141 (DOL 1989, 0952).

5.7.7 Packaging and Transport

The OUPL should contact EM-7 to determine requirements for handling hazardous waste to ensure that practices for storage, packaging, and transportation comply with ARs 10-2 (February 1991, ES&H manual) and 10-3 (April 1993, ES&H manual). Disposal of hazardous wastes generated from a project will be handled by EM-7.

5.7.8 Government Vehicle Use

Only government vehicles can be driven onto contaminated sites. All personnel must wear seat belts in a moving vehicle.

5.7.9 Extended Work Schedules

Work outside normal work hours must have the prior approval of the OUPL and SSO.

5.8 Permits

5.8.1 Excavation Permits

Any excavation at OU sites must be conducted in accordance with Laboratory AR 1-12, Excavation or Fill Permit Review (October 1991, ES&H manual). Field team leaders will be responsible for determining when excavation permits are required. The OUPL and field team leader are responsible for requesting the excavation permit (Form 70-10-00.1). At the top of the form, indicate that this is an ER Program activity. The permit is reviewed by Health and Safety and EM divisions for environmental safety and health concerns.

5.8.2 Other Permits

Additional permits that may be required for field activities include radiation work permits, lockout/tagout permits, and special work permits for spark/flame-producing operations or confined space entry. The SSO and OUPL are responsible for obtaining permits and maintaining documentation. Permits will be specifically addressed in the site-specific health and safety plan.

6.0 PERSONAL PROTECTIVE EQUIPMENT

6.1 General Requirements

PPE will be selected, provided, and used in accordance with the requirements listed in this section.

If engineering controls and work practices do not provide adequate protection against hazards, PPE may be required. Use of PPE is required by OSHA regulations in 29 CFR Part 1910, Subpart I (DOL 1989, 0952) (Table III-7). These regulations are reinforced by EPA regulation 40 CFR Part 300 (EPA 1990, 0559), which requires private subcontractors working on Superfund sites to conform to applicable OSHA provisions and any other federal or state safety requirements deemed necessary by the lead agency overseeing the activities.

The use of PPE for radiological protection is also governed by the radiation work permit (or safety work permits/radiation work). AR 3-7 (January 1991, ES&H manual) and Article 325, Article 461, Table III-1, and Appendix 3C of the DOE Radiological Control Manual contain guidelines for the use of protective clothing during radiological operations. Efforts should be made to keep disposable PPE used for radiological work from becoming contaminated with hazardous chemicals; this would generate mixed waste unnecessarily. In sites where both types of contaminants are present, this may not be possible.

If PPE is required for an ER operation, a PPE program must be in place. Hazard identification, medical monitoring, training, environmental surveillance, selection criteria, use, maintenance, and decontamination of PPE are the essential elements of an effective PPE program.

Medical approval may be required before donning certain PPE. See Section 9 for more details.

<u>TABLE III-7</u>

OSHA STANDARDS FOR PPE USE

Type of Protection	Regulation*
General	29 CFR Part 1910.132 29 CFR Part 1910.1000 29 CFR Part 1910.1001-1045
Eye and face	29 CFR Part 1910.133(a)
Hearing	29 CFR Part 1910.95
Respiratory	29 CFR Part 1910.134
Head	29 CFR Part 1910.135
Foot	29 CFR Part 1910.136
Electrical protective devices	29 CFR Part 1910.137

*(DOL 1989, 0952)

6.2 Levels of PPE

The individual components of clothing and equipment must be assembled into a full ensemble that protects the worker from site-specific hazards and minimizes the hazards and disadvantages of the PPE. Attachment A lists ensemble components based on the widely used EPA levels of protection: Levels A, B, C, and D. This list can be used as a starting point for ensemble creation; however, each ensemble must be tailored to the specific situation to provide the most appropriate level of protection.

The type of equipment used and the level of protection required should be re-evaluated periodically as information about the site increases and as workers are required to perform different tasks. Personnel should be able to upgrade or downgrade their level of protection with the concurrence of the SSO. The level of radiological PPE may only be changed as specified in the applicable permits. The following are reasons to upgrade:

- known or suspected presence of dermal hazards,
- occurrence or likely occurrence of gas or vapor emission,
- change in work task that will increase contact or potential contact with hazardous materials, or
- request of the individual performing the task.

The following are reasons to downgrade:

- new information indicating that the situation is less hazardous than was originally thought,
- removal of a hazard from the site, or
- change in work task that reduces contact with hazardous materials.

6.3 Selection, Use, and Limitations

PPE for a particular activity will be selected based on an evaluation of the hazards anticipated or previously detected at a work site. The equipment selected will provide protection from chemical and/or radiological materials that are known or suspected to be present and to which workers may be exposed.

6.3.1 Chemical Protective Clothing

Chemical protective clothing will be selected based on an evaluation of the performance characteristics of the clothing relative to the requirements of the site, the task-specific conditions and duration, and the potential hazards identified at the site.

6.3.2 Radiological Protective Clothing

Radiological protective clothing, as prescribed by the radiological work permit, should be selected based on the contamination level in the work area, the anticipated work activity, worker health considerations, and nonradiological hazards that may be present. A full set of radiological protective clothing includes coveralls, cotton glove liners, gloves, shoe covers, rubber overshoes, and a hood. A double set of protective clothing includes two pairs of coveralls, cotton glove liners, two pairs of gloves, two pairs of shoe covers, rubber overshoes, and a hood.

Cotton glove liners may be worn inside standard gloves for comfort but should not be worn alone or considered a layer of protection. Shoe covers and gloves should be sufficiently durable for the task. Leather or canvas work gloves should be worn instead of or in addition to standard gloves for work activities requiring additional strength or abrasion resistance. Hard hats in contamination areas should be used as specified in the radiological work permit; they should be distinctly colored or marked.

Table III-8 provides general guidelines for selection.

6.3.3 Protective Equipment

Protective equipment, including protective eye wear and shoes, head gear, hearing protection, splash protection, lifelines, and safety harnesses, must meet standards set by the American National Standards Institute.

6.4 Respiratory Protection Program

When engineering controls cannot maintain airborne contaminants at acceptable levels, appropriate respiratory protective measures will be instituted. The Health and Safety Division administers the respiratory protection program, which defines respiratory protection requirements; verifies that personnel have met the criteria for training, medical surveillance, and fit testing; and maintains the appropriate records.

All supplemental workers will submit documentation of participation in an acceptable respiratory protection program to the Industrial Hygiene Group (HS-5) for review and signature approval before using respirators on site.

TABLE III-8

GUIDELINES FOR SELECTING RADIOLOGICAL PROTECTIVE CLOTHING

	Removable Contamination Values		
Work activity	**Low (1 to 10 times values)**	**Moderate (10 to 100 times values)**	**High (>100 times values)**
Routine	Full set of protective clothing	Full set of protective clothing	Full sets of protective clothing, double gloves, double shoe covers
Heavy work	Full set of protective clothing, work gloves	Double set of protective clothing, work gloves	Double set of protective clothing, work gloves
Work with pressurized or large volume liquids, closed system breach	Full set of nonpermeable protective clothing	Double set of protective clothing (outer set nonpermeable), rubber boots	Double set of protective clothing and nonpermeable outer clothing, rubber boots

7.0 HAZARD CONTROLS

7.1 Engineering Controls

Engineering controls are mechanical means for reducing hazards to workers; they include guarding moving parts on machinery and tools and using ventilation during confined space entry. OSHA regulations state that engineering controls should be used as the workers' first line of defense against hazards.

7.1.1 Airborne Dust

Airborne dust can be a nuisance or a hazard when radionuclides and/or hazardous substances attach to soil particles.

Dust generated by drilling or other disturbances of the soil can be controlled by spraying water or water containing surfactants onto the soil. Large quantities of water, supplied by a truck, may be necessary in large dusty areas or areas of little vegetation. Spraying may need to be repeated frequently to maintain moist soil. The amount of water applied should be controlled to prevent the spread of contamination by run-off or as mud tracked off site on vehicle tires.

Other measures for reducing exposure to dust include positive air-pressure cabs on heavy equipment, a windscreen to contain dust from small earth-moving operations, and, in extreme cases, a temporary enclosure. The last measure is more expensive and may increase the level of PPE required for workers in the enclosure.

7.1.2 Airborne Volatiles

Drilling, trenching, and soil and tank sampling activities may produce gases, fumes, or mists that may be inhaled or ingested by workers. Natural ventilation (wind) can be an effective control measure; workers should be located upwind of the activity whenever possible.

Mechanical ventilation is desirable in closed or confined spaces. A fan or blower may be attached to a large hose to push or pull contaminants from the confined space. Pulling the air is more effective at removing the vapors, whereas pushing air into the area ensures acceptable oxygen levels.

7.1.3 Noise

Drilling and trenching can produce high noise levels. On most rigs, the highest noise levels are on the side of the rig that is left open to cool the engine. Barriers may be constructed to reduce these high noise levels. Insulated cabs usually reduce noise to an acceptable level for equipment operators.

7.1.4 Trenching

Excavations deeper than 5 ft should be entered only when entry is necessary. OSHA regulations for trenches and excavations require engineering controls such as shoring, sloping, and benching to prevent cave-ins.

- **Benching** consists of digging a series of steps around the excavation at a specified angle of repose determined by the soil type. Benching is typically used for large excavations.
- **Sloping** is similar to benching but is performed without the steps. Again, the angle of repose is determined by the soil type. This method is generally used for medium-sized excavations, such as tank removal.
- **Shoring** can be done in many ways, but in all cases, the sides of the excavation are supported by a wall that is braced to prevent cave-ins. This method is used most often in deep, narrow trenches such as exploratory trenches and those used for installing water pipes or drainage systems.

7.1.5 Drilling

Drilling rigs contain hazards from moving parts and energy sources. Engineering controls include guards to prevent personnel from coming into contact with moving parts and a maintenance program to ensure replacement of worn or broken parts. Rigs should be inspected at the beginning of the job and periodically during the project.

7.2 Administrative Controls

Administrative controls are used when engineering controls are not feasible. They limit the degree of exposure (e.g., how long a worker is exposed to a hazard or how close to the hazard the worker remains). Worker rotation will not be used to achieve compliance with PELs or dose limits.

7.2.1 Airborne Chemical and Radiological Hazards

Personnel should enter the exclusion zone only when required. Chemical and radiological hazards will be monitored while personnel perform duties. If the concentration of radionuclides or hazardous materials exceeds acceptable limits, personnel will leave the area until natural or mechanical ventilation reduces concentrations to an acceptable level.

7.2.2 Noise

Administrative controls for noise include providing workers with quiet rest and lunch areas in which sound levels do not exceed 70 decibels. Workers should also be located as far from loud noise sources as practicable. Duration of exposure should be limited to the minimum time. Under no circumstances should workers be exposed to noise levels for durations greater than the time limits specified in 29 CFR 1910.95, Occupational Noise Exposure, Table G-16 (DOL 1989, 0952).

Rotation of workers between noisy jobs and less noisy jobs is not a good practice because, while it may reduce the amount of hearing loss individuals incur, it spreads the risk among other workers.

7.2.3 Trenching

Trenches less than 5 ft deep do not require protective systems (sloping, benching, or shoring). However at 4 ft, the trench must be monitored and a means of egress provided every 25 ft. Soil piles, tools, and other debris must be stored at least 2 ft from the edge of the excavation. Inspections should be made by a qualified person before a field team member is allowed to enter the excavation. When the area is not occupied, all excavations must be marked to restrict access.

7.2.4 Working Near the Mesa Edge

Personnel will remain at least 5 ft from the edge of the mesa. If necessary, ropes or guards will be used to delineate this restricted area. During canyon-side and outfall sampling, the worker taking the sample must be tied to a lifeline before descending over the edge and an attendant must always be present.

8.0 SITE MONITORING

Each site will be monitored for chemical, physical, and radiological agents. This information will be used to delineate work zone boundaries, identify appropriate engineering controls, select the appropriate level of PPE, ensure the effectiveness of decontamination procedures, and protect public health and safety. Biological monitoring is covered in Sections 9.0 and 10.0.

A monitoring program that meets the requirements of 29 CFR 1910.120 will be implemented (DOL 1989, 0952). A detailed monitoring strategy that describes the frequency, duration, and type of samples to be collected will be incorporated into each site-specific health and safety plan. Laboratory-approved sampling, analytical, and record-keeping methods must be used.

If exposures exceed acceptable limits, the HSPL, OUPL, and ER Program Manager will be notified. As soon as possible, the Health and Safety Division will initiate an investigation of the source, exposures to personnel working in the OU and in adjoining areas, any bioassay or other medical evaluations needed, and environmental impacts, if needed.

Subcontractors will be responsible for providing their own monitoring equipment and for determining their employees' occupational exposures to hazardous chemical and physical agents during the RFI. The Laboratory will perform oversight duties during these activities.

8.1 Airborne Contaminants

DOE has adopted OSHA PELs and ACGIH TLVs (ACGIH 1990, 0858) as standards for defining acceptable levels of exposure. The more stringent of the two limits applies.

8.1.1 Air Sampling Methods

Air sampling for chemical contaminants may use both direct and indirect methods. The SSO will determine the most appropriate sampling method for each situation. If there are any questions about sampling methodology, the SSO will consult with the HSPL or a certified industrial hygienist.

Direct methods provide near real-time results and are often used as screening tools to determine levels of PPE or the need for additional sampling. Examples of direct-reading instruments include the HNu photoionization detector, the organic vapor analyzer with flame ionization detector, and the gas detector pump with colorimetric tubes. These instruments are portable, easy to operate, and durable but are less specific and sensitive than many indirect-reading instruments.

In indirect sampling, a sample is collected in the field and transported to a laboratory for analysis. Indirect methods provide greater specificity and sensitivity but are less convenient and require a greater turnaround time for results.

8.1.2 Monitoring the Site

Site history should be used to determine whether the site needs to be monitored for specific chemical agents. Instruments that monitor for a wide range of chemicals, such as the organic vapor analyzer, combustible gas indicator, and HNu, may be used.

Initial air monitoring will be performed to characterize the exposure levels at the site and to determine the appropriate level of personal protection needed. Additional monitoring is required when

- work is initiated in a different part of the site,
- unanticipated contaminants are identified,
- a different type of operation is initiated (i.e., soil boring versus drum opening), or
- spills or leakage of containers are discovered.

Instrument readings should be taken in or near the worker's breathing zone. Individuals working closest to the source have the greatest potential for exposure to concentrations above acceptable limits. Monitoring strategies will emphasize worst-case conditions if monitoring each individual is inappropriate.

The perimeter, defined as the boundary of the OU, will be monitored to characterize airborne concentrations in adjoining areas. If results indicate that contaminants are moving off site, control measures must be re-evaluated.

8.2 Physical Hazards

Physical hazards that can readily be measured include noise, vibration, and temperature. These variables must be monitored to prevent injuries and illnesses related to overexposure. Most of the instruments used to measure physical hazards are direct reading and many have the ability to take short-term measurements and integrated, longer term measurements. Typically, short-term measurements are made during an initial survey and are used to determine whether longer term (e.g., full shift) monitoring is warranted.

8.2.1 Monitoring Personnel

Noise dosimeters are used to estimate the actual exposure that a worker receives during a shift. Results should be compared to the ACGIH TLVs (ACGIH 1990, 0858), in accordance with Laboratory policy, to determine whether workers must be included in a hearing conservation program.

Accelerometers can be used to monitor vibration levels, an isolated problem that does not warrant an ongoing monitoring program. The SSO should be aware of equipment and tasks that might expose workers to significant whole-body or hand and arm vibration. Typically, these include operation of heavy equipment, such as bulldozers and scrapers, and power hand tools, such as impact wrenches and concrete breakers.

Monitoring for heat stress is not mandated but can provide useful exposure information. Use of personal heat stress monitors must be approved by the HSPL prior to field use. Monitoring for cold stress is generally not performed or warranted for this type of operation.

8.2.2 Monitoring the Area

A sound-level survey meter should be used initially to characterize sound levels, which can help guide personal monitoring. If the sound-level survey and personal dosimetry indicate that sound levels exceed acceptable levels, then an octave-band analyzer may be used to characterize the noise. This provides important data for designing engineering controls.

Area monitoring for temperature extremes is usually sufficient for determining whether workers may be exposed to harmful conditions. Thermometers, psychrometers, and anemometers are direct-reading instruments that provide the necessary data.

8.3 Radiological Hazards

Sites that may have radiological hazards will be monitored, as necessary, to ensure that exposures are within the requirements of DOE Order 5480.11 (DOE 1990, 0732) and are as low as reasonably achievable (ALARA). Airborne radioactivity, external radiation fields, and surface contamination will be monitored. The Laboratory's workplace monitoring program is described in AR 3-7, Radiation Exposure Control (January 1991, ES&H manual). The success of the monitoring program in controlling exposures is measured by the dosimetry and bioassay programs. Chapter 3, Part 7, of the DOE Radiological Control Manual provides additional guidelines for radiological control during construction and restoration projects. All monitoring will be carried out in accordance with approved procedures and all monitoring instruments will meet the Laboratory's requirements for sensitivity, calibration, and quality assurance.

8.3.1 Airborne Radioactivity Monitoring

Occupied areas with the potential for airborne radioactivity will be monitored. Monitoring may include the use of portable high- and low-volume air samplers, continuous air monitors, and breathing-zone samplers. In areas where concentrations are likely to exceed 10% of any derived air concentration listed in DOE Order 5480.11 (DOE 1990, 0732), real-time continuous air monitoring will be provided. The results will be a basis for establishing dust suppression activities, upgrading PPE, and stop work actions.

8.3.2 Monitoring for External Radiation Fields

The site will be monitored for external radiation fields with portable survey instruments capable of measuring beta/gamma radiation over a wide range. In areas where radiation above an action level is expected, the monitoring should be continuous. Additional action levels may be established based on external radiation monitoring results.

8.3.3 Monitoring for Surface Contamination

Monitoring for surface contamination during operations will be conducted whenever a new surface is uncovered that may be radioactively contaminated. Personnel and equipment will be monitored whenever there is reason to suspect contamination and upon exit from an area that may be radioactively contaminated. Action levels for decontamination will be established.

8.3.4 Monitoring Personnel for External Exposure

In accordance with DOE Order 5480.11 (DOE 1990, 0732), dosimetry will be provided to OU workers who may, over a 1-yr period, exceed any one of the following:

- 100 mrem (0.001 sievert) effective dose equivalent to the whole body,
- 5 rem (0.05 sievert) dose equivalent to the skin,
- 5 rem (0.05 sievert) dose equivalent to any extremity, or
- 1.5 rem (0.015 sievert) dose equivalent to the lens of the eye.

Normally, workers meeting the above criteria will be monitored with thermoluminescent dosimeters (TLDs) provided by the Laboratory or the subcontractor; subcontractor TLDs must meet DOE requirements. Section 10 discusses monitoring personnel for internal exposure.

8.3.5 ALARA Program

To ensure that ALARA levels are maintained in the workplace, exposure of personnel should be monitored frequently. The ALARA program for ER projects consists of the following efforts.

8.3.5.1 Workplace ALARA Efforts

Engineering and administrative controls will be used to limit exposures and maintain ALARA levels. To verify that controls are adequate, the workplace will be monitored for radioactive materials and chemicals detectable by field instruments as indicated by expected or observed levels of exposure. Activities that result in unexpectedly high potential exposures will be terminated until acceptable ALARA levels are achieved.

8.3.5.2 Programmatic ALARA Efforts

The external and internal exposures of record for personnel are TLD readings and bioassay data, respectively. Field dose calculation, direct-reading pocket meters, and event-based lapel air sampling data are used to maintain estimates of personnel exposures to radioactive materials and hazardous chemicals. These estimates are correlated with job-specific activities (work location and work category) and individual-specific activities (job function).

Exposure estimates are reviewed periodically to identify unfavorable trends and unexpectedly high potential exposures. Activities showing unfavorable trends will be investigated, and recommendations will be made for additional administrative or physical controls, as appropriate.

All unfavorable trends and unexpectedly high potential exposures must be reported to the HSPL, who will make recommendations for corrective action.

9.0 MEDICAL SURVEILLANCE PROGRAM

Medical surveillance is required by 29 CFR 1910.120 (DOL 1989, 0952) for personnel who are or may be exposed to hazardous substances at or above established PELs for 30 days in a 12-month period, for those whose duties require the use of respirators, and for those that have symptoms indicating possible overexposure to hazardous substances.

All field team members in ER Program investigations will participate in a medical surveillance program. Line management is responsible for identifying employees that must be included in the surveillance program. The program will conform to DOE Order 5480.10 (DOE 1985, 0062), 29 CFR 1910.120 (DOL 1989, 0952), AR 2-1 (July 1991, ES&H manual), and any criteria established by the Occupational Medicine Group (HS-2) at the Laboratory.

Subcontractors are responsible for medical surveillance of their employees. Subcontractors must provide adequate documentation that their medical program complies with all applicable standards, DOE orders, and Laboratory requirements. This documentation must be submitted for review and approval before work begins. The Health and Safety Division will audit subcontractor programs.

9.1 Medical Examinations

An occupational and medical history will be taken and an initial exam will be done to determine fitness for duty. The examining physician will provide a report to the OUPL indicating approval to work on hazardous waste sites and wear respiratory protective equipment. The report will list work restrictions, if any.

Periodic medical exams will also be included in the program. AR 2-1 (July 1991, ES&H manual) specifies that Laboratory employees who work with hazardous waste, asbestos, beryllium, carcinogens, high noise, lasers, and certain other materials must undergo the exams. The content and frequency of medical exams depends on site conditions, current and expected exposures, job tasks, and the medical history of the workers.

A final medical examination will be provided for terminating personnel.

9.2 Treatment and Record Keeping

Any employee who develops signs or symptoms of exposure or who has been exposed at or above PELs in an uncontrolled or emergency situation will receive immediate medical treatment.

An accurate record of all medical surveillance required by 20 CFR 1910.120 (DOL 1989, 0952) will be retained for the period specified and meet the criteria of that regulation. In the event of an on-the-job injury, HS-2 will implement required reporting and record-keeping procedures. The site-specific health and safety plan describes the actions to be taken by the employee at the time of the injury/ illness.

9.3 Certification Exams

In addition to the above medical surveillance requirements, medical certification is required for employees whose work assignments include respirator use, Level A chemical protective clothing, and/or operation of cranes and heavy equipment. To become certified and maintain certification, medical evaluations, as specified by HS-2, are required.

10.0 BIOASSAY PROGRAM

RFI activities will include intrusive investigations of areas that may be contaminated. Because of the uncertainties associated with this fieldwork, the project internal exposure monitoring program is based on the assumption that personnel will be exposed to radioactive or hazardous chemical contaminants. Monitoring and control of internal contamination by hazardous chemical contaminants is included in the medical surveillance program. Monitoring of radioactive contaminants is covered by the project internal dosimetry program, in accordance with the provisions of HS-12. These provisions are outlined in the following sections.

10.1 Baseline Bioassays

Individuals carrying out field activities or visiting or inspecting field activities are assigned one of the following job categories:

- full-time on-site activities,
- support activities (e.g., supervision or inspection),
- routine or frequent visits (e.g., observing or auditing), or
- nonroutine or infrequent visits (e.g., management observations).

Individuals in the first three categories must submit baseline urine samples and undergo whole-body counting prior to participation in field activities. The baseline urine samples are analyzed for the solubility Class D and Class W compounds that could reasonably be expected to be encountered at the Laboratory. Whole-body counting analyzes for the gamma-emitting radionuclides that could reasonably be expected to be encountered at the Laboratory.

Results of the baseline bioassay analyses will be evaluated by a health physics specialist for evidence of previous exposure. Individuals exhibiting evidence of previous exposure will not be permitted to enter sites until an evaluation indicates that additional exposure will not result in exposures above applicable regulatory limits. This evaluation may include additional, rigorous sampling and/or counting to establish the physical and temporal parameters necessary to adequately assess the committed effective dose equivalent.

10.2 Routine Bioassays

The routine bioassay program is used to measure the effectiveness of the respiratory protection program. Frequency of the bioassay will depend on potential exposure to airborne radioactive materials and will be determined by a health physics specialist.

Evidence of inadequate respiratory protection will be cause for an investigation of the responsible field operation(s). The HSPL is responsible for investigating and identifying probable causes of respiratory protection program failure and for recommending corrective actions.

11.0 DECONTAMINATION

11.1 Introduction

Decontamination is critical to health and safety at hazardous waste sites and is defined as the process of removing or neutralizing contaminants that have accumulated on personnel and equipment. Decontamination protects workers from hazardous substances that may contaminate protective clothing, respiratory protection equipment, tools, vehicles, and other equipment. It minimizes the transfer of harmful materials into clean areas, helps prevent mixing of incompatible chemicals, and prevents uncontrolled transportation of contaminants from the site.

All personnel exiting an exclusion zone will be monitored to verify that they are free of significant contamination. Monitoring will be performed in accordance with Health and Safety Division requirements.

If monitoring indicates that an employee is contaminated with chemicals, biological agents, or radioactive materials, the employee's immediate supervisor will notify the SSO, who will record the details of the incident, determine whether any personal injury is involved, initiate decontamination, and notify the OUPL and HSPL. Equipment will also be monitored for contamination and decontaminated, if necessary, before being removed from the site. The SSO is responsible for these tasks. All contamination incidents will be reported immediately and will follow Laboratory Occurrence Reporting Program requirements to assure prompt notifications and appropriate emergency response actions.

11.1.1 Decontamination Plan

A site decontamination plan will be part of the site-specific health and safety plan and must include

- the number and layout of decontamination stations,
- the decontamination equipment needed,
- appropriate decontamination methods,
- procedures for preventing contamination of clean areas,
- methods and procedures to minimize worker contact with contaminants during removal of protective clothing, and
- methods for disposing of clothing and equipment that are not completely decontaminated.

The plan should be revised whenever the type of protective clothing or equipment changes, the site conditions change, or the site hazards are reassessed based on new information. The SSO is responsible for enforcing the decontamination plan.

11.1.2 Decontamination Facilities

The SSO will verify that decontamination facilities are maintained in acceptable condition and that supplies of decontaminating agents and other necessary materials are available. Personnel decontamination facilities will be equipped with showers, clean work clothing, decontamination agents, and, when necessary, a decontamination area where Health and Safety Division personnel can assist in decontaminating individuals. All wash solutions will be disposed of appropriately.

11.1.3 General Decontamination Methods

Cost, availability, and ease of implementation influence the selection of a decontamination method, but the primary determining factors are the following:

the decontamination method must be effective for the specific substances present and the method itself must not pose any health or safety hazards.

Specific and detailed decontamination methods will be included in the site decontamination plan. General approaches to decontamination are discussed below.

11.1.3.1 Physical Removal

In many cases, contaminants can be removed by dislodging/displacement, rinsing, wiping off, and evaporation. Physical methods involving high pressure or heat should be used only when necessary and with caution because they can spread contaminants and cause burns. Contaminants that can be removed by physical means can be categorized as follows:

- **Loose contaminants**. Dusts and vapors that cling to equipment and workers or become trapped in small openings, such as the weave of fabrics, can be removed with water or a liquid rinse. Multiple rinses with clean solutions remove more contaminants than a single rinse with the same volume of solution. Continuous rinsing with large volumes will remove even more contaminants than multiple rinses with a lesser total volume. Removal of electrostatically attached materials can be enhanced by coating the clothing or equipment with commercially available wash additives or antistatic sprays.

- **Adhering contaminants**. Some contaminants adhere by forces other than electrostatic attraction. Adhesive qualities vary with the specific contaminants and temperature. For example, contaminants such as glues, cements, resins, and muds are much more adhesive than elemental mercury and consequently are difficult to remove by physical means. Physical removal methods for these contaminants include scraping, brushing, and wiping. Removal can be enhanced by solidifying or melting. Contaminants can be solidified by removing moisture using adsorbents such as ground clay, cat litter, or powdered lime, chemical reactions via polymerization catalysts and chemical reagents, and freezing with ice water or dry ice.

- **Volatile liquids**. Volatile liquid contaminants can be removed from clothing or equipment by evaporation, which can be enhanced by steam jets followed by a water rinse. Care must be taken to prevent worker inhalation of the vaporized chemicals.

11.1.3.2 Chemical Removal

Physical removal of contaminants should be followed by a wash/rinse process using cleaning solutions. These cleaning solutions normally use solvents or surfactants.

Solvents must be chemically compatible with the equipment being cleaned, especially when decontaminating clothing. Organic solvents include alcohols, ethers, ketones, aromatics, straight-chain alkanes, and common petroleum products. Care must be taken in selecting, using, and disposing of organic solvents that may be flammable or toxic.

Halogenated solvents are generally incompatible with PPE and may be toxic. They should be used for decontamination only when other cleaning agents will not remove the contaminant. Use of halogenated solvents must be approved by the HSPL.

Table III-9 provides a general guide to the solubility of several contaminants in four types of solvents: water, dilute acids, dilute bases, and organic solvents. Because of the potential hazards, solvents other than water should be used for decontamination only if recommended by an industrial hygienist or another qualified health professional.

Surfactants augment physical cleaning methods by reducing adhesive forces between contaminants and the surface being cleaned and by preventing redeposit of the contaminants. Household detergents are among the most common surfactants. Some detergents can be used with organic solvents to improve the dissolving and dispersal of contaminants into the solvent.

11.1.3.3 Inactivation

Disinfection with chemical disinfectants can inactivate infectious agents. Standard sterilization techniques are generally impractical for large equipment and for clothing and equipment. Disposable PPE is therefore recommended for use with infectious agents.

Chemical detoxification methods include halogen stripping, neutralization, oxidation/reduction, and thermal degradation. These methods may require the use of strong reagents or heat and should only be used for decontamination if recommended by an industrial hygienist or another qualified health professional.

TABLE III-9

GENERAL GUIDE TO CONTAMINANT SOLUBILITY

Solvent	Soluble Contaminants
Water	Inorganic compounds, salts, some organic acids, alcohols, and other polar compounds
Dilute acids	Basic (caustic) compounds, amines, hydrazines
Dilute bases detergent soap	Acidic compounds, phenols, thiols, some nitro and sulfonic compounds
Organic solvents[a] alcohols ethers ketones aromatics straight-chain alkanes (e.g., hexane) common petroleum products (e.g., fuel oil, kerosene)	Nonpolar compounds (e.g., hydrocarbons and most organic compounds)

[a] WARNING: Some organic solvents can permeate and/or degrade personal clothing.

11.1.4 Emergency Decontamination

If personnel become contaminated with caustics, acids, and/or high levels of radioactive materials (100 mrad/hr), emergency shower facilities will be used as a first level of decontamination. These facilities will be able to accommodate a minimum of two individuals at one time. Appropriate medical and radiation safety personnel will assist as needed. Use of these facilities will be in accordance with Health and Safety Division requirements.

11.2 Personnel

11.2.1 Radiological Decontamination

Personnel exiting any area in which they may have become radioactively contaminated will be monitored for contamination. This excludes personnel exiting areas containing only radionuclides, such as tritium, that cannot be detected using hand-held or automatic monitoring equipment.

The monitored equipment used should be able to detect total contamination of at least the values specified in Table III-10. Use of automatic monitoring units that meet the above requirements is encouraged.

Personnel with detectable radioactive contamination on their skin or clothing, other than noble gases or natural background radioactivity, will be promptly decontaminated.

11.2.2 Chemical Decontamination

The decontamination of chemically contaminated personnel will be detailed in the site decontamination plan. Section 11.1.3.2 provides guidance on chemical decontamination.

11.3 Equipment Decontamination

Before they are released from the site, tools and equipment contaminated with removable radioactive and chemical materials in excess of applicable limits will be decontaminated. Tools and equipment that cannot be decontaminated in the field may be appropriately packaged and removed to a decontamination facility. Transportation of contaminated tools or equipment off site must be approved by the HSPL.

11.4 Waste Management

Fluids and materials from decontamination processes will be contained, sampled, and analyzed for contaminants. Those materials determined to be contaminated in excess of applicable limits should be packaged in approved containers and disposed of in accordance with EM Division procedures.

TABLE III-10

SUMMARY OF CONTAMINATION VALUES

Nuclide[a]	Removable (dpm/100 cm^2)[b,c]	Total (fixed + removable) (dpm/100 cm^2)
Natural uranium, uranium-235, uranium-238, and associated decay products	1,000 alpha	5,000 alpha
Transuranics, radium-226, radium-228, thorium-230, thorium-228, protactinium-231, actinium-227, iodine-125, and iodine-129	20	500
Natural thorium, thorium-232, strontium-90, radium-223, radium-224, uranium-232, iodine-126, iodine-131, and iodine-133	200	1,000
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except strontium-90 and others noted above. Includes mixed fission products containing strontium-90	1,000 beta gamma	5,000 beta gamma
Tritium organic compounds, surfaces contaminated by HT, HTO, and metal tritide aerosols	10,000	10,000

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[a] The values in this table apply to radioactive contamination deposited on but not incorporated into the interior of the contaminated item. Where contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for the alpha- and beta-gamma-emitting nuclides apply independently.

[b] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by swiping the area with dry filter or soft absorbent paper while applying moderate pressure and then assessing the amount of radioactive material on the swipe with an appropriate instrument of known efficiency. For objects with a surface area less than 100 cm^2, the entire surface should be swiped, and the activity per unit area should be based on the actual surface area. Except for transuranics, radium-228, actinium-227, thorium-228, thorium-230, protactinium-231, and alpha emitters, it is not necessary to use swiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual contamination levels are below the values for removable contamination.

[c] The levels may be averaged over 1 m^2 if the maximum activity in any area of 100 cm^2 is less than three times the guide values.

12.0 EMERGENCIES

12.1 Introduction

The Laboratory Emergency Management Office oversees and implements the full range of activities necessary for preparing for, mitigating, responding to, and recovering from emergency incidents at the Laboratory. All emergency action plans for ER operations must be consistent with the Laboratory Emergency Response Plan. The SSO, with assistance from the field team leader, will have the responsibility and authority for coordinating all emergency response activities until the proper authorities arrive and assume control. ER subcontractors are responsible for developing and implementing their own emergency action plans, as defined in 29 CFR 1910.38 (DOL 1989, 0952). Emergency response is defined by 29 CFR 1910.120 (DOL 1989, 0952).

Additional references include Laboratory AR 1-1, Accident and Occurrence Incident Reporting (August 1992, ES&H manual); AR 1-2, Emergency Preparedness (May 1990, ES&H manual); AR 1-8, Working Alone (April 1991, ES&H manual); and Technical Bulletin 101, Emergency Preparedness (May 1990, ES&H manual).

12.2 Emergency Response Plan

The Laboratory Emergency Response Plan establishes an organization capable of responding to the range of emergencies at the Laboratory. This organization is responsible for all elements of response throughout the duration of an emergency. Provisions are made for rapid mobilization of the response organizations and for expanding response commensurate with the extent of the emergency. The Laboratory Emergency Response Plan is designed to be compatible with emergency plans developed by local, state, tribal, and federal agencies through establishment of communications channels with these agencies and by setting criteria for the notification of each agency.

An Emergency Manager with the authority and responsibility to initiate emergency action under the provisions of the Laboratory Emergency Response Plan is available at all times. The Incident Commander is responsible for initial notification and communications and for providing protective action recommendations to buildings/areas within the emergency response zone and off site.

For emergencies that require evacuation (i.e., fire, medical, security, explosions, releases, and others), an emergency response plan specific to OU 1111 is required. This plan will establish evacuation routes for an emergency. In a worst case, an evacuation of all personnel from the work area would be required; in most instances, a safe distance may be established.

The SSO, with assistance from the field team leader, will have responsibility and authority for coordinating all emergency response activities until the proper authorities arrive and assume control. A copy of OU 1111 emergency response plans will be available at the work site at all times, and all personnel working at the site will be familiar with the plans.

12.3 Emergency Action Plan

An emergency action plan provides information for contingencies that may arise during field operations; it also provides site personnel with instructions for the appropriate responses in the event of on-site or off-site emergencies. The emergency action plan will be attached to the site-specific health and safety plan. At a minimum, the following elements will be included in the written plan:

- pre-emergency planning,
- emergency escape procedures and routes/site map,
- procedures to be followed by personnel who remain to operate critical equipment before they evacuate,
- procedures to account for all employees after evacuation,
- rescue and medical duties for those who are to perform them,
- names of those who can be contacted for additional information on the Health and Safety Project Plan,
- emergency communications,
- types of evacuation to be used,

- dissemination of emergency action plan to employees initially and whenever the plan changes,
- agreement with local medical facilities to treat injuries/illnesses,
- emergency equipment and supplies,
- injuries or illnesses,
- motor vehicle accidents and property damage, and
- site security and control.

12.4 Provisions for Public Health and Safety

Emergency planning is presented in the Laboratory's ES&H manual. The Laboratory identifies four categories of emergencies related to the release of hazardous materials into the environment. These categories are based on Emergency Response Planning Guideline (ERPG) concentrations developed by the American Industrial Hygiene Association and on the maximum concentration of toxic material that can be tolerated for up to 1 hr.

The categories are defined as follows:

- **Unusual event.** This normally would not be considered an emergency but could reduce the safety of the facility. No potential exists for significant releases of radioactive or toxic materials off site.

- **Site alert**. This would substantially reduce the safety level of the facility. Off-site releases of toxic materials are not expected to exceed ERPG-1 concentrations.

- **Site emergency**. An event that involves actual or likely major failures of facility functions necessary for the protection of human health and the environment. Releases of toxic materials to areas off site may exceed ERPG-2 concentrations.

- **General emergency**. This substantially interferes with the functioning of facility safety systems. Releases of radioactive materials to areas off site may exceed protective response recommendations, and toxic materials may exceed ERPG-3.

12.5 Notification Requirements

Field team members will notify the SSO of emergency situations. The SSO will notify the appropriate emergency assistance personnel (e.g., fire, police, and ambulance), the OUPL, the HSPL, the Laboratory Health and Safety Division according to DOE Order 5500.2 (DOE 1991, 0736), and DOE Albuquerque Operations Office (AL) Order 5000.3 (DOE/AL 1991, 0734). The Health and Safety Division is responsible for implementing notification and reporting requirements according to DOE Order 5484.1 (DOE 1990, 0733).

A form for emergency contacts (similar to the one shown in Table III-11) will be available in the field. This emergency contact form will be copied and posted in prominent locations at the work site. Two-way radio communication will be maintained at remote sites when possible.

TABLE III-11

EMERGENCY CONTACTS

Site Safety Officer Name:	Pager: Call:	
Environmental Restoration Health and Safety Project Leader Name: Susan Alexander	Pager: Call:	104-6579 665-5144
24-Hour LANL Health/Safety Coordinator Call:	Pager: Call:	104-1123 667-4512 (work) 672-3659 (home)

The emergency contact number at the Laboratory is 9-911. Dialing 911 from a Laboratory phones reaches emergency services but a response will be delayed.

12.6 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, safety, or health protection significance.

The OUPL will submit a completed DOE Form F 5484.X for any of the following occurrences, according to Laboratory AR 1-1 (August 1992, ES&H manual).

- **Occupational injury**. An 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 is an occupational injury. Conditions resulting from animal bites, such as insect or snake bites, or from one-time exposure to chemicals are considered injuries.

- **Occupational illness**. Any abnormal condition or disorder caused by exposure to environmental factors associated with employment is considered an occupational illness. 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**. Regardless of fault, accidents that cause damage to DOE property or accidents wherein DOE may be liable for damage to a second party are reportable where damage is $1,000 or more. This includes damage to facilities, inventories, equipment, and properly parked motor vehicles.

- **Government motor vehicle accidents with damages of $150 or more or involving an injury.** Accidents are reportable to DOE if (1) damage to a government vehicle not properly parked is greater than or equal to $250; (2) damage to DOE property is greater than or equal to $500 and the driver of a government vehicle is at fault; (3) 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 (4) any individual is injured and the driver of a government vehicle is at fault.

The HSPL will work with the OUPL and the field team leader to ensure that health and safety records are maintained with the appropriate Laboratory group, as required by DOE orders. The reporting forms are as follows:

- DOE-AL Order 5000.3, Unusual Occurrence Reporting (DOE 1990, 0253);
- DOE Form 5484.3, Supplementary Record of Occupational Injuries and Illnesses, DOE Order 5484.1 (Attachment 1) (DOE 1990, 0733);
- DOE Form 5484.4, Tabulation of Property Damage Experience, DOE Order 5484.1 (Attachment 2) (DOE 1990, 0733);
- DOE Form 5484.5, Report of Property Damage or Loss, DOE Order 5484.1 (Attachment 4) (DOE 1990, 0733);
- DOE Form 5484.6, Summary of Exposures Resulting in Internal Body Depositions of Radioactive Materials for CY 19xx, DOE Order 5484.1 (Attachment 11) (DOE 1990, 0733);
- DOE Form 5484.8, Termination Occupational Exposure Report, DOE Order 5484.1 (Attachment 10) (DOE 1990, 0733);
- DOE Form OSHA-200, Log of Occupational Injuries and Illnesses, DOE Order 5484.1 (Attachment 7) (DOE 1990, 0733);
- DOE Form EV-102A, Summary of DOE and DOE Contractor Occupational Injuries and Illnesses, DOE Order 5484.1 (Attachment 8) (DOE 1990, 0733); and
- DOE Form F5821.1, Radioactive Effluent/Onsite Discharges/Unplanned Releases, DOE Order 5484.1 (Attachment 12) (DOE 1990, 0733).

Copies of these reports will be stored with the appropriate Laboratory group. Specific reporting responsibilities are given in Section 1, General Administration, of the Laboratory ES&H manual.

13.0 PERSONNEL TRAINING

13.1 General Employee Training and Site Orientation

All Laboratory employees and supplemental workers must successfully complete Laboratory general employee training (GET), which is offered by the Health and Safety Division. The OUPL is responsible for scheduling GET training for supplemental workers.

Several other types of required training are discussed in the following sections. Site workers will receive each type of training before or during the course of field activities.

13.2 OSHA Requirements

OSHA's Hazardous Waste Operations and Emergence Response regulations standard (29 CFR 1910.120) (DOL 1989, 0952) regulates the health and safety of employees involved in HAZWOP. According to this standard, persons will not participate in field activities until they have been trained to the level required by their job function and responsibility. The SSO is responsible for ensuring that all persons entering the exclusion zone are properly trained.

At the time of job assignment, all general site workers will receive a minimum of 40 hr of initial hazardous waste operations instruction off site and a minimum of 3 days of actual field experience under the direct supervision of a trained, experienced supervisor. Occasional site workers will receive a minimum of 24 hr of initial instruction. Workers who may be exposed to unique or special hazards will be provided additional training.

On-site management and supervisors who supervise or are directly responsible for employees engaged in HAZWOP will receive at least 8 hr of additional specialized training on managing such operations at the time of job assignment.

All persons required to have OSHA training will receive 8 hr of refresher training annually.

Personnel must be given site-specific training before they are granted access to the site. Attendance and understanding of the site-specific training must be documented. A weekly health and safety briefing and periodic training (as warranted) will be given. Daily tailgate safety meetings will update workers on changing site conditions. Training should include the topics indicated in Table III-12 in accordance with 29 CFR 1910.120(i)(2)(ii) (DOL 1989, 0952).

13.3 Radiation Safety Training

Basic radiation worker training is required for all employees whose job assignments involve operation of radiation-producing devices, who work with radioactive materials, who are likely to be routinely occupationally exposed above 0.1 rem (0.001 sievert) per year, or who require unescorted entry into a radiological area. This training is a 4-hr extension to GET for new employees.

Radiation protection training is required for all Laboratory employees, subcontractors, visiting scientists, and DOE and Department of Defense personnel. This is a 1-hr presentation as part of GET.

13.4 Hazard Communication

Laboratory employees will be trained in hazard communication, in accordance with Health and Safety Division requirements. Subcontractors will provide training to their employees in compliance with 29 CFR 1910.120 (DOL 1989, 0952).

13.5 Explosives Training

At PRSs where explosives are known or suspected to be present, additional safety training may be required.

13.6 Facility-Specific Training

Certain areas of the Laboratory (e.g., firing sites) may require additional facility-specific training.

TABLE III-12

TRAINING TOPICS

Initial Site-Specific	Weekly	Periodic (as warranted)	Subject
X		X	Site Health and Safety Plan, 29 CFR 1910.120(e)(1)
X		X	Site Characterization and Analysis, 29 CFR 1910.120(i)
X		X	Chemical Hazards, Table 1
X		X	Physical Hazards, Table 2
X		X	Medical Surveillance Requirements, 29 CFR 1910.120(f)
X	X		Symptoms of Overexposure to Hazards, 29 CFR 1910.120(e)(1)(vi)
X		X	Site Control, 29 CFR 1910.120(d)
X		X	Training Requirements, 29 CFR 1910.120(e)
X	X	X	Engineering and Work Practice Controls, 29 CFR 1910.120(g)
X	X	X	PPE, 29 CFR 1910.120(g), 29 CFR 1910.134
X	X	X	Respiratory Protection, 29 CFR 1910.120(g), 29 CFR 1910.134, ANSI Z88.2-1980
X		X	Overhead and Underground Utilities
X	X	X	Scaffolding, 29 CFR 1910.28(a)
X	X		Heavy Machinery Safety
X		X	Forklifts, 29 CFR 1910.27(d)
X		X	Tools
X		X	Backhoes, Front End Loaders
X		X	Other Equipment Used at Site
X		X	Pressurized Gas Cylinders, 29 CFR 1910.101(b)
X	X	X	Decontamination, 29 CFR 1910.120(k)
X		X	Air Monitoring, 29 CFR 1910.120(h)
X		X	Emergency Response Plan, 29 CFR 1910.120(l)
X	X		Handling Drums and Other Containers, 29 CFR 1910.120(j)
X		X	Radioactive Wastes
X		X	Explosive Wastes
X		X	Shock Sensitive Wastes
X		X	Flammable Wastes
X	X	X	Confined Space Entry
X			Illumination, 29 CFR 1910.120(m)
X	X	X	Buddy System, 29 CFR 1910.120(a)
X		X	Heat and Cold Stress
X		X	Animal and Insect Bites
X		X	Spill contaminant

13.7 Records

Records of training will be maintained by the Health and Safety Division and in the project file to confirm that every individual assigned to a task has had adequate training for that task and that every employee's training is up-to-date.

REFERENCES

ACGIH (American Conference of Governmental Industrial Hygienists) 1992. "1992-1993 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices," ISBN: 0-936712-86-4, Cincinnati, Ohio. (ACGIH 1990, 0858)

DOE (US Department of Energy), June 22, 1983. "Occupational Safety and Health Program for DOE Contractor Employees at Government-Owned Contractor-Operated Facilities," DOE Order 5483.1A, Washington, DC. (DOE 1983, 0058)

DOE (US Department of Energy), May 15, 1984. "Environmental Protection, Safety, and Health Protection Standards," DOE Order 5480.4, Washington, DC. (DOE 1984, 0059)

DOE (US Department of Energy), June 26, 1985. "Contractor Industrial Hygiene Program," DOE Order 5480.10, Washington, DC. (DOE 1985, 0062)

DOE (US Department of Energy), December 21, 1988. "Radiation Protection for Occupational Workers," DOE Order 5480.11, Washington, DC. (DOE 1988, 0076)

DOE (US Department of Energy), May 30, 1990. "Occurrence Reporting and Processing of Operations Information," DOE Order 5000.3A, Washington, DC. (DOE 1990, 0253)

DOE (US Department of Energy), June 29, 1990. "Radiation Protection for Occupational Workers," DOE Order 5480.11, Change 2, Washington, DC. (DOE 1990, 0732)

DOE (US Department of Energy), October 17, 1990. "Environmental Protection, Safety, and Health Protection Information Reporting Requirements," DOE Order 5484.1, Change 7, Washington, DC. (DOE 1990, 0733)

DOE (US Department of Energy), April 30, 1991. "Emergency Categories, Classes, and Notification and Reporting Requirements," DOE Order 5500.2B, Washington, DC. (DOE 1991, 0736)

DOE/AL (US Department of Energy, Albuquerque Operations Office), October 24, 1986. "Unusual Occurrence Reporting System," DOE/AL Order 5000.3, Albuquerque, New Mexico. (DOE/AL 1986, 0734)

DOL (US Department of Labor), July 1989. "Containing a Codification of Documents of General Applicability and Future Effect," 29 CFR Parts 1910.1000 to End, Washington, DC. (DOL 1989, 0952)

EPA (US Environmental Protection Agency), March 8, 1990. "National Oil and Hazardous Substances Pollution Contingency Plan," Final Rule, 40 CFR Part 300, Federal Register, Vol. 55, No. 46, p. 8666. (EPA 1990, 0559)

LANL (Los Alamos National Laboratory), November 1992. "Installation Work Plan for Environmental Restoration," Revision 2, Los Alamos National Laboratory Report LA-UR-92-3795, Los Alamos, New Mexico. (LANL 1992, 0768)

Attachment A

LEVELS OF PPE

ATTACHMENT A

LEVELS OF PPE

Level of Protection	Equipment	Protection Provided	Should Be Used When	Limiting Criteria
A	Recommended: • Pressure-demand, full face-piece SCBA[*] or pressure-demand supplied-air respirator with escape SCBA • Fully encapsulating, chemical-resistant suit • Inner chemical-resistant gloves • Chemical-resistant safety boots/shoes • Two-way radio communications Optional: • Cooling unit • Coveralls • Long cotton underwear • Hard hat • Disposable gloves and boot covers	The highest available level of respiratory, skin, and eye protection	The chemical substance has been identified and requires the highest level of protection for skin, eyes, and the respiratory system based on either • measured (or potential for) high concentration of atmospheric vapors, gases, or particulates • site operations and work functions involving a high potential for splash, immersion, or exposure to unexpected vapors, gases, or particulates of materials that are harmful to skin or capable of being absorbed through the intact skin Substances with a high degree of hazard to the skin are known or suspected to be present, and skin contact is possible Operations must be conducted in confined, poorly ventilated areas until the absence of conditions requiring Level A protection is determined	Fully encapsulating suit material must be compatible with the substances involved
B	Recommended: • Pressure-demand, full face-piece SCBA or pressure-demand supplied-air respirator with escape SCBA • Chemical-resistant clothing (overalls and long-sleeved jacket; hooded, one- or two-piece chemical splash suit; disposable chemical-resistant one-piece suit) • Inner and outer chemical-resistant gloves • Chemical-resistant safety boots/shoes • Hard hat • Two-way radio communications Optional: • Coveralls • Disposable boot covers • Face shield • Long cotton underwear	The same level of respiratory protection but less skin protection than Level A, it is the minimum level recommended for initial site entries until the hazards have been further identified	The type and atmospheric concentration of substances have been identified and require a high level of respiratory protection but less skin protection. This involves atmospheres • with IDLH concentrations of specific substances that do not represent a severe skin hazard • that do not meet the criteria for use of air-purifying respirators Atmosphere contains less than 19.5% oxygen Presence of incompletely identified vapors or gases is indicated by direct-reading organic vapor detection instrument, but vapors and gases are not suspected of containing high levels of chemicals harmful to skin or capable of being absorbed through the intact skin	Use only when the vapor or gases present are not suspected of containing high concentrations of chemicals that are harmful to skin or capable of being absorbed through the intact skin Use only when it is highly unlikely that the work being done will generate either high concentrations of vapors, gases, or particulates or splashes of material that will affect exposed skin

ATTACHMENT A (concluded)

LEVELS OF PPE

Level of Protection	Equipment	Protection Provided	Should Be Used When	Limiting Criteria
C	Recommended: • Full face-piece, air-purifying, canister-equipped respirator • Chemical-resistant clothing (overalls and long-sleeved jacket; hooded, one- or two-piece chemical splash suit; disposable chemical-resistant one-piece suit) • Inner and outer chemical-resistant gloves • Chemical-resistant safety boots/shoes • Hard hat • Two-way radio communications Optional: • Coveralls • Disposable boot covers • Face shield • Escape mask • Long cotton underwear	The same level of skin protection as Level B but a lower level of respiratory protection	The atmospheric contaminants, liquid splashes, or other direct contact will not adversely affect any exposed skin The types of air contaminants have been identified, concentrations measured, and a canister is available that can remove the contaminant All criteria for the use of air-purifying respirators are met	Atmospheric concentration of chemicals must not exceed IDLH levels The atmosphere must contain at least 19.5% oxygen
D	Recommended: • Coveralls • Safety boots/shoes • Safety glasses or chemical splash goggles • Hard hat Optional: • Gloves • Escape mask • Face shield	No respiratory protection. Minimal skin protection	The atmosphere contains no known hazard Work functions preclude splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals	This level should not be worn in the exclusion zone The atmosphere must contain at least 19.5% oxygen

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*Self-contained breathing apparatus

Attachment B

COMMON CHEMICALS IN PHOTOGRAPHIC PROCESSING

Attachment B

Common Chemicals in Photographic Processing

Common Developer Constituents

Metol (4-methylaminophenol)
Hydroquinone
Paraphenylene diamine derivatives
Ethylenediamine
Pentachlorophenol and sodium pentachlorophenolate
Potassium phosphate
Potassium hydroxide
Diethylene glycol

Common Bleaching Constituents

Bleach replenisher: acetic acid, ammonium bromide, and potassium nitrate
Bleaching agents: ammonium bromide, hydrobromic acid, ammonium tetraacetoferrate(III), and potassium salt of ethylenediamine tetraacetic acid
Other constituents in bleaching solutions: sodium ethylenediaminetetraactetate and sodium diethenetriaminepentacetate

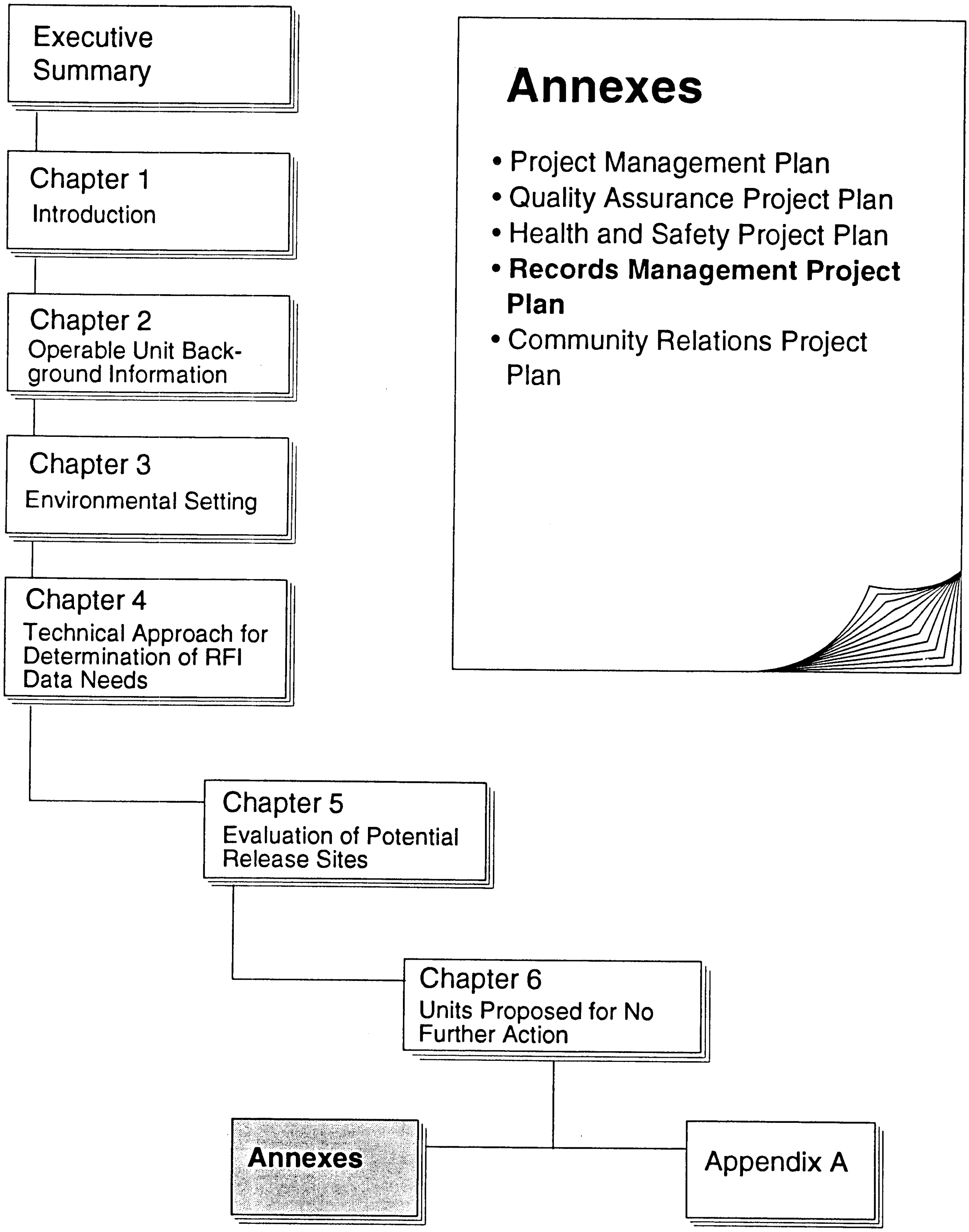
Common Cleaning Constituents

Concentrated formaldehyde
Chlorinated and fluorinated solvents (1,1,1-trichloroethane, methylene chloride, Freon, and others)
Hydrochloric acid

Miscellaneous

Potassium dichromate: used in reversal solutions
Formaldehyde: used as a stabilizer
Ammonia: adjusts pH values
tert-Butylaminoborane: exposure
Sodium hydrosulphite: reducing agent
Methanol
Potassium sulfite, ethylenediaminetetraacetic acid and 1-tyioglycerol: conditioner and replenishers

Sources:
Encyclopedia of Occupational Health and Safety
Processing constituent list from KODAK C-41
Processing constituent list from KODAK Ektachrome E-6
Safe Handling Considerations for the EKTAPRINT 3 PROCESS - KODAK



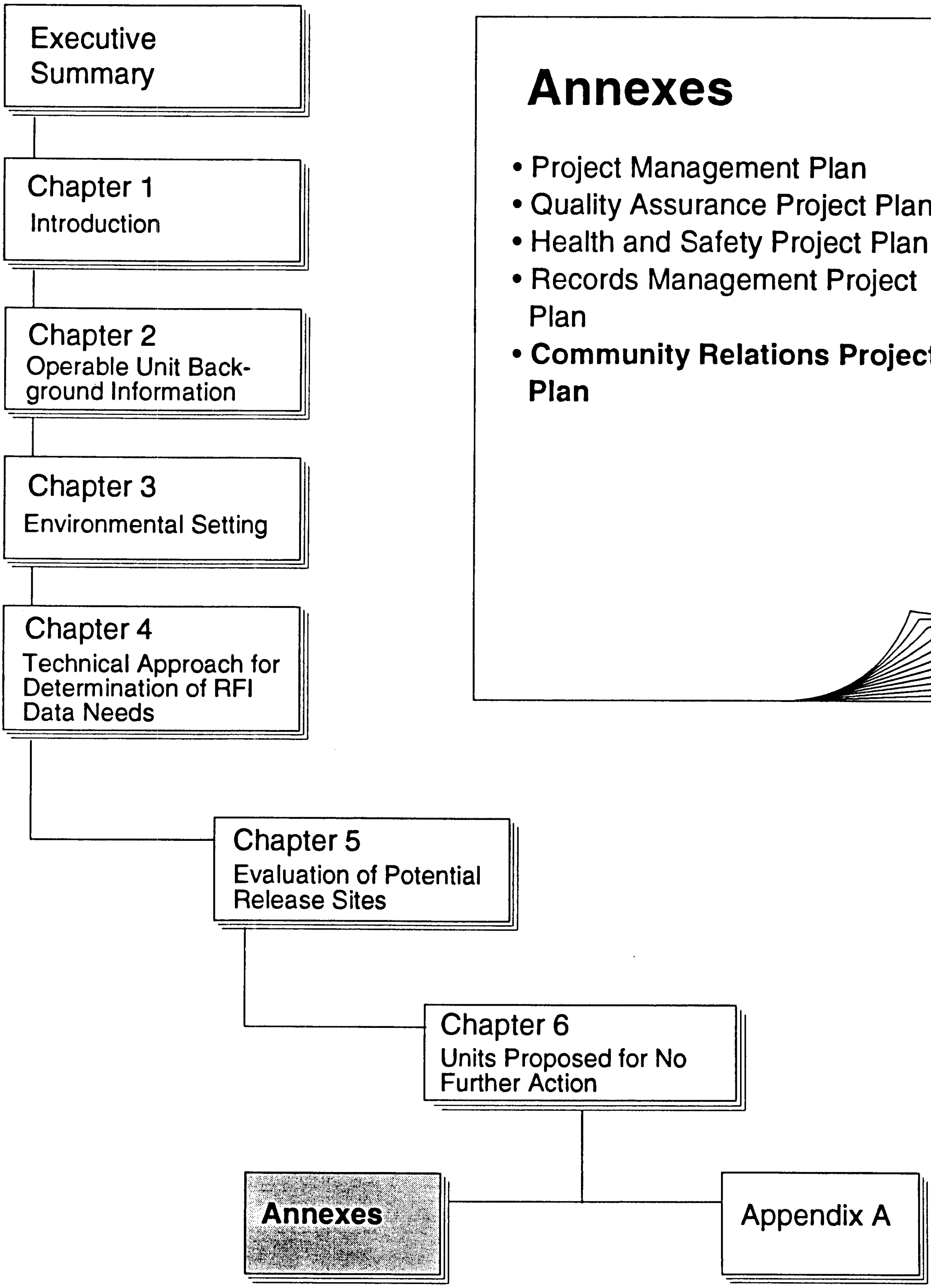
Annexes

- Project Management Plan
- Quality Assurance Project Plan
- Health and Safety Project Plan
- **Records Management Project Plan**
- Community Relations Project Plan

This work plan will follow the records management program plan provided in Annex IV of Revision 2 of the installation work plan (LANL 1992, 0768).

REFERENCES

LANL (Los Alamos National Laboratory), November 1992. "Installation Work Plan for Environmental Restoration," Revision 2, Los Alamos National Laboratory Report LA-UR-92-3795, Los Alamos, New Mexico. (LANL 1992, 0768)



Annexes

- Project Management Plan
- Quality Assurance Project Plan
- Health and Safety Project Plan
- Records Management Project Plan
- **Community Relations Project Plan**

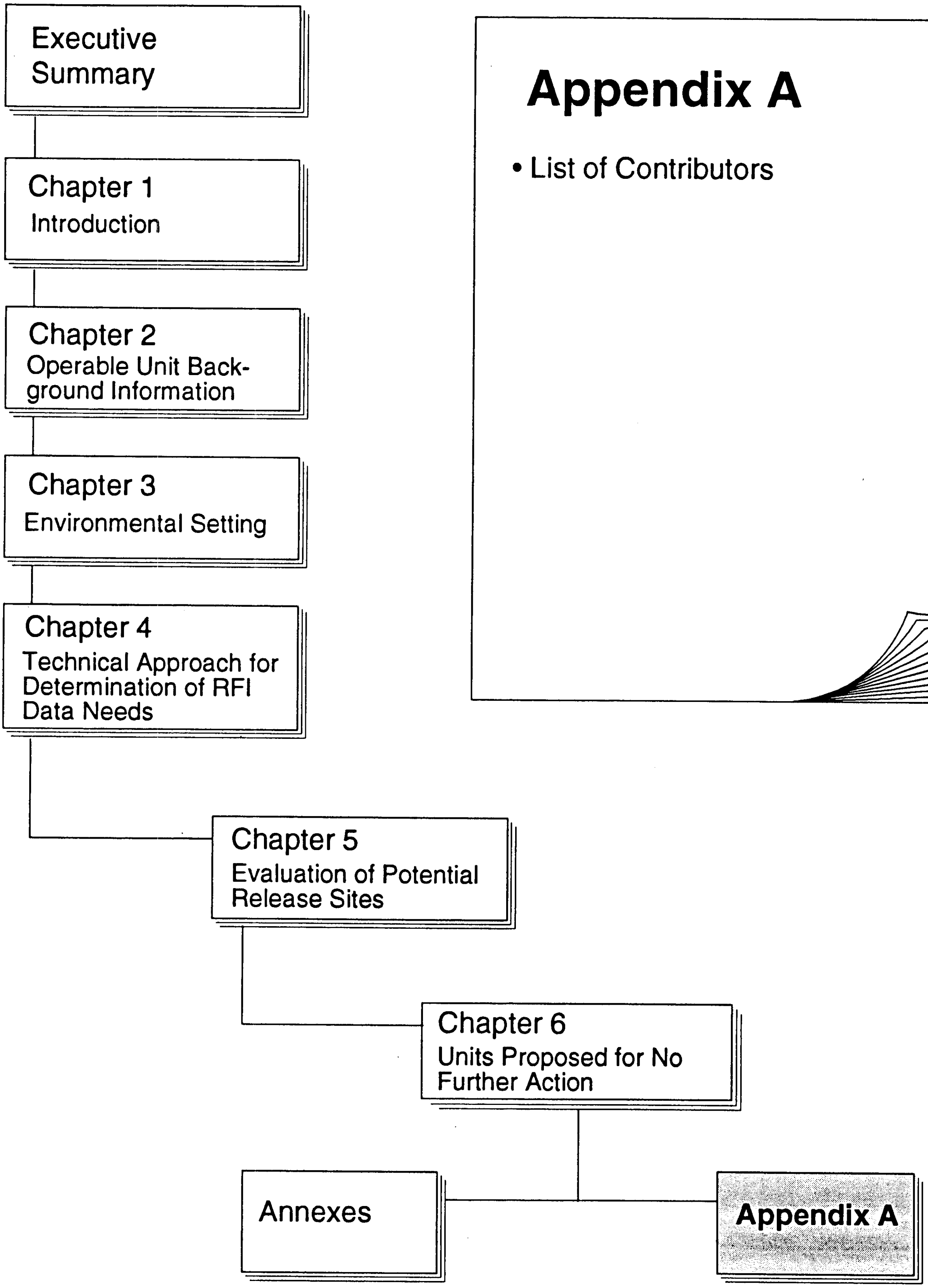
This work plan will follow the community relations program plan provided in Annex V of Revision 2 of the installation work plan (LANL 1992, 0768).

REFERENCES

LANL (Los Alamos National Laboratory), November 1992. "Installation Work Plan for Environmental Restoration," Revision 2, Los Alamos National Laboratory Report LA-UR-92-3795, Los Alamos, New Mexico. (LANL 1992, 0768)

Appendix A

- List of Contributors



LIST OF CONTRIBUTORS

Name and Affiliation	Education/Expertise	OU 1111 Work Plan Assignment
Cheryl K. Rofer, EES-1	M.S. Organic Chemistry 28 years in development of process and remediation technologies, including Environmental Restoration Program management	Operable unit project leader
Mark E. Ander, EES-3	Ph.D. Geophysics 22 years in development and interpretation of geophysical techniques	Geophysical methods
Marcella M. Backsen, B. I. Literary Services	B.A. English A.A.S. Computer Science 3 years in technical writing and editing	Technical writing/editing
Kathryn D. Bennett, EM-8	M.S. Environmental Science 3 years in NEPA biological activities, including Laboratory wetlands evaluation, endangered/threatened species studies, and environmental data base development	Biological evaluation
Laurence W. Creamer, M-7	Technical School graduate Industrial Electronics 16 years with Detonator Development Group; nuclear safety study, test-firing supervisor, facilities manager	Archival research, explosives safety
Edward H. Essington, EES-15	M.S. Plant Science 36 years in chemical, colloidal, and radioactive constituent migration in surface and subsurface media	Soil science, sampling plans
Teralene S. Foxx, EM-8	M.S. Biology 17 years in field ecology and waste site characterization	Biological evaluation
James D. Griffin, Sr., Retired Engineer	B.S. Mechanical Engineering 46 years in recovery and detonator development groups, management of detonator development	Archival research, explosives safety
George D. Guthrie, EES-1	Ph.D. Mineralogy/Crystallography 8 years in mineralogy research, development of environmental restoration sampling plans	Geology, sampling plans, graphics
Andrea Kron, cARTography by Andrea Kron	B.A. Geology 17 years experience in cartography, geology, and technical illustration	Graphics

Beverly Larson, EM-8	M.A. Anthropology 16 years field experience, including 6 years as Laboratory archaeologist	Cultural evaluation
Wilbert H. Meyers, Retired Engineer	B.S. Chemical Engineering 44 years in recovery and detonator development groups, management of chemical processing and detonator production	Archival research, sampling plans, explosives safety
Eric Montoya, EES-1	Currently studying for degree in Electrical Engineering NNMCC 1992-present NMSU 1991-1992 3 years in illustration	Graphics
Wilfred L. Polzer, EES-15	Ph.D. Soil Chemistry 40 years in soil and water chemistry, including processes and mechanisms that influence radioactive and chemical waste migration	Soil science, sampling plans
Lawrence O. Ticknor, A-1	M.S. Statistics 9 years in statistical analysis of experiments and environmental restoration problems	Statistics, sampling plans
Alvin D. Van Vessem, Retired Engineer	B.S. Mechanical Engineering 38 years in recovery and detonator development groups, management of Detonator Development Group	Archival research, explosives safety
Bradford P. Wilcox, EES-15	Ph.D. Watershed Hydrology 7 years in run-off and erosion processes of arid and semiarid ecosystems	Hydrology, sampling plans

Word processing by Carol White, EES-1.

We would like to acknowledge John McAfee, Barbara Stine, Michael Holder, and Jerry Vasilik of M-7 and Diane Griechen of M-DO for their support and cooperation in coordinating the work of the OU 1111 team with explosives operations at TA-22 and TA-40.

GLOSSARY

Acetone A volatile solvent, C_3H_6O, used for parts cleaning and recrystallization of PETN.

Alcohol A colorless liquid that is used as a solvent. (Parker 1989) Ethyl alcohol, C_2H_5OH, was used in OU 1111 for recrystallization of PETN. Other alcohols with different numbers of carbon atoms may also have been used.

Alluvial aquifer An acquifer located in sediment accumulated in canyon bottoms.

Alluvial fan A fan-shaped accumulation of sediment deposited by a stream. (LANL 1992)

Alluvium Clay, silt, sand, gravel, or other rock materials transported by flowing water and deposited in fairly recent geologic time as sorted or semisorted sediments in riverbeds, estuaries, flood plains, lake shores, and fans at the base of mountain slopes. (LANL 1992)

Alpha radiation Ionizing radiation composed of alpha particles emitted in the radioactive decay of certain nuclides. Alpha particles consist of two protons and two neutrons bound together; an alpha particle is identical to the nucleus of a helium atom. It is the least penetrating of the three common types of radiation—alpha, beta, gamma—and can be blocked by a sheet of paper or the outer dead layer of skin. (LANL 1992)

Anion A negatively charged ion, a component of an acid or a salt. (Stevenson and Wyman 1991)

Area of concern A site that potentially contains only non-RCRA hazardous materials.

Artesian Referring to groundwater confined under hydrostatic pressure. (Bates and Jackson 1980)

Atmospheric dispersion The spread or wide distribution of a constituent from a fixed or constant source.

Background level The general level of a constituent existing in the environment independent of deposition processes associated with PRSs. This level may result from natural processes (e.g., the inherent composition of soil or rock) or from human processes (e.g., fallout from atmospheric nuclear testing).

Baratol An explosive composed of TNT and barium nitrate.

Basalt A hard, dense, dark volcanic rock. (LANL 1992)

Baseline risk assessment A risk assessment conducted using an appropriate, site-specific exposure scenario but assuming no mitigating or corrective measures beyond those already in place. (LANL 1992)

Bedrock Solid rock that underlies all soil, clay, gravel, and loose material on the earth's surface. (LANL 1992)

Benzene A hydrocarbon, C_6H_6, that is used as a solvent. (Stevenson and Wyman 1991)

Berm A mound of earth. At OU 1111, berms are used to protect buildings from explosions or to contain explosion debris. (Dobratz 1981)

Beta radiation Ionizing radiation composed of electrons emitted in the radioactive decay of certain nuclides. Beta radiation can be blocked by an inch of wood or a thin sheet of aluminum.

Blasting caps Devices used to initiate less sensitive explosives. They contain an explosive that can easily be detonated electrically. Blasting caps may be detonated by electrostatic discharges resulting from touch by a human body. (Dobratz 1981)

Bioremediation The use of bacteria and microorganisms to consume waste, usually organic materials. Bioremediation methods are under development for fixation or removal of metals and for *in situ* destruction of explosives.

Breccia Rock consisting of sharp, angular fragments cemented together or embedded in a fine-grained matrix. (LANL 1992)

Bridgewire A small diameter wire placed in contact with an explosive charge. When a high electrical current is passed through the bridgewire, the bridgewire explodes and causes the explosive to detonate. (Dobratz 1981)

Calcite A common mineral, a principal constituent of limestone. (Parker 1989)

Carbon tetrachloride A solvent, CCl_4, used for parts cleaning and recrystallization of PETN.

Cavate A cave that was excavated by humans.

Cesium-137 A radioactive alkali metal, a common product of nuclear weapons explosions. Cesium-137 and its decay products release beta and gamma radiation. (Stevenson and Wyman 1991)

Chloroethane A colorless, oily liquid, C_2H_5Cl, that is used as a solvent. (Parker 1989)

Chromate An anion, CrO_4^{2-}, or a compound containing the chromate ion.

Colloid Any fine-grained material that can easily be suspended or is in suspension. (Bates and Jackson 1980)

Colluvium Rock debris, brought principally by gravity, that has accumulated at the base of a cliff or slope. (LANL 1992)

Composite, composite sample A sample that is formed by combining and homogenizing several grab samples. (LANL 1992)

Composition B An explosive composed of TNT and RDX.

Composition C An explosive consisting of RDX and a plasticizer that may or may not be explosive. (Kohler and Meyer 1993)

Conceptual exposure model A model of the ways in which human or environmental receptors might be exposed to hazardous substances. The model includes primary and secondary sources of the substances, release and transport mechanisms, and exposure routes to receptors.

Concrete bowl A large bowl-shaped structure, TA-6-37, used for testing explosive devices in 1944. It is 200 ft in diameter.

Conglomerate Rock consisting of pebbles and gravel embedded in a loosely cementing material. (LANL 1992)

Constituent Any compound or element present in environmental media, including both naturally occurring and anthropogenic materials.

Contaminant Any constituent present in environmental media or on structural debris at a concentration that may present a risk to human health or the environment. (LANL 1992)

Contaminant of concern Any constituent present in environmental media or on structural debris at a concentration above its screening action level. (LANL 1992)

Control bunker A building, made of highly reinforced concrete or protected by an earthen berm, that is used to protect workers and equipment when firing explosives. (Dobratz 1981)

Core A sample of soil or sediment taken by driving a tube into the soil or sediment. The soil is removed from the tube in a cylindrical section in which vertical positioning of layers is maintained. (Stevenson and Wyman 1991)

Critical mass The smallest amount of fissionable material that will allow a self-sustaining nuclear chain reaction. (Stevenson and Wyman 1991)

Cyanide A toxic component of metal plating baths, CN^-.

Cyclotol High explosive composed of RDX and TNT. (Parker 1989)

dc resistivity survey Observation of electric fields caused by direct current introduced into the ground as a means of studying earth resistivity, the property that resists the flow of electrical current. (Sheriff 1984)

Decommissioning The permanent removal from service of surface facilities and components necessary for preclosure activities only, after facility closure, in accordance with regulatory requirements and environmental policies. (LANL 1992)

Depleted uranium Uranium from which most of the fissionable isotope uranium-235 has been removed, uranium consisting primarily of uranium-238.

Detonator A device, such as a blasting cap, employing a sensitive primary explosive to detonate a less sensitive explosive charge. (Parker 1989)

Diethanolamine A colorless, water-soluble compound, $(HOCH_2CH_2)_2NH$, that is soluble in acetone and alcohol. Used in detergents, as an absorbent of acid gases, and as a chemical intermediate. (Parker 1989)

Diethyl ether An extremely volatile and explosive solvent, $(C_2H_5)_2O$.

Dipole-dipole profile A geophysical method that uses a linear array of equally spaced current and voltage electrodes to measure electrical resistivity in the subsurface.

Dosimeter An instrument that measures the total dose of nuclear radiation received in a given period of time. (Parker 1989)

Dry well An excavated well filled with stone. Water from the drainage it receives percolates into the soil. (Parker 1989)

Effective porosity The per cent of the total volume of a given mass of soil or rock that consists of interconnecting interstices. (Bates and Jackson 1980)

Electromagnetic survey A wide range of geophysical techniques used to determine subsurface conductivity structures. A primary field is generated at the surface and is perturbed by the subsurface conductivity. The resulting field is then measured at the surface and used to map the subsurface electromagnetic structure. Electromagnetic surveys are used to locate buried metal objects.

Engineered cover A cover consisting of soil, gravel, sand, clay, geotextiles, or other material arranged in such a way as to optimize water movement around, into, and out of disposal pits.

Erosion The process of wearing away of a surface, usually soil, by physical means (wind and water). (Stevenson and Wyman 1991)

Evapotranspiration Discharge of water from the earth's surface to the atmosphere by evaporation from lakes, streams, and soil surfaces, and by transpiration from plants. (LANL 1992)

Explosive lens A composite explosive material used to focus an explosive shock wave. The process by which the shock wave is shaped is analogous to the focusing of light waves through glass lenses. (Dobratz 1981)

Exposure route The means by which a human or environmental receptor could be exposed to hazardous substances. For example, an exposure route for workers near contaminated soil could be inhalation of soil particles.

Fact sheet A summary of facts about an operable unit and proposed actions.

Fat Man One of the first two nuclear weapons designed and built at Los Alamos.

Fault A fracture or zone of fractures along which there has been displacement of the sides relative to one another parallel to the fracture. (LANL 1992)

Field screening Analytical measurements made in the field for the purpose of rapid decisions related to methods of packaging and transportation of samples and placement of additional samples.

Filter trench A sand bed emplaced in the ground to allow percolation of liquids from a septic system.

Firing chamber The common name for a control bunker. (Dobratz 1981)

Firing site An area in which explosives are fired. Magazines, preparation buildings, and firing chambers may be part of a firing site. (Dobratz 1981)

Fissionable material Material that is capable of producing a nuclear fission chain reaction, uranium-235 and plutonium-239.

Fluoride A negative ion formed from the element fluorine, makes tooth enamel less soluble in acid environments but also has toxic properties at higher concentrations. (Stevenson and Wyman 1991)

Fracture A crack, joint, or fault in a rock formed because of mechanical failure by stress. (Parker 1989)

Gamma radiation Ionizing radiation emitted in the radioactive decay of certain nuclides. Gamma rays are similar to x-rays and require heavy shielding, such as concrete or steel, to be blocked.

Geomorphic structure Feature on the land surface. Geomorphic structures may include drainage channels, stream beds, and alluvium deposits.

Geophysical survey A wide range of physical methods used to map changes in physical properties to determine subsurface structures. They are classed according to the type of signal used to investigate a particular physical property, e.g., acoustic resistivity, magnetic, electromagnetic, gravity, and others.

Gravel mulch A layer of gravel spread evenly over an area of soil to prevent erosion.

Ground-penetrating radar A geophysical method that uses electromagnetic energy at radar frequencies to probe the shallow structure of the ground. High frequencies are transmitted into the ground and the energy, which is reflected back by buried objects, is detected.

Half-life The time required for one-half of the radioactive atoms initially present in a sample to decay. Each radionuclide has a characteristic half-life ranging from a fraction of a second to thousands of years. (LANL 1992) More generally, the time required for one-half of a constituent to decompose or disappear.

Heavy metals Metallic elements with high atomic weights, for example, mercury, chromium, cadmium, lead, and uranium. They can be toxic at low concentrations and tend to accumulate in the food chain. (Executive Enterprises Inc., undated)

HMX An explosive, octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine ($C_4H_8N_8O_8$). (Dobratz 1981)

HNS An explosive, 2,2',4,4',6,6'-hexanitrostilbene $[C_6H_2(NO_3)_3CH{=}CHC_6H_2(NO_3)_3]$. (Dobratz 1981)

Hydraulic conductivity The volume of water that will move through a medium in a unit of time under a unit hydraulic gradient through a unit area measured perpendicular to the direction of flow. (LANL 1992)

Hydraulic gradient A change in the static pressure of groundwater, expressed in terms of the height of water above a datum, per unit of distance in a given direction. (LANL 1992)

Hydrocarbons Chemicals composed of hydrogen and carbon only. Gasoline and other fuels are composed of hydrocarbons.

Implosion A bursting inward, as in the compression of fissionable material by ordinary explosives in a nuclear weapon. (Parker 1989)

Infiltration Water flow into the soil from the ground surface. (LANL 1992)

Initiator A nuclear weapons component. (LANL 1992)

Injection well A well into which fluids are injected.

In situ In the original location.

Interfingered The intergradation of markedly different rocks through a vertical succession of thin interlocking or overlapping wedge-shaped layers. (Bates and Jackson, 1980)

Isotope Atoms of a single element that have the same number of protons but a different number of neutrons. Therefore, they have different atomic masses and nuclear properties. (Stevenson and Wyman 1991)

Jumbino A metal containment bottle for explosions. It was used to develop Jumbo.

Jumbo A vessel intended to contain the chemical explosion and debris from the Trinity test if it failed to produce a nuclear detonation. It was built but not used.

Leach field An area containing a buried distribution system of pipes and clay tile to allow percolation of liquids from a septic system.

Lithology The description of a rock on the basis of such characteristics as structure, color, mineral composition, grain size, and arrangement of its component parts. (LANL 1992)

Loam A type of rich soil consisting of clay, silt, sand, and organic material. (Stevenson and Wyman 1991)

Magazine A structure constructed and located for the storage of explosives. (Parker 1989)

Magnetometry (magnetic mapping) Measurement of a natural magnetic field or its components on the surface of the earth. Typically it is used to locate concentrations of buried magnetic material, e.g., metals.

Main aquifer Water-bearing formations deep under the Pajarito Plateau. They are probably found mostly in the Santa Fe Group and Puye Formation.

Manhattan Project The wartime United States project to develop a nuclear weapon.

Materials Disposal Area An area in which waste materials were disposed of, usually in pits dug for this purpose.

National Pollutant Discharge Elimination System (NPDES) A provision of the Clean Water Act that prohibits discharge of pollutants into waters of the United States, unless a special permit is issued by EPA, a state, or a tribal government. (Executive Enterprises, Inc. undated)

Nitrates Compounds containing the NO_3^- radical. (Parker 1989)

Nitrites Compounds containing the radical NO_2^-. (Parker 1989)

Nitroguanidine An explosive, $HNC(NH_2)NHNO$, also known as picrite. (Parker 1989)

Nuclide A general term for various configurations of protons and neutrons in atomic nuclei. (Stevenson and Wyman 1991)

Observational approach An approach to waste site characterization and remediation in which sufficient characterization is conducted to provide a general understanding of probable conditions and reasonable deviations. Remedial alternatives are evaluated on this basis, and if remediation is required, further characterization is conducted as necessary during remediation.

Olivine An olive-green, grayish-green, or brown mineral. A common rock-forming mineral of basic, ultrabasic, or low-silica igneous rocks. (Bates and Jackson 1980)

Operable Unit In this work plan, an aggregation of geographically related PRSs. Also, a discrete action that composes an incremental step toward comprehensively addressing site problems. This discrete portion of a remedial response manages migration or eliminates or mitigates a release, threat of release, or pathway of exposure. The cleanup of a site can be divided into a number of operable units, depending on the complexity of the problems associated with the site. Operable units may address geographical portions of a site, specific site problems, or initial phases of an action, or may consist of any set of actions performed over time or any actions that are concurrent but located in different parts of a site. (LANL 1992)

Outfall The place where an effluent is discharged. (Stevenson and Wyman 1991)

Outflow areas Areas receiving outflow from a septic tank or explosives sump. This term includes sand filters, leach fields, outfalls and their related run-off areas, filter trenches, and seepage pits.

Pentaerythritol tetranitrate (PETN) A white crystalline explosive compound, $C(CH_2ONO_2)_4$, that is insoluble in water. (Parker 1989)

Perched aquifer An isolated body of groundwater that is separated from the main aquifer by unsaturated sediments.

Perchloroethylene A stable, colorless liquid, C_2Cl_4, used as a solvent. (Parker 1989)

Permeability The ease with which water and other fluids migrate through the geological strata. (Stevenson and Wyman 1991)

Phoswich counter A radiation counter designed to detect low levels of beta and gamma radiation.

Photoprocessing chemicals Chemicals used to develop and fix film. A listing of typical photoprocessing chemicals is given in Attachment B of Annex III. (Dobratz 1981)

Polychlorinated biphenyls (PCBs) Mixtures of chlorinated aromatic compounds that were widely used as insulating and cooling agents. (Stevenson and Wyman 1991)

Potential release site (PRS) The generic name for both SWMUs and AOCs.

Potting laboratory A laboratory in which components are encapsulated in plastic or epoxy-type compounds. (Dobratz 1981)

Precipitation The process of recovering a solid by cooling a solution or adding another solvent. It is typically used to purify solids or to change their physical characteristics, such as crystal size. (Dobratz 1981)

Primacord A cord impregnated with explosives and used to initiate other explosives. It is commonly used to delay final detonation. (Dobratz 1981)

Pumice A light-colored vesicular rock commonly having the composition of rhyolite. (Bates and Jackson 1980)

Pump oil Oil used in vacuum and other pumps, usually hydrocarbons or silicones.

Radionuclide A radioactive element characterized according to its atomic mass and atomic number. Radionuclides can be manmade or naturally occurring. They may emit alpha, beta, or gamma radiation. (Executive Enterprises, Inc. undated)

RDX A white, crystalline explosive hexahydro-1,3,5-trinitro-1,3,5-triazocine, $C_3H_6O_6N_6$. (Parker 1989)

Recharge The process by which water is added to the zone of saturation, either directly into a geologic formation or indirectly by way of another formation or through unconsolidated sediments. (LANL 1992)

Reconnaissance sampling Sampling to confirm the presence or absence of contaminants.

Recrystallization The process of dissolving a solid in a solvent and reforming the solid from solution. It is typically used to purify solids or to change their physical characteristics, such as crystal size.

Rhyolite A group of extrusive igneous rocks. They are typically porphyritic and commonly exhibit flow texture. (Bates and Jackson 1980)

Run-off That portion of rain water or snow melt that enters surface streams rather than infiltrating into the ground. (Stevenson and Wyman 1991)

Sand filter A sand bed emplaced in the ground to allow percolation of liquids from a septic system. The outflow is distributed across the sand bed by a system of pipes.

Sand recovery A method to recover material by covering an explosive test shot with sand.

Satellite waste storage area The common name for a hazardous waste satellite storage area, as defined by RCRA.

Screening action level (SAL) A media-specific concentration level for a constituent that can be compared with measurements of concentration levels made during RFI investigations to make preliminary or even final decisions about the site. The derivation of SALs is based on conservative criteria, usually low risk under a very restrictive exposure scenario. If a regulatory standard exists and is lower than the value derived by this risk-based computation, it will be used for the SAL. (LANL 1992)

Sediment Soil, sand, and minerals washed from land into water, usually after rain. (Executive Enterprises, Inc. undated)

Seepage pit A pit filled with stones and/or sand into which a waste stream flows. Suspended solids are deposited, and liquid percolates into the surrounding media. (Dobratz 1981)

Seismic survey A geophysical method that uses artificially induced acoustic waves to map geologic structures. The acoustic waves are reflected or refracted by the structure and the resulting signals are measured at the earth's surface.

Shrapnel Solid debris, particularly metals, thrown out of an explosion.

Silk screening A method for transferring a pattern onto a material by forcing paint through holes in a piece of silk. (Dobratz 1981)

Soil washing A soil remediation method in which a solvent, usually water, is used to remove contaminants by solubilization or floatation.

Solid waste Waste material not discarded into surface waters by water treatment systems or directly into the atmosphere. (Stevenson and Wyman 1991)

Solid waste management unit (SWMU) Any discernible unit at which solid wastes have been placed at any time, regardless of whether the unit was intended for the management of solid or hazardous waste. Such units include any area at or around a facility at which solid waste has been routinely and systematically released. (EPA 1990)

Spark gap A device to provide electricity to a detonator. Spark gaps do not contain explosives.

Squib A small explosive device loaded with low explosive. Its output is primarily heat flash. (Dobratz 1981)

Strontium-90 A radioactive isotope released in nuclear fission. (Stevenson and Wyman 1991)

Sulfate An anion, SO_4^{2-}, or a compound containing the sulfate anion.

Sump A pit or tank that catches liquid runoff for drainage or disposal. The sumps discussed in this work plan are specially designed to separate solid explosives from wastewater.

Swipe The act of wiping a piece of filter paper across a material to pick up contaminants for testing. (Dobratz 1981)

Tailgate meeting A meeting during field operations to communicate recent information from sampling, changes in plans, or safety reminders. It may be held at the tailgate of a vehicle used during the operation. Tailgate meetings are typically held every day during a sampling operation.

TATB An explosive 1,3,5 triamino-2,4,6 trinitrobenzene, $C_6(NH_3)_3(NO_3)_3$. (Dobratz 1981)

Tetryl A yellow, water-insoluble, crystalline explosive, $(NO_2)_3C_6H_2N(NO_2)CH_3$. (Dobratz 1981)

Thallium azide An extremely sensitive explosive, TlN_3, investigated for a short time at Los Alamos as an explosive for detonators. It was found to be too sensitive, and its use was discontinued.

TNT An explosive, 2,4,6-trintrotoluene, $CH_3C_6H_2(NO_3)_3$. TNT can be melted without detonation and, therefore, has been used as a base for many explosive formulations in which its properties are modified by addition of another explosive or an inert compound. (Dobratz 1981)

Transect A straight line projected across the ground.

Transport mechanisms Ways in which contaminants may be moved from source areas to contact with human or environmental receptors.

Trichloroethylene A volatile solvent, C_2HCl_3, used in degreasing parts and other metal-working operations.

Trinity test The proof test of the implosion weapon during the Manhattan Project. Carried out at the White Sands Range, southeast of Socorro, New Mexico. (Dobratz 1981)

Tritium An isotope of hydrogen containing 1 proton and 2 neutrons in the nucleus. (Stevenson and Wyman 1991)

Tuff A compacted deposit of volcanic ash and dust that contains rock and mineral fragments. (LANL 1992)

Vadose zone The unsaturated zone between the surface soil (root zone) and the groundwater. (Nielsen and Biggar 1982)

Vapor deposition laboratory A laboratory in which metals are deposited, from a vapor, in uniform thin films on various substrates. The process takes place in enclosed vacuum systems.

Volcanic ash A fine material composed of volcanic products ejected from volcanoes during explosive events. (Dobratz 1981)

Volcaniclastic Pertaining to a clastic rock containing volcanic material in whatever proportion and without regard to environment and origin. (Bates and Jackson 1980)

Voluntary corrective action (VCA) Selection and implementation of an obvious and effective corrective action during or following the RFI. (LANL 1992)

Vugs A small cavity in a rock usually lined with minerals that differ from those of the enclosing rock. (Parker 1989)

Water recovery A method tested during the Manhattan Project for containing the chemical explosion and debris from the Trinity test if it failed to produce a nuclear detonation. In the tests, scale models of implosion devices containing no fissionable material were detonated inside containers of water. The water and explosion debris then fell into a paved area, one of which was the concrete bowl.

Watershed The land area that drains into a stream. (Executive Enterprises, Inc. undated)

Wetland An area that is regularly saturated by surface or groundwater and contains a prevalence of vegetation that is adapted for life in saturated soil conditions. (Executive Enterprises, Inc. undated)

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