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RFI Work Plan for Operable Unit 1144

Environmental Restoration Program

May 1992

A Department of Energy
Environmental Cleanup Program

Received by ER-RPF
MAY 20 1992
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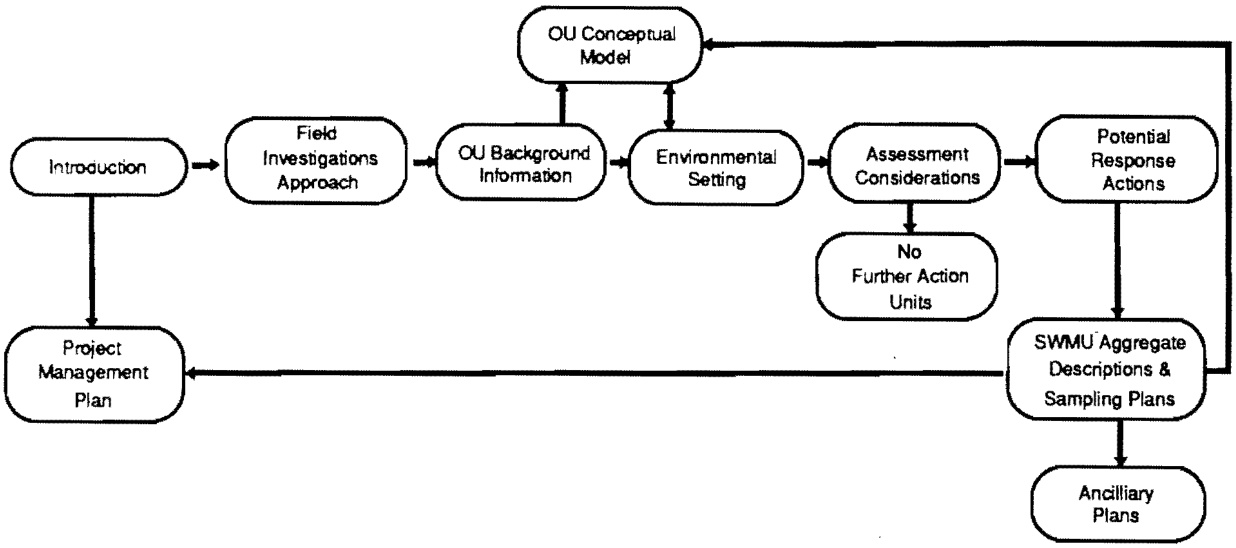
Los Alamos
NATIONAL LABORATORY

LA-UR-92-900

EXECUTIVE SUMMARY



RFI Work Plan for Operable Unit 1144 Environmental Restoration Program

EXECUTIVE SUMMARY

E.1 INTRODUCTION

E.1.1 Purpose

The Technical Area 49 (TA-49) work plan, as part of the Los Alamos National Laboratory's Environmental Restoration (ER) Program, is designed to serve two purposes:

- satisfy the regulatory requirements of the Hazardous and Solid Waste Amendment (HSWA) Module VIII of the Laboratory's Resource Conservation and Recovery Act (RCRA) Part B operating permit, and
- serve as the field characterization plan for personnel who will implement the RCRA Field Investigation (RFI). Results from the RFI will lead to a decision about the necessity for a Corrective Measures Study (CMS).

Module VIII of the RCRA permit was issued by the Environmental Protection Agency (EPA) to address the Department of Energy's (DOE's) Environmental Restoration Program. The Laboratory's ER program is consistent with not only RCRA requirements, but also the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

E.1.2 HSWA Requirements

The TA-49 RFI work plan is designed to meet scheduled requirements of Module VIII that address a certain percentage of the Laboratory's solid waste management units (SWMUs; that is, potential release sites) in an RFI work plan to be submitted to the EPA and the New Mexico Environment Department (NMED) by May 23, 1992. The TA-49 work plan thus contributes to the Laboratory's commitment to address cumulative totals of 35% of Table A SWMUs and 55% of Table B SWMUs by May 1992, as required by the HSWA Module.

Although the TA-49 work plan addresses only two of the 603 SWMUs listed in the HSWA Module, it should be noted that a single TA-49 SWMU [49-001, Materials Disposal Area AB (MDA AB)], was estimated in 1986 to contain over 80% of the Laboratory's inventory of buried transuranic waste (TRU) by radioactive content.

The Laboratory's November 1990 SWMU report lists a total of 9 TA-49 SWMUs that are subdivided into 21 subunits. All of these are addressed in the TA-49 work plan. The SWMU report lists no areas of concern (AOCs) for TA-49, and the TA-49 work plan proposes no new SWMUs or AOCs to add to this list. SWMU 49-009, listed as an underground fuel tank, is believed never to have existed and is proposed for no further action (NFA).

Two other SWMUs [49-007(a) and (b), septic systems] also are proposed for NFA because they are recent National Pollutant Discharge Elimination System (NPDES)-permitted systems with no credible source of contamination.

E.1.3 Installation Work Plan

The HSWA Module requires that an installation-wide work plan be prepared to describe the system for accomplishing all RFI/CMS work at the Laboratory. This requirement is satisfied by a Laboratory-wide Installation Work Plan (IWP), which was originally submitted to the EPA on November 19, 1990, and is updated annually. The IWP presents the Laboratory's overall management and technical approach for meeting the requirements of the HSWA Module, describes the Laboratory's SWMUs, and outlines their aggregation into 24 Operable Units (OUs).

All Laboratory OUs are tiered to the IWP and relevant information in the IWP is incorporated by reference. The TA-49 OU is in the second set of OU work plans that are necessary to meet the HSWA Module's requirements, as defined in the IWP.

The IWP and the TA-49 work plan also address radioactive materials and other hazardous substances not subject to RCRA regulation. It is understood that language in this work plan pertaining to subjects outside the scope of RCRA is not enforceable under the RCRA Part B operating permit. However, the policy of the Laboratory and the DOE is to conduct the RFI taking into account all hazardous materials, whether or not they are regulated by statute.

E.1.4 History and Location of the TA-49 Operable Unit

The Laboratory's TA-49, also known as Frijoles Mesa site, occupies approximately 1280 acres along the south-central boundary of the Laboratory. TA-49 is bounded by Bandelier National Monument to the south and west and by other Laboratory TAs to the north and east. SWMUs at the TA-49 OU are located on the mesa top at an elevation of approximately 7140 ft. Figures EXEC-1 and EXEC-2 show the location of TA-49 in relation to regional and perimeter properties and to other Laboratory TAs. Figure EXEC-3 shows a site diagram and the location and nature of SWMUs at the TA-49 OU.

The perponderance of TA-49 contaminants consists of buried radionuclides, lead, and beryllium from underground hydronuclear and related experiments conducted from 1959 to 1961. The experimental areas containing almost all of these residues are managed as MDA AB. Because the buried waste there includes about 40 kg of plutonium, 93 kg of uranium-235, 170 kg of uranium-238, 11 kg of beryllium, and possibly more than 90,000 kg of lead, the TA-49 work plan emphasizes MDA AB.

Because this site has been used primarily for experiments involving special nuclear material (SNM), the identity and quantity of wastes at TA-49 are known with an unusual degree of confidence. This knowledge, which is the result of accountability required by such experiments, significantly reduces the types of

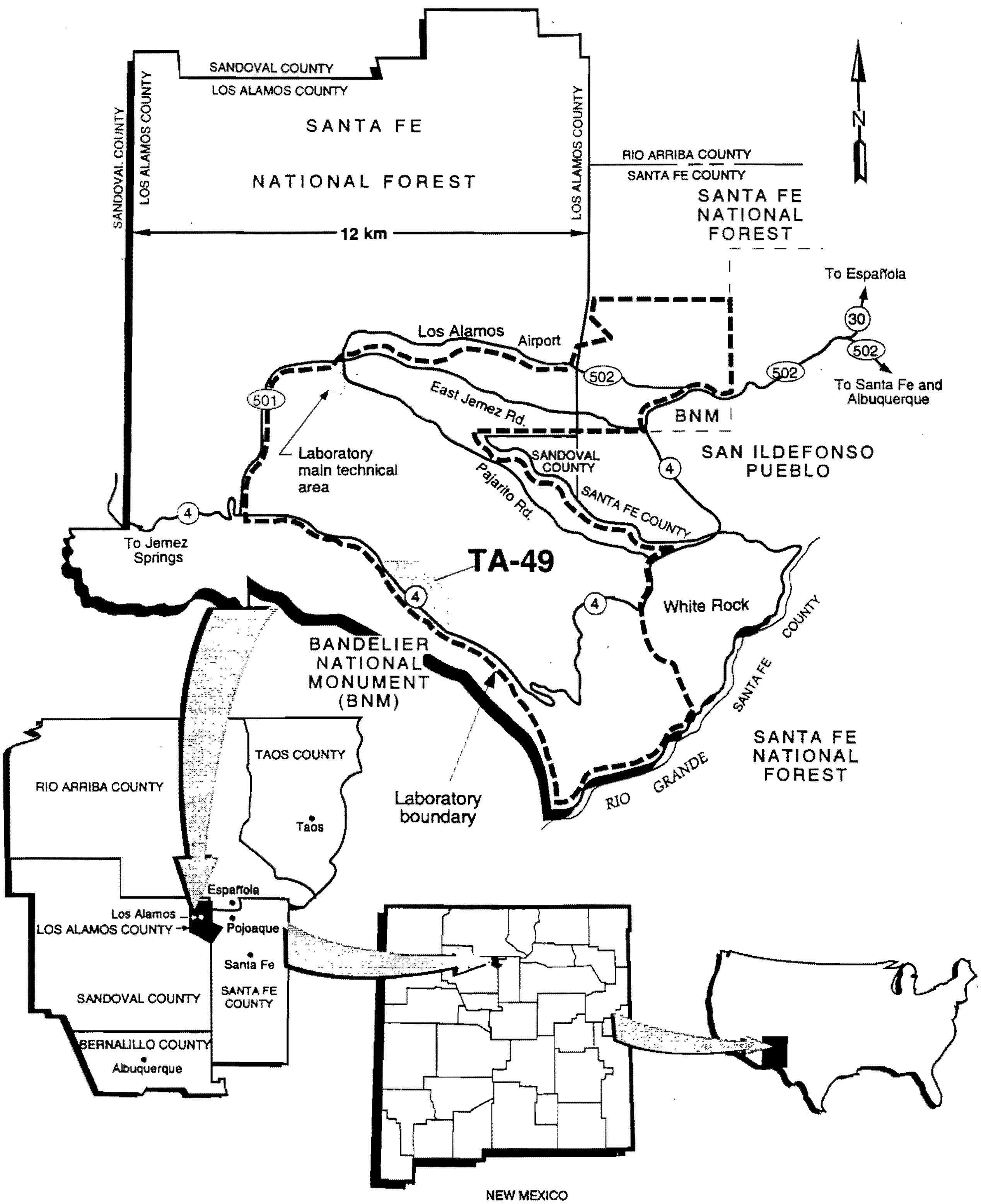


Figure EXEC-1 Regional location of the TA-49 Operable Unit.

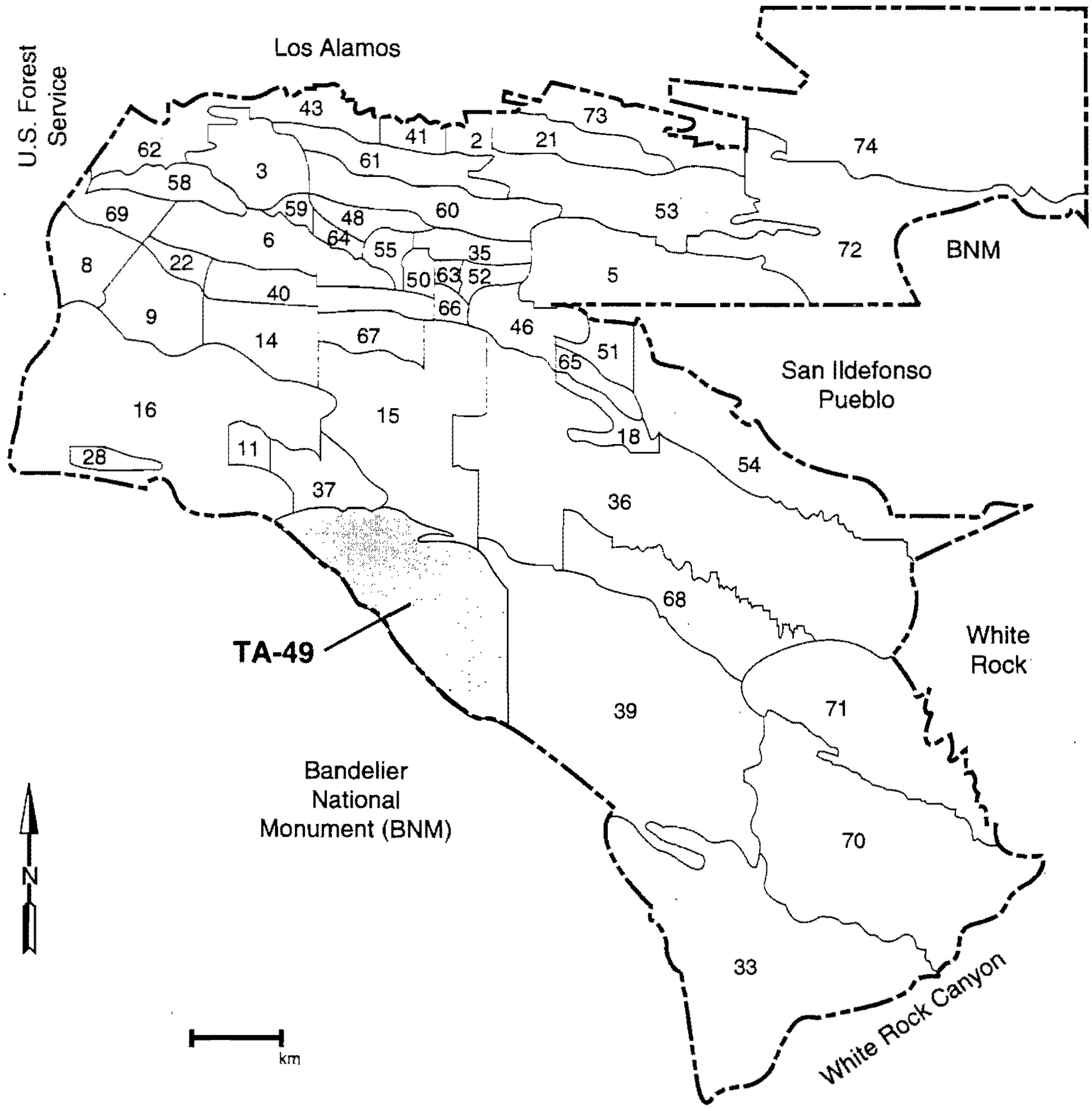
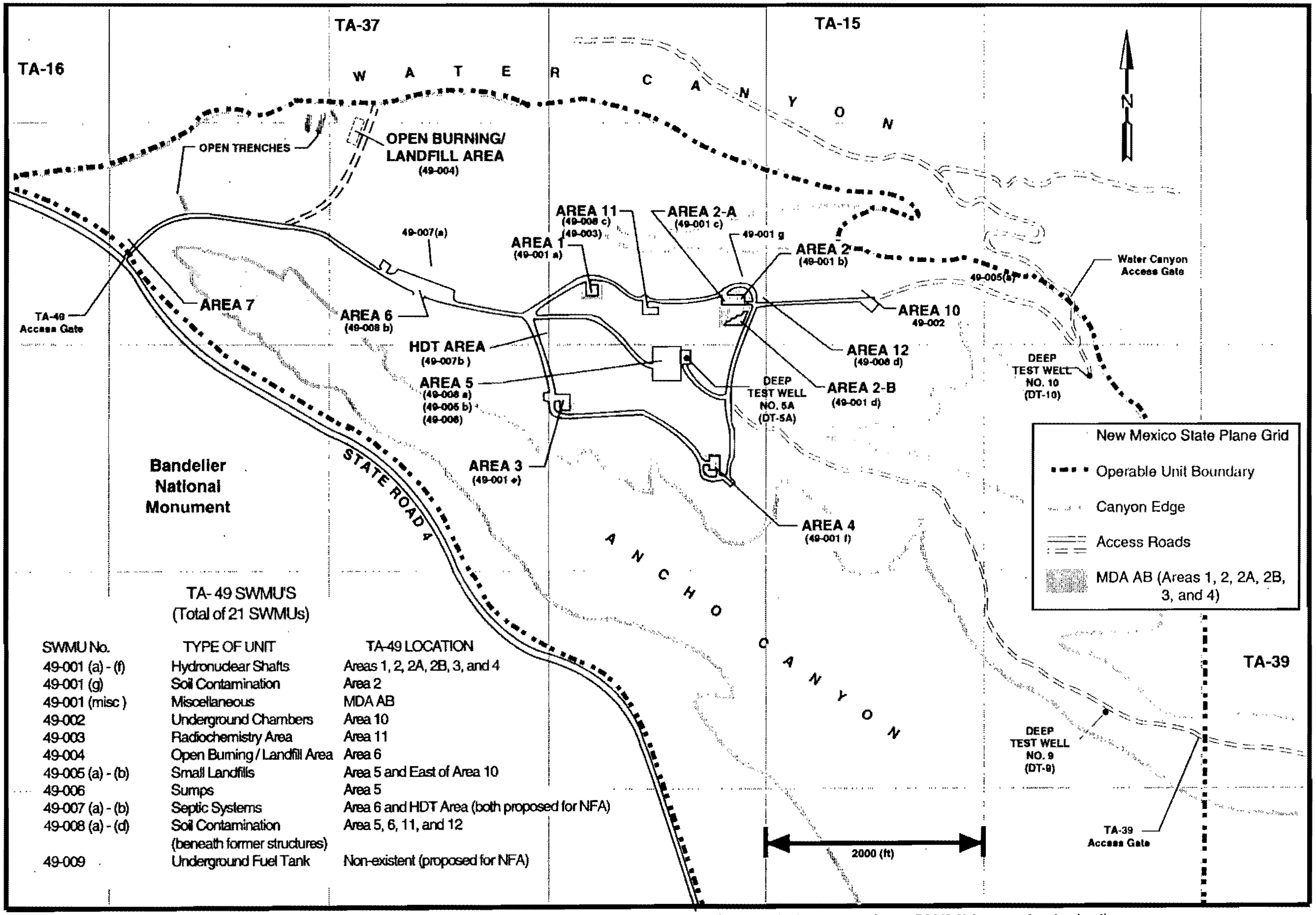


Figure EXEC-2 Location of TA-49 in relation to other TAs and landholdings surrounding the Laboratory.



TA- 49 SWMU'S
(Total of 21 SWMUs)

SWMU No.	TYPE OF UNIT	TA-49 LOCATION
49-001 (a) - (f)	Hydronuclear Shafts	Areas 1, 2, 2A, 2B, 3, and 4
49-001 (g)	Soil Contamination	Area 2
49-001 (misc)	Miscellaneous	MDA AB
49-002	Underground Chambers	Area 10
49-003	Radiochemistry Area	Area 11
49-004	Open Burning / Landfill Area	Area 6
49-005 (a) - (b)	Small Landfills	Area 5 and East of Area 10
49-006	Sumps	Area 5
49-007 (a) - (b)	Septic Systems	Area 6 and HDT Area (both proposed for NFA)
49-008 (a) - (d)	Soil Contamination (beneath former structures)	Area 5, 6, 11, and 12
49-009	Underground Fuel Tank	Non-existent (proposed for NFA)

Figure EXEC-3 Site diagram and SWMU list of the TA-49 Operable Unit (a total of 21 SWMUs are included).

contaminants that must be considered during the RFI. Thus a small set of indicator analytes can be selected for determining the nature and extent of contamination at TA-49 SWMUs.

E.1.5 Contaminants and Pathways of Concern

The 21 SWMUs identified at TA-49 fall into several conceptual categories, as follows:

- backfilled shafts containing significant quantities of explosively dispersed uranium, plutonium, lead, and beryllium;
- highly localized surface and near-surface soil and debris, associated with the hydronuclear experiments, which are contaminated above levels of concern;
- surface and near-surface soil that may be contaminated, but probably below levels of concern, by radionuclides, lead, beryllium, and possibly other materials; and
- landfills, septic systems, and shafts with low potential for low-level radionuclide, lead, and beryllium contamination.

The developed areas of TA-49 are located primarily near the center of the mesa top and lie about 1200 ft above the main aquifer. Prior site characterization indicates that perched water zones are absent at TA-49.

Because of the site's relatively remote location, existing institutional controls, and absence of known contaminant-transport pathways of significance under current site conditions, no pathways or receptors are of short-term concern given current land use in the vicinity of TA-49. Groundwater pathways are not of immediate concern because of the great depth to groundwater and the lack of transport mechanisms. Surface water and air pathways are not of immediate concern because the great bulk of TA-49 contaminants are buried in shafts and because of institutional control of the site.

In the context of this work plan, "short-term" will imply the 100-yr time frame assumed for institutional control by DOE Order 5820.2A, which addresses management of buried TRU waste. However, if land use changes beyond this time frame (for example, through the loss of institutional control), or if dramatic climactic changes occur, exposure pathways of concem then would include:

- exposure of buried contaminants through erosion, followed by surface water run-off and sediment transport or aerial resuspension,
- artificial site disturbance,
- infiltration through the vadose zone, and
- biological transport.

The TRU wastes at TA-49 will remain hazardous for much longer than the 100 yr assumed for institutional control. However, the technical difficulties associated with buried TRU removal are formidable, as described in Chapter 5 of this OU work plan. For these reasons, capping/stabilization of the site, accompanied by long-term monitoring and maintenance, has been identified as the likely remedial action to be taken at TA-49. As part of this remedial strategy, additional corrective measures will be taken as required during the period of monitoring and maintenance. This approach is consistent with the conditional remedy concept described in Section 3.8 of the IWP. Implementation of this conditional remedy for MDA AB requires confirmation by the RFI that significant waste migration from the MDA AB shafts has not occurred and that it is unlikely to occur over extended periods of time. Therefore, evaluation of the likelihood of waste migration is a key aspect of the TA-49 RFI work plan.

E.2 Technical Approach

The IWP provides for use of the observational approach to select an eventual remedy in the face of inevitable uncertainties about the site environment. The essence of the observational approach is that the most likely remedial actions eventually taken can be selected before full site characterization is accomplished and that these potential actions can be used to constrain the scope of the field investigation.

This approach accommodates other goals, including the use of action levels as criteria for identifying releases and determining the need for a CMS. The observational approach also advocates the use of discrete field work phases and a sequential sampling strategy wherein the results gained from each sample set guide the nature and location of subsequent sampling events.

The IWP also calls for the development of data quality objectives (DQOs) to establish the types, quantity, and quality of data required to meet the objectives of the RFI. The TA-49 work plan embraces the philosophies of the observational and DQO approaches.

E.2.1 Investigative Strategy

The Laboratory ER Program will conduct site-wide background studies (Framework Studies) of hydrology, geology, geochemistry, and other topics to support OU-specific investigations. These studies will have general applicability for all OUs and will only be done once. The Baseline Characterization section of the TA-49 work plan is integrated with site-wide investigations that focus on general environmental characteristics to provide a context in which the migration potential of contaminants from TA-49 SWMUs will be evaluated. The balance of the TA-49 field sampling plan is directed toward groupings of related SWMUs and focuses on identifying the nature and extent of contamination. TA-49 investigation groups addressed in specific sections of the work plan are listed below.

- Material Disposal Area AB (hydronuclear shafts)
- Area 11 (radiochemistry and small-scale shot area)
- Landfills, trenches, and Area 6 soil contamination
- Area 5 (control area)
- Area 10 (underground experimental chamber)
- Area 12 (Bottle House area)
- NFA units

Because almost all TA-49 contaminants reside in MDA AB, the emphasis of the work plan is on this investigation group.

To the extent possible, the TA-49 work plan also has been tailored to integrate with RFIs of adjoining TAs and with the Laboratory's routine environmental surveillance program.

E.2.2 Analytical Strategy

Highly localized radiological, lead, and beryllium contaminants represent by far the most significant contamination at TA-49, and thus are the primary focus of SWMU-specific investigations. Other contaminants are known or suspected to exist at TA-49 only in very limited quantities and generally will be associated with the aforementioned contaminants. Sampling plans take these factors into account to maximize the effectiveness of the RFI.

Field radiological screening will be used to identify grossly contaminated samples and areas of contamination. In addition, extensive use of radiological area survey methodology is proposed to detect TRU hot spots above levels of concern.

Field laboratory analyses can be used to provide rapid quantitative data to guide field operations. An on-site field laboratory will be used, as appropriate, to provide high-quality analytical data, to verify field screening and field surveys, and to minimize the number of samples that must be sent to off-site laboratories for more expensive analyses.

The primary TA-49 indicator analytes are

- gross alpha, beta, and gamma radioactivity,
- total uranium,
- isotopic plutonium,
- gamma spectrometry (which yields gross gamma radioactivity, americium-241, and cesium-137 levels), and
- RCRA-regulated metals (notably, lead and beryllium).

On a SWMU-specific basis, analysis for potential minor contaminants such as semivolatile organic compounds (SVOCs) is proposed.

E.2.3 Scope

The RFI field work described herein is expected to require about 5 yr to complete, contingent upon the availability of funding. A single 3-yr phase of field work is expected to be sufficient to complete the RFI for most SWMUs, but a second phase will be executed if field results warrant.

For MDA AB and Area 11, a second phase of investigation probably will be necessary.

A summary of the scope of the investigations is given in Table EXEC-1, which lists the sections of the work plan in which investigations are described. Table EXEC-2 and Figure EXEC-4 summarize the schedule for the planned field investigations and reports as proposed in this OU work plan.

Figure EXEC-5 contains a milestone chart and Table EXEC-3 shows the projected baseline funding and schedule for the TA-49 RFI/CMS, based on projections in the February 24, 1992 version of the DOE ER/WM Five Year Plan.

E.3 Reports

The HSWA permit specifies the submission of periodic reports, including monthly programmatic status reports and quarterly technical progress reports. Execution of the TA-49 RFI will provide data for these reports. At the conclusion of the RFI, a comprehensive report will be prepared that summarizes the entire RFI investigation.

Reports generated during the TA-49 RFI will be made available for review by the public at the ER Community Reading Room in Los Alamos, New Mexico. The final RFI report, as well as periodic progress reports, also will be available. The Reading Room is open to the public from 9 a.m. to 4 p.m. on Laboratory business days.

E.4 Technical Memoranda/Work Plan Modifications

Because of the time required to complete the field work, interim reports will be generated and submitted as appropriate portions of the TA-49 effort are completed. These technical memoranda will serve both as partial RFI Phase I reports that summarize results to date and as partial Phase II work plans for any follow-up activities that might be required (including revisions of initial field sampling plans). These technical memoranda/work plan modifications will be submitted for work conducted on both individual SWMUs and aggregates of SWMUs. A summary of planned submission dates is given in Table EXEC-2.

TABLE EXEC-1

SUMMARY OF THE SCOPE OF THE TA-49 RFI [a]

(a) Phase I Investigations

	Discrete Samples						
Chapter/Section	Number of Soil/Sediment Samples	Number of Water Samples	Number of QA/QC Samples	Number of Core Samples	Number of Boreholes Drilled/ Borehole Length (ft)	Geophysical Survey Area (ft^2)	Radiological Screening Area (ft^2)
6.1 Baseline	9	9	6	0	0/0	0	0
6.3 Area 6	57	0	9	23	9/125	500	214,100
6.4 Area 5	30	0	6	2	2/20	94,000	94,000
6.5 Area 10	18	0	3	0	0/0	13,000	13,000
6.6 Area 12	20	0	3	0	0/0	0	14,000
6.2 Area 11	40	0	6	40	15/138	65,000	65,000
7.0 MDA AB	108	0	15	314	11/2,686	94,250	101,250

(b) Phase II Investigations

	Discrete Samples						
Chapter/Section	Number of Soil/Sediment Samples	Number of Water Samples	Number of QA/QC Samples	Number of Core Samples	Number of Boreholes Drilled/ Borehole Length (ft)	Geophysical Survey Area (ft^2)	Radiological Screening Area (ft^2)
6.1 Baseline	0	6	3	0	0	0	0
6.2 Area 11	15	0	3	27	9/81	0	0
7.0	100	0	15	138	4/600	60,000	60,000

[a] The number of QA/QC samples includes borehole and surface samples.

TABLE EXEC-2

SCHEDULE OF PHASE I FIELD WORK (FY 93, FY 94, AND FY 95) AND TECHNICAL MEMORANDA/ WORK PLAN MODIFICATION REPORTS FOR THE TA-49 RFI

Results of RFI field work will be presented in three principle documents: quarterly technical progress reports, technical memoranda/work plan modifications, and the RFI Report. The schedule below summarizes the future documents associated with implementation of this OU work plan that are deliverable to EPA and DOE.

Document	EPA	DOE	Date Due
Monthly	X	X	25th of the following month
Quarterly	X		Feb. 15, May 15, Aug. 15
Annual	X	X	Nov. 15
Phase Reports	X	X	As in baseline; DOE milestones

Chapter and Section	Phase I Field Work	RFI Report Publication Dates: Draft	RFI Report Publication Dates: Final
6.1 Baseline	1 Oct. 92 – 29 Sept. 95	1 Mar. 95	30 Sept. 95
6.3 Area 6 6.4 Area 5 6.5 Area 10 6.6 Area 12	1 Oct. 93 – 29 Sept. 95		
6.2 Area 11 7.0 MDA AB	1 Oct. 92 – 29 Sept. 95		

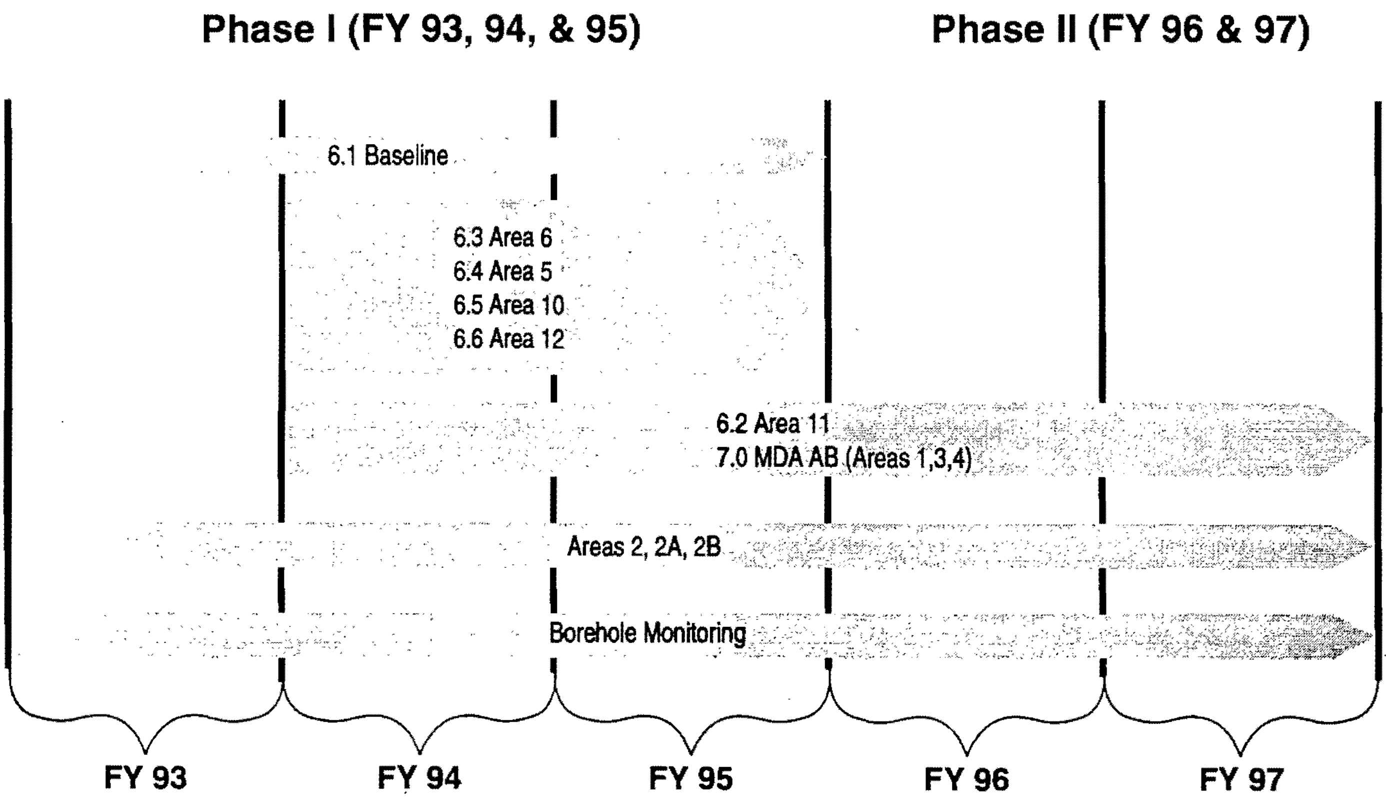
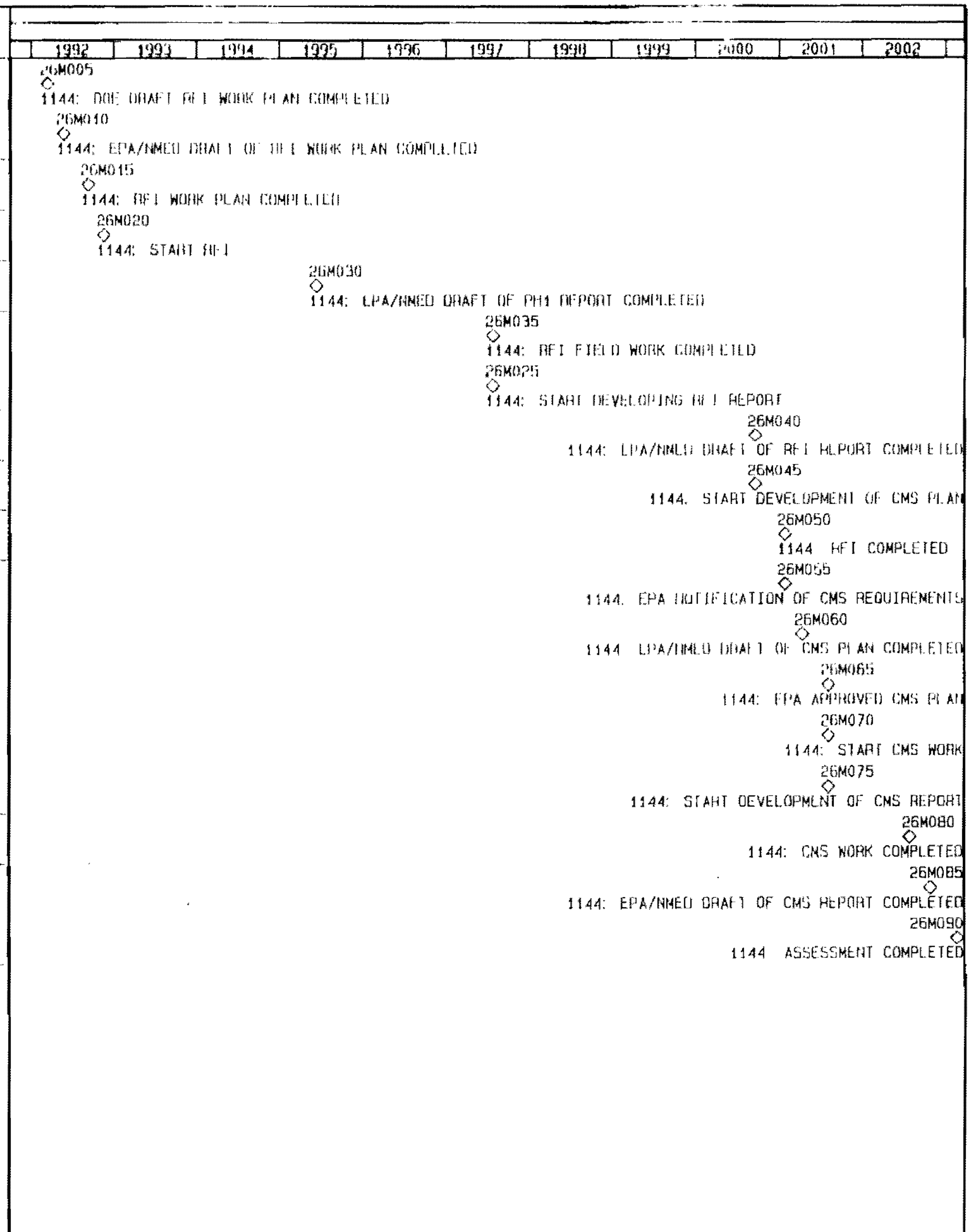


Figure EXEC-4. TA-49 RFI schedule proposed in this OU work plan.

ACTIVITY ID	ACTIVITY DESCRIPTION	EARLY START	EARLY FINISH
26M005	1144: DOE DRAFT RFI WORK PLAN COMPLETED		12MAR92
26M010	1144: EPA/NMED DRAFT OF RFI WORK PLAN COMPLETED		22MAY92
26M015	1144: RFI WORK PLAN COMPLETED		8SEP92
26M020	1144: START RFI	19NOV92	
26M030	1144: EPA/NMED DRAFT OF PH1 REPORT COMPLETED		13JUN95
26M035	1144: RFI FIELD WORK COMPLETED		29JUL97
26M025	1144: START DEVELOPING RFI REPORT	30JUL97	
26M040	1144: EPA/NMED DRAFT OF RFI REPORT COMPLETED		21SEP00
26M045	1144: START DEVELOPMENT OF CMS PLAN	22SEP00	
26M050	1144: RFI COMPLETED		29JAN01
26M055	1144: EPA NOTIFICATION OF CMS REQUIRENENTS		29JAN01
26M060	1144: EPA/NMED DRAFT OF CMS PLAN COMPLETED		13APR01
26M065	1144: EPA APPROVED CMS PLAN		6AUG01
26M070	1144: START CMS WORK	7AUG01	
26M075	1144: START DEVELOPMENT OF CMS REPORT	7AUG01	
26M080	1144: CMS WORK COMPLETED		31JUL02
26M085	1144: EPA/NMED DRAFT OF CMS REPORT COMPLETED		31OCT02
26M090	1144: ASSESSMENT COMPLETED		24FEB03



Plot Date 7MAY92
Data Date 1OCT91
Project Start 1OCT91
Project Finish 24FEB03

(c) Primavera Systems, Inc.

Activity Bar/Early Dates
Critical Activity
Progress Bar
Milestone/Flag Activity

A144 Sheet 1 of 1

LANL EM-8 ELLER
ADS 1144: TA-49 BASELINE
MILESTONE BAR CHART

ENVIRONMENTAL RESTORATION

Date	Revision	Checked	Approved

Figure EXEC-5. TA-49 Operable Unit (ADS 1144) RFI/CMS Milestone Chart, based on projections in the February 24, 1992 version of the DOE ER/WM Five-Year P

LANL EM-8 ELLER FINEST HOUR ADS 1144:TA-49 BASELINE

REPORT DATE 7MAY92 17:01 RUN NO. 27 ENVIRONMENTAL RESTORATION START DATE 1OCT91 FIN DATE 24FEB03

SCHEDULE SUMMARY REPORT DATA DATE 1OCT91 PAGE NO. 1

	TAR DUR	CUR DUR	%	SUMMARY DESCRIPTION	BUDGET	EARNED	CURRENT START	EARLY FINISH	TARGET START	EARLY FINISH	VAR.
1	0	250	0	ASSESSMENT - RFI WORK PLAN	361084.00	.00	1OCT91	30SEP92			
2	0	2082	0	ASSESSMENT - RFI	4087839.00	.00	14SEP92	29JAN01			
3	0	889	0	ASSESSMENT - RFI REPORT	738589.00	.00	1JUL97	29JAN01			
4	0	254	0	ASSESSMENT - CMS PLAN	25781.00	.00	22SEP00	28SEP01			
5	0	245	0	ASSESSMENT - CMS	478710.00	.00	7AUG01	31JUL02			
6	0	515	0	ASSESSMENT - CMS REPORT	124078.00	.00	30JAN01	24FEB03			
7	0	2087	0	ASSESSMENT - ADS MANAGEMENT	1537513.00	.00	1OCT91	23FEB00			
8	0	687	0	ASSESSMENT - VCA	76235.00	.00	2JAN97	30SEP99			
3	0	0	0	3	.00	.00	14JUN95	13JUN95			
REPORT TOTAL					7429829.00	.00					

Table EXEC-3. TA-49 Operable Unit (ADS 1144) RFI/CMS Milestone Chart, based on projections in the February 24, 1992 version of the DOE ER/WM Five-Year Plan.

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ACRONYMS AND ABBREVIATIONS

AA	Atomic absorption
ADS	Activity Data Sheet
AEC	US Atomic Energy Commission
AEOC	Alternate Emergency Operations Center
AOC	Area of concern
AP	Administrative Procedure
ARAR	Applicable or Relevant and Appropriate Requirements
ASA`	American Society of Agronomy, Inc.
ASTM	American Society of Testing Materials
AT	Accelerator Technology Division
AT-9	High Power Microwave Group
BDL	Below detection limits
BNM	Bandelier National Monument
CA	Corrective actions
CEARP	Comprehensive Environmental Assessment and Response Program
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
Ci	Curie
CLP	Contract Laboratory Program
CMS	Corrective Measures Study
COC	Contaminants of concern
COE	US.Army Corp of Engineers
COLIWASA	Composite Liquid Waste Sampler
DEC	DOE Environmental Checklist
D&D	Decontamination and Decommissioning
DOE	US Department of Energy
DOE/AL	US Department of Energy Albuquerque Operations Office
DOE/HQ	US Department of Energy Headquarters
DOE/LAAO	US Department of Energy Los Alamos Area Office
DOT	Department of Transportation
DQO	Data Quality Objectives
EA	Environmental Assessment
EES-1	Geology and Geochemistry Group
EIS	Environmental Impact Statement
EM	Environmental Management (Division)
EMO	Emergency Management Office
EM-7	Waste Management Group
EM-8	Environmental Surveillance Group
EM-9	Health and Environmental Chemistry Group
EM-13	Environmental Restoration Group
ENG-5	Facilities Maintenance Group
EPA	US Environmental Protection Agency
ER	Environmental Restoration
ES&H	Environment, Safety, and Health
ESG	Environmental Surveillance Group
FID	Flame Ionization Detector

FIDLER	Field Instrument for Detection of Low Energy Radiation
FIMAD	Facility for Information Management, Analysis, and Display
FSP	Field Sampling Plan
FY	Fiscal year
FYP	Five Year Plan
gal.	Gallon
GC	Gas chromotography
GIS	Geographical Information System
GM	Geiger-Mueller
H&S	Health and safety
HDT	Hazardous Devices Team
HE	High explosive
HPIC	High Pressure Ion Chamber
HRS	Hazard Ranking System
HS	Health and Safety (Division)
Ft	Foot
HSWA	Hazardous and Solid Waste Act Amendments
ICPMS	Inductively coupled plasma-mass spectroscopy
In	Inch
INC	Isotope and Nuclear Chemistry (Division)
IRM	Interim Remedial Measure
IWP	Installation Work Plan
J	Field Testing (Division)
Kd	Distribution coefficient
Kg	Kilogram
LANL	Los Alamos National Laboratory; the Laboratory
LAMPF	Los Alamos Meson Physics Facility
LASL	Los Alamos Scientific Laboratory (LANL before 1979)
M	Dynamic Testing (Division)
MCL	Maximum concentration level
MDA	Material Disposal Area
MDL	Minimum detection limit
Mi	Mile
MS	Mass spectrometry
NAI DETECTOR	Sodium iodide detector
NEPA	National Environmental Policy Act
NFA	No further action
NIST	National Institute of Standards and Technology
NMED	New Mexico Environment Department.
NPDES	National Pollutant Discharge Elimination System
OM	Operational Management
OS	Operational Security and Safeguards
OS-4	Computer and Communications Security Group
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
OUPL	Operable Unit Project Leader
PCB	Polychlorinated biphenyl
PID	Photoionization detector
PL	Project Leader
PM	Program Manager (ER)
PMP	Program Management Plan
PQL	Practical Quantitation Limits

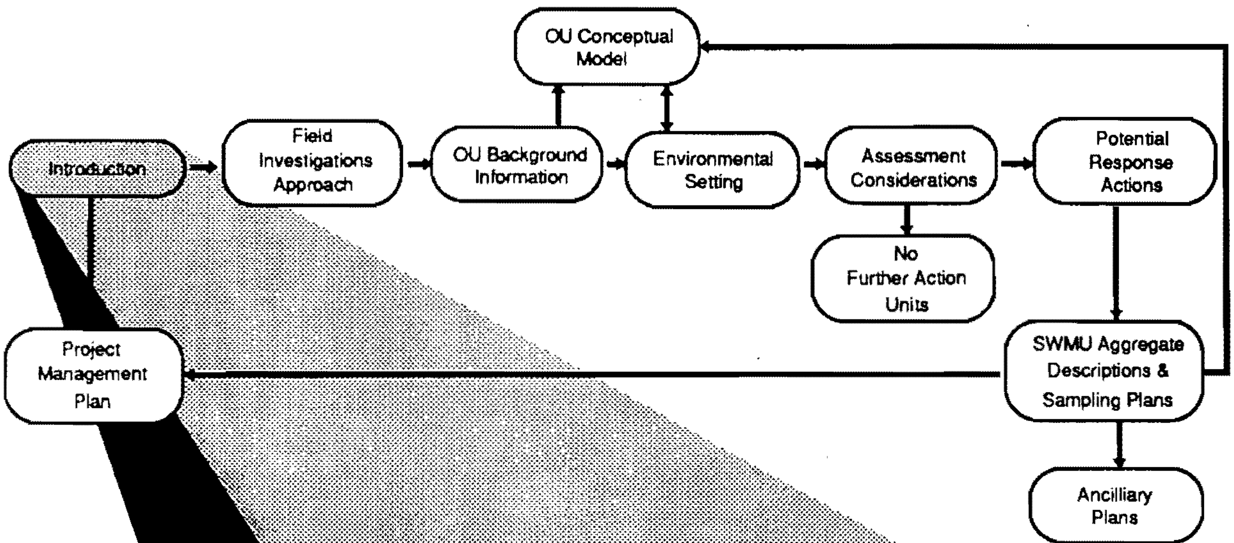
QAPjP	Quality Assurance Project Plan
QA	Quality assurance
QAP	Quality Assurance Plan
QA/QC	Quality Assurance/Quality Control
QP	Quality Administrative Procedure
QPP	Quality Program Plan
QPPL	Quality Program Project Leader
RA	Remedial Action
Rd	Retardation Factor
RD	Remedial Design
RFA	RCRA Facility Assessment
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RI	Remedial Investigation
RMP	Records Management Plan
RPF	Records Processing Facility
SAP	Sampling and Analysis Plan
SARA	Superfund Amendment Reauthorization Act
SMF	Sample Management Facility
SNM	Special nuclear material
SOP	Standard operating procedure
SSP	Site-Specific plan
SVOC	Semivolatile organic compound
SWMU	Solid Waste Management Unit
TA	Technical Area
TAL	Target analyte list
TCLP	Toxicity characteristic leaching procedure
TCL	Target Compound List
TLD	Thermoluminescent dosimeter
TRU	Transuranic
TU	Tritium units
UC	University of California
USATHAMA	US Army Toxic and Hazardous Materials Agency
USC	US Code
USDA	US Department of Agriculture
USGS	US Geological Survey
UST	Underground storage tanks
VCA	Voluntary corrective action
VCP	Vitrified clay pipe
VOA	Volatile organic analyses
VOC	Volatile organic compound
WBS	Work Breakdown Structure
WIN	Waste Information Network
WIPP	Waste Isolation Pilot Plant
XRF	X-Ray fluorescence
µCi	Microcurie

RADIONUCLIDES[a] AND METALS

^{241}Am	Americium-241
^{137}Cs	Cesium-137
^{239}Pu, ^{240}Pu, ^{241}Pu	Plutonium-239, 240, 241
^{90}Sr	Strontium-90
^{3}H	Tritium
^{235}U, ^{238}U	Uranium-235, 238
Pb	Lead
Be	Beryllium

[a]Numbers refer to specific isotopes of radionuclides.

Chapter 1



Introduction

- ER Program Overview
- HSWA Requirements
- TA-49 Operable Unit Description
- Work Plan Organization

1.0 INTRODUCTION

1.1 Overview of the Environmental Restoration Program

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

The Laboratory's operational requirements, outlined in the Resource Conservation and Recovery Act (RCRA) operating permit, are implemented by the Laboratory's ER program. In particular, the Hazardous and Solid Waste Amendment (HSWA) Module VIII and schedules of the Part B Operating Permit issued by the Environmental Protection Agency (EPA) give specific requirements affecting the conduct of the ER program (EPA 1990, 0306). The HSWA Module became effective on May 23, 1990. The Laboratory's ER program also is consistent with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

The HSWA Module requires the Laboratory to prepare an installation-wide work plan to contain the programmatic elements of a RCRA Facility Investigation (RFI) Work Plan. This requirement was satisfied by a Laboratory-wide Installation Work Plan (IWP) submitted to the EPA on November 19, 1990 (LANL 1990, 0144). The IWP, which is updated annually, serves as the plan by which DOE/UC will conduct the ER program at the Laboratory. The IWP describes the ER program and its history at the Laboratory, provides an installation-wide description of current conditions, identifies the Laboratory's Solid Waste Management Units (SWMUs) and their aggregation into a number of Operable Units (OUs), and presents the Laboratory's overall management and technical approach for meeting the requirements of the HSWA Module. The IWP is the document to which individual OU work plans are tiered. Relevant information presented in the IWP will be referenced but not repeated in OU work plans.

1.2 Hazardous and Solid Waste Amendment Requirements

The HSWA Module also requires the Laboratory to prepare OU work plans for specific investigations. The Technical Area 49 (TA-49) work plan is one of 24 OU work plans to be prepared. Within the ER program, the TA-49 assessment task is identified by Activity Data Sheet (ADS) 1144 and the OU is referenced as OU 1144. Additional information regarding the Laboratory's ER program, its implementation, and the guidance under which the TA-49 work plan was prepared is given in Chapter 3 of the IWP.

The TA-49 work plan addresses two of the SWMUs listed in Table A of the HSWA Module of the Laboratory's Part B Operating Permit and addresses one of the priority SWMUs (SWMU 49-001) appearing in Table B of the HSWA Module. The TA-49 work plan thus contributes to the Laboratory's commitment to address 35% of Table A SWMUs and 55% of Table B SWMUs, by May 23, 1992, as required by the HSWA Module. The significance of the small number of TA-49 SWMUs is misleading because Materials Disposal Area AB or MDA AB (SWMU 49-001 in Tables A and B) was estimated in 1986 to contain over 80% of the Laboratory's inventory of buried transuranic (TRU) waste by radioactivity content (Purtymun and Ahlquist 1986, 03-0013).

Table 1.2-1 summarizes the designations and alternative identification schemes for the TA-49 SWMUs listed in the November 1990 Laboratory SWMU report (LANL 1990, 0145). This table also identifies logical groupings for SWMU investigations and the work plan section in which each SWMU is addressed.

The November 1990 Laboratory SWMU report lists 9 TA-49 SWMUs that are subdivided into 21 SWMU subunits, of which only 2 are listed in the May 1990 HSWA Module. Appendix G of the November 1990 IWP lists 20 SWMUs and omits SWMU 49-001 (misc.), which is a nonspecific category that has been incorporated into the other 7 SWMU subunits comprising MDA AB. All of these SWMUs are addressed specifically in the TA-49 OU work plan. No Areas of Concern (AOC) are listed for TA-49 in the 1990 SWMU report. No new SWMUs or AOCs were identified during the preparation of the TA-49 OU work plan.

Section 3.9 of the November 1991 IWP (LANL 1991, 0553) states that each OU work plan may propose a HSWA Module Class III permit modification to adjust the number of SWMUs listed in Table A of the HSWA Module. Such adjustments may be made to remove SWMUs if it is determined that they need no further investigation. As described in Chapter 8, no further action (NFA) is proposed for three TA-49 SWMUs listed in the Laboratory's November 1990 SWMU Report (none of these are listed in the HSWA Module). Two of these SWMUs consist of recently installed National Pollutant Discharge Elimination System (NPDES)-permitted septic systems that have no credible source term. The third NFA SWMU, currently listed as an "underground fuel tank," is believed never to have existed. The detailed basis for deletion of these SWMUs from the Laboratory's SWMU list is given in Chapter 8.

Because conduct of the TA-49 RFI is scheduled to take approximately 5 yr, contingent on the availability of funding, the Laboratory proposes to submit technical memoranda (Phase Reports) on site characterization activities for TA-49 SWMUs to update the EPA and other interested parties on RFI field work progress. These update memoranda also may serve as work plan modifications for revising field sampling plans, as appropriate, to reflect initial characterization results. Therefore, technical memoranda will be essentially partial RFI Phase I reports and partial RFI Phase II work plans. The schedule for these technical memoranda/work plan modifications is presented in Table EXEC-2 and in Annex I (Project Management Plan) of this OU work plan.

1.3 Description of the TA-49 Operable Unit and Solid Waste Management Units

Technical Area-49 occupies Frijoles Mesa at the southern boundary of the Laboratory. Figure EXEC-1 shows the regional location of the Laboratory and Figure EXEC-2 shows the location of TA-49 with respect to other Laboratory TAs as well as public and private properties surrounding the Laboratory.

TABLE 1.2-1

TA-49 SWMU INVESTIGATION GROUPS AND DESIGNATIONS[a]

Investigation Group	Work Plan Chapter for Section	Original SWMU List in Table A,B of Permit	Current SWMU List	Location	Description	CEARP Identification Number	RFA Unit	ER Release Site Information
MDA AB	7	49-001 (Priority SWMU)	49-001(a)	Area 1	Experimental shafts	b	49.001	
			49-001(b)	Area 2	Experimental shafts	b		
			49-001(c)	Area 2A	Experimental shafts	b		
			49-001(d)	Area 2B	Experimental shafts	b		
			49-001(e)	Area 3	Experimental shafts	b		
			49-001(f)	Area 4	Experimental shafts	b		
			49-001(g)	Area 2	Soil contamination	b		
			49-001(misc)	MDA-AB	Miscellaneous	TA49-3-CA-I-HW/RW	49.005 49.001	TSK51:1-13
Control Area	6.4		49-005(b)	Area 5	Landfill	b		TSK52:25
			49-008(a)	Area 5	Soil Contamination	b		TSK52:19
			49-006	Area 5	Sumps	b		TSK52:17
			49-005(a)	East of Area 10	Landfill	b		TSK52:26
Landfills, Trenches, and Area 6 Soil Contamination	6.3		49-004	Area 6	Landfill	TA49-2-L-I-HW/RW	49.006	TSK52:24
			49-008(b)	Area 6	Soil Contamination	b		TSK52:23
Experimental Chamber (Area 10)	6.5		49-002	Area 10	Underground Chamber	TA49-3-CA-I-HW/RW		TSK52:27
Radiochemistry and Small-Scale Shot Area	6.2	49-003(2)	49-003	Area 11	Leachfield	TA49-1-CA-I-HW/RW TA49-3-CA-1-HW/RW	49.003 49.004	TSK52:14
			49-008(c)	Area 11	Soil Contamination	b		TSK52:18
Bottle House Area (Area 12)	6.6		49-008(d)	Area 12	Underground Chamber; Soil Contamination	b		TSK52:22,31
Underground Tank Septic Systems	8.2 8.3		49-009	c	Underground Tank	b		TSK52:30
			49-007(a)	Area 6	Septic System	TA49-5-ST-A-HW		TSK52-15
			49-007(b)	HDT Area	Septic System	TA49-5-ST-A-HW		TSK52:16

[a]Baseline characterization is addressed in Section 6.1.
[b]No corresponding ER Program Unit.
[c]Nonexistent; no further action proposed (Chapter 8).

Figure EXEC-3 identifies the location of SWMUs and other salient site features at TA-49. TA-49 occupies approximately 1280 acres; its boundaries are defined by TA-15 to the north (the edge of Water Canyon), Bandelier National Monument to the west and south (State Road 4), TA-39 to the east, and TAs -16 and -37 to the north and west. Appendix A contains a topographic map of TA-49 that indicates the location of SWMUs and other relevant aspects of the OU. Appendix B contains site maps and drawings, survey coordinates of shafts, and other engineering details relevant to the TA-49 RFI. Engineering data are available from the period of peak experimental activity at TA-49 (1959–1961) to the present. Details of the TA-49 environment, its past use, and known or potential release sites are given in Chapters 3–8 and in Appendix D.

TA-49 has been used from the mid-1940s to the present as a buffer zone for firing sites in adjacent TAs -15 and -39. A period of intense experimental activity at TA-49 took place from late 1959 through mid-1961, during which hydronuclear and related experiments deposited significant amounts of plutonium, uranium, lead, and beryllium in underground shafts. These activities were responsible for almost all of the radioactive and hazardous materials existing at TA-49 at the present time. Much smaller amounts of highly localized contamination, predominantly radionuclides in the near surface at MDA AB and Area 11, also are known to be present at TA-49.

As described in Chapter 3 of this OU work plan, other limited uses of TA-49 have occurred since 1961. Presently, small portions of the site are used as a training area by the Laboratory's Hazardous Devices Team (HDT), for siting of the Laboratory's Alternate Emergency Operations Center (AEOC), for high-power microwave experimentation by Group AT-9, and for ground-resistance experiments by Group OS-4. One of the Laboratory's meteorological stations also is located at TA-49 (referred to as the Bandelier Meteorological Station). However, other than the use of small amounts of explosives by the HDT during training exercises, current TA-49 activities involve no use of significant quantities of hazardous or radioactive materials.

1.4 Work Plan Organization

The purpose of the TA-49 Work Plan is twofold: to satisfy the regulatory requirements of the HSWA module and to serve as the detailed field sampling plan for personnel who will implement the RFI characterization activities discussed herein. The HSWA Module sets out the general scope of the work plan, establishes the expected correspondence between the RFI tasks identified in EPA guidance documents (EPA 1989, 0088) and the equivalent ER Program tasks, and specifies the requirements to be fulfilled, as outlined in the IWP and the OU work plans. These considerations are summarized in Table 1.4-1, which has been adapted from the HSWA Module (pg. 32).

Table 3.2 of the 1991 IWP proposes an outline for OU work plans, which may be modified somewhat to fit the needs of individual OUs. The TA-49 work plan includes all the elements specified by this outline, but the form has been modified to be more logically consistent with the TA-49 OU.

The EPA defines five general tasks within the RFI process (EPA 1989, 0088; EPA 1990, 0306). These tasks are described below, with reference to the chapter of the TA-49 work plan that addresses each task.

- ***RFI Task I, Description of Current Conditions.*** This task consists of a presentation of facility background information and a general discussion of the nature and extent of contamination. General historical background information on TA-49 is presented in Chapters 3 and 4. SWMU-specific information is contained in Chapters 6–8.
- ***RFI Task II, RFI Work Plan.*** This task requires plans for Project Management, Quality Assurance, Data Management, Health and Safety, and Community Relations. These plans are presented in Annexes I–V.
- ***RFI Task III, Facility Investigation.*** This task sets out requirements for further environmental characterization of the site. The environmental setting is described in Chapter 4 and known data on the nature and extent of contamination at individual SWMUs are presented with the field investigation objectives and sampling plans in Chapters 6 and 7. Pathway and assessment considerations are discussed in Chapter 5. SWMUs proposed for no further action are addressed in Chapter 8.
- ***RFI Task IV, Investigative Analysis.*** This task contains subsets of Data Analysis and Protection Standards and is addressed in the IWP.
- ***RFI Task V, Reports.*** This task calls for preliminary, work plan, progress, draft, and final reports. As outlined in the IWP, Laboratory work plans are provided on an installation-wide basis and for specific ER program activities such as the TA-49 RFI. The site-specific TA-49 OU work plan has been prepared in accordance with this requirement. Table EXEC-2 and Annex I (Project Management Plan) of this OU work plan give schedules for TA-49 RFI reports. Periodic reports for the entire ER Program, as well as draft and final RFI Reports, will be submitted as described in the IWP.

TABLE 1.4-1
RFI GUIDANCE FROM THE LABORATORY'S RCRA PART B PERMIT (pp.32) AND CORRESPONDING PORTIONS OF THE TA-49 RFI WORK PLAN

Scope of the RFI		ER Program Equivalent	
RCRA Facility Investigation Specified Tasks:	LANL IWP	LANL Task/Site RI/FS	Corresponding Portions of the TA-49 Work Plan
Task I: Description of Current Conditions	I. LANL Installation RI/FS Work Plan	I. Task/Site Conditions	I.
A. Facility Background	A. Installation Background	A. Task/Site Background	A. Chapters 3 and 4
B. Nature and Extent of Contamination	B. Tabular Summary of Contamination by Site	B. Nature and Extent of Contamination	B. Chapters 6 - 8
Task II: RFI Work Plan	II. LANL Installation RI/FS Work Plan	II. LANL Task/Site RI/FS Documents	II.
A. Data Collection QA Plan	A. General SOPs for Sampling, Analysis, and QA	A. QA Project Plan and Field Sampling Plan	A. Annex II and Chapters 6 and 7
B. Data Management Plan	B. Technical Data Management Program	B. Technical Data Management Plan	B. Annex IV
C. Community Relations Plan	C. Health and Safety Program	C. Health and Safety Plan	C. Annex III
	D. Community Relations Program	D. Community Relations Plan	D. Annex V
Task III: Facility Investigation	III.	III. Task/Site Investigation	III.
A. Environmental Setting		A. Environmental Setting	A. Chapter 4
B. Source Characterization		B. Source Characterization	B. Chapters 6 - 8
C. Contamination Characterization		C. Contamination Characterization	C. Chapters 6 - 8
D. Potential Receptor Identification		D. Potential Receptor Identification	D. Chapter 5
Task IV: Investigative Analysis	IV.	IV. LANL Task/Site Investigative Analysis	IV.
A. Data Analysis		A. Data Analysis	A. IWP
B. Protection Standards		B. Protection Standards	B. IWP
Task V: Reports	V. Reports	V. LANL Task/Site Reports	V.
A. Preliminary and Work Plan	A. LANL Installation RI/FS Work Plan	A. QA Project Plan, Field Sampling Plan, Technical Data Management Plan, Health and Safety Plan, Community Relations Plan	A. Annexes I - V
B. Progress	B. Annual Update of LANL Installation RI/FS Work Plan	B. LANL Task/Site RI/FS Documents and LANL Monthly Management Status Report	B. Chapter 1; Annex I
C. Draft and Final	C. Draft and Final	C. Draft and Final	C. Chapter 1; Annex I

Chapter 1 References

EPA (US Environmental Protection Agency), May 1989. "Interim Final RCRA Facility Investigation (RFI) Guidance, Volume I of IV, Development of an RFI Work Plan and General Considerations for RCRA Facility Investigations," EPA/530-SW-89-031, OSWER Directive 9502.00-6D, Office of Solid Waste, Washington, DC. (EPA 1989, 0088)

EPA (US Environmental Protection Agency), April 10,1990. RCRA Permit No. NM0890010515, EPA Region VI, issued to Los Alamos National Laboratory, Los Alamos, New Mexico, effective May 23, 1990, EPA Region VI, Hazardous Waste Management Division, Dallas, Texas. (EPA 1990, 0306)

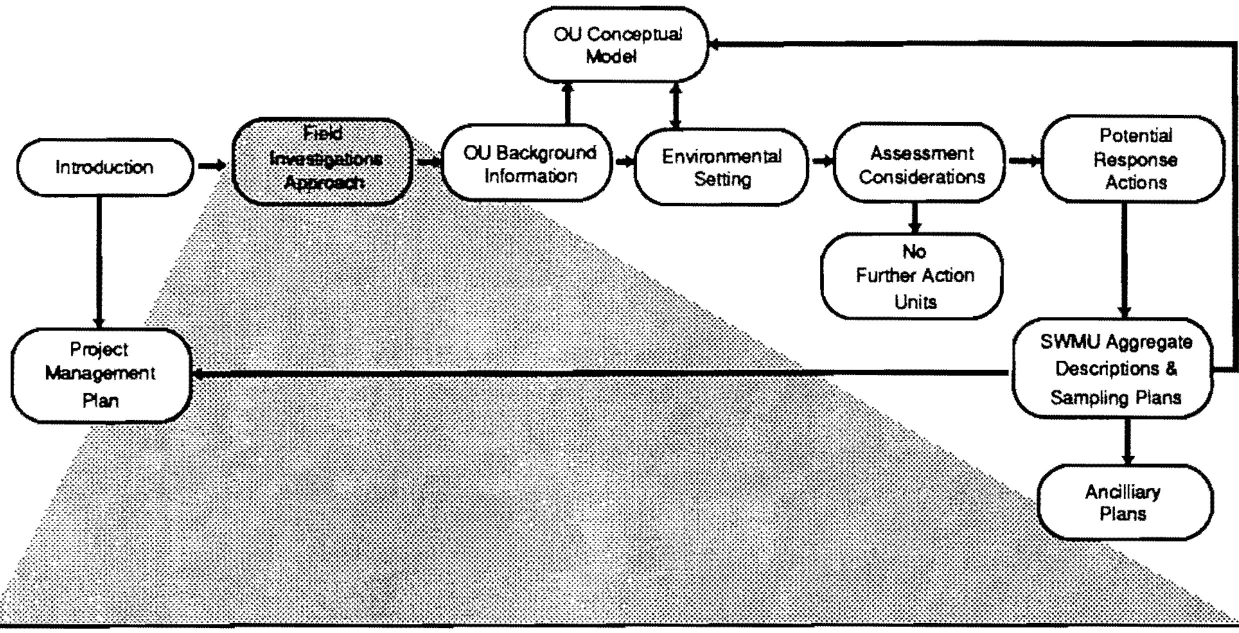
LANL (Los Alamos National Laboratory), November 1990. "Installation Work Plan for Environmental Restoration," Los Alamos National Laboratory Report LA-UR-90-3825, Los Alamos, New Mexico. (LANL 1990, 0144)

LANL (Los Alamos National Laboratory), November 1990. "Solid Waste Management Units Report," Volumes I through IV, Los Alamos National Laboratory document LA-UR-90-3400, prepared by International Technology Corporation under Contract 9-XS8-0062R-1, Los Alamos, New Mexico. (LANL 1990, 0145)

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

Purtymun, W.D., and Ahlquist, A. J. 1986. "Geologic and Hydrologic Evaluation of Technical Area 49," Los Alamos National Laboratory Environmental Surveillance Group memorandum HSE-8-86-1183, Los Alamos, New Mexico. (Purtymun and Ahlquist 1986, 03-0013)

Chapter 2



Approach to RCRA Field Investigations

- Observational Approach
- Data Quality Objectives
- Decision Analysis
- Cost-Effectiveness
- Aggregation of SWMUs
- Technical Approach
- Technical Objectives
- Integration with CERCLA, NEPA, and DOE Orders
- Natural Resource Damage Assessment
- Voluntary Corrective Actions
- Modeling
- Framework Studies
- Conditional Remedies
- NFA Units

2.0 APPROACH TO RESOURCE CONSERVATION AND RECOVERY ACT FIELD INVESTIGATIONS

The IWP (LANL 1991, 0553) specifies the ER Program's technical and management approaches for compliance with the HSWA Module of the RCRA Part B operating permit (EPA 1990, 0306) and other regulatory obligations. These approaches define the framework within which the TA-49 OU RFI work plan must function, as well as general concepts and objectives guiding the field investigation, and are described in this chapter.

2.1 Observational Approach

The observational approach embodies the philosophy that remedial action can, and often should, be initiated without "full" characterization of the nature and extent of contamination (see Appendix J of the IWP). For many SWMUs, concepts for probable remedial action can be formulated before complete characterization information has been collected to define all uncertainties related to unit conditions. The goal is to collect only the data that is required to reduce uncertainties to an acceptable level. In some cases, there may be clear benefits from focusing on particular remedial actions while still in early stages of the characterization process.

For example, to apply the observational approach to the stabilization-in-place remedial option, the only characterization needed is that which defines the consequences of leaving waste in place. For other SWMUs, removal will clearly be an appropriate remedial alternative; in which case, full characterization may be curtailed in preference to monitoring during waste removal.

Probable remedial alternatives for the TA-49 OU are presented in Chapter 5 of this work plan. It is likely that for many TA-49 SWMUs, Phase I of the RFI will demonstrate that no further action (NFA) is the appropriate remedial decision. At the other extreme lies MDA AB, for which the RFI probably will require at least two phases extending over a 5-yr period. Given present information on MDA AB, the most likely remedial response is the conditional remedy of capping/stabilization accompanied by long-term institutional control, maintenance, and monitoring. Using the observational approach, the RFI for the TA-49 OU has been designed to provide that information required to evaluate the appropriateness of likely remedial responses.

2.2 Data Quality Objectives

The data quality objective (DQO) process provides a step-by-step procedure for focusing the objectives of the field investigation and ensuring that proposed data collection activities are carefully developed from, and tied back to, decision criteria and strategies. The result is a clear definition of the key remedial issues and specification of the types, quantity, and quality of data required to achieve RFI objectives. The philosophy and details of the DQO process are given in various EPA publications (for example, EPA 1987, 0086).

The DQO process has been embraced in the development of the TA-49 OU work plan. General DQOs are addressed in Chapter 5 and are developed more specifically for individual SWMUs in the relevant sections of Chapters 6 and 7. These portions of the work plan include discussions of DQO logic diagrams, decision points, and decision criteria.

2.3 Decision Analysis

The decision analysis approach, which provides for efficient identification and evaluation of corrective measures alternatives, is described in Appendix I of the IWP. This appendix describes how decision analysis will be used in the ER Program. Because the decision analysis process is being developed concurrently with the TA-49 OU work plan, the process will be applied to this operable unit during the first year of field work, reflecting the decision-making framework described in the IWP. Future documents describing work at the TA-49 OU will also reflect this approach.

2.4 Cost-Effectiveness Analysis

Cost-effectiveness analysis compares the costs of alternative strategies for achieving remedial goals to the cost of the least expensive alternative, if appropriate. Coupled with the observational approach, the application of this philosophy during the RFI may lead to the decision that additional characterization for a SWMU is less cost effective than proceeding directly to a remedial action. This decision requires an assessment of the uncertainties that would result from incomplete characterization against the probable costs and benefits of additional characterization. This general philosophy has been followed in the development of the TA-49 RFI work plan.

2.5 Aggregation of Solid Waste Management Units

TA-49 SWMUs have been aggregated into logical investigation groups on the basis of location and/or known physical characteristics (Table 1.2-1). Each grouping is assigned a section in Chapters 6 and 7, where the relevant field investigation plan is described. The logic for these groupings and their relationship to the work plan design are discussed in Section 3.5 of this work plan.

2.6 Technical Approach

Chapter 3 of the IWP outlines the technical approach generally employed in the Laboratory's ER Program. Key elements are summarized in this subsection as they pertain to the development of the TA-49 OU work plan.

2.6.1 Action Levels

The use of Action Levels (defined in EPA's proposed Subpart S regulations) as criteria for identifying releases from SWMUs and for determining the need for a Corrective Measures Study (CMS) is discussed in Subsection 3.5.2.2 and Appendix F of the IWP. Section 5.1 of this OU work plan discusses action levels in relation to the TA-49 RFI/CMS.

2.6.2 Sequential Sampling and Work Plan Phases

Field sampling plans in this work plan are based on sampling concepts discussed in Appendix H of the IWP. In general, sequential sampling uses the results from each sample set to determine if additional sets are required and to guide the selection of the subsequent sample set. In this iterative process, each incremental set of samples aids in determining the required number of additional samples and their optimal locations.

Sequenced sampling is closely related to the concept of a phased approach to the RFI. Only a single phase of work is expected to be necessary for most TA-49 SWMUs, but two phases are planned for both MDA AB and Area 11, which contain almost all of the site contaminants. Phase I will provide initial information required for detailed planning of the subsequent phase.

2.6.3 Risk Assessment

In general, RFI characterization leads to risk assessment which, with decision analysis, is used to determine the need for remedial action. Health-risk-based analyses will be used to set clean-up levels at Laboratory SWMUs. The TA-49 RFI is designed to provide data for both radiological and nonradiological risk assessment following the RFI at individual SWMUs and over the entire OU. The ER Program is currently developing baseline risk assessment scenarios and criteria that will be presented in the 1992 version of the IWP. This approach will be developed in adequate time for data analysis.

2.6.4 Integration with Other Laboratory Activities

To the maximum practical extent, the TA-49 RFI work plan has been integrated with other Laboratory-wide environmental activities. In particular, the ER Framework Studies program and the Laboratory's Environmental Surveillance Program have interests that strongly overlap with the TA-49 RFI. The TA-49 RFI also will be integrated with work plans currently being developed for adjacent TAs -15, -39, and -16 and for the Canyons Assessment work plan to be developed later. Specific examples of integrated activities are deep borehole placement and other subsurface characterization. Data needs for the TA-49 RFI that overlap with other environmental activities of this nature are pointed out in the TA-49 work plan.

RFI coordination with non-ER operations at TA-49 is required also. Because both current and planned use of TA-49 for on-site Laboratory operations is light and the activities generally are located away from SWMUs, the impact of the RFI should be minimal on non-ER site activities. However, the RFI must be coordinated with these routine activities, as well as with TA-15 firing site activities and Hazardous Devices Team activities, which require occasional planned evacuation of TA-49.

2.7 Technical Objectives

2.7.1 General Technical Objectives

The technical objectives of the TA-49 RFI are summarized below:

- determine whether contaminants are present above action levels at each SWMU;
- identify those contaminants that are present above action levels;
- determine the vertical and lateral extent of contamination
- Identify contaminant migration pathways OU-wide and for each SWMU;
- acquire sufficient information to allow quantitative migration pathways analysis and baseline risk assessment;
- provide data necessary for preliminary assessment of potential remedial alternatives; and
- provide the basis for detailed planning of the Correction Measures Study (CMS).

The approaches used to attain these objectives for the TA-49 OU are outlined in the next several sections. In addition to these technical objectives, management objectives require that the RFI be conducted in an efficient, cost-effective manner and that the RFI be coordinated properly with institutional constraints of the Laboratory.

2.7.2 Baseline Characterization

Characterization of site-specific hydrogeologic properties is a specific requirement of Section P of the HSWA Module (EPA 1990, 0306). Limited baseline characterization during the TA-49 RFI will help define the variability of environmental factors relevant to the evaluation of the potential for contaminant migration from individual TA-49 SWMUs. Baseline characterization also will provide information necessary for distinguishing SWMU-related contaminants from OU-wide contamination and natural variations in background levels.

Because this type of data is relevant Laboratory-wide, planning for this portion of the RFI has been deferred (to the extent practical) to Framework Studies investigations, but the baseline characterization essential to the TA-49 OU is proposed in this OU work plan.

2.7.3 Individual SWMU Characterization

A combination of discrete surface sampling and surface radiological surveys for transuranic (TRU) contaminants will be used to define the spatial extent and distribution of surface contamination at individual TA-49 SWMUs. Characterization of additional vertical and lateral boreholes and recovered core samples (especially at MDA AB) and monitoring of the existing network of boreholes will be used to assess subsurface units. Details of the characterization plan for each SWMU are addressed in Chapters 6 and 7.

2.7.4 Field Investigation Methods

Common methodologies applicable to the conduct of TA-49 RFI activities are summarized in Appendix C of this work plan and are referenced in the individual SWMU sampling plans. Field survey, field screening, field laboratory, and off-site analytical laboratory measurements will be used for individual SWMUs as appropriate.

2.8 Integration with CERCLA, NEPA, and DOE Orders

Section 1.4.4 of Annex I of the IWP Program Management Plan discusses the integration of the RCRA-based ER Program with applicable requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Environmental Policy Act (NEPA). Additionally, the ER Program will comply with all other applicable federal acts, state statutes, and DOE orders and policy statements identified in the IWP Program Management Plan.

Appendix I of this OU work plan contains NEPA-related documents that pertain to cultural and biological assessments relevant to the TA-49 work plan (as of May 1992). It is expected that DOE will issue a categorical exclusion for RFI activities at the TA-49 OU.

DOE Orders applicable to the Laboratory's ER program are identified in the IWP Program Management Plan. Compliance with the requirements of these orders is an integral part of Laboratory operations and is ensured through the documented policies, planning, auditing, and work review procedures of the Laboratory.

For the TA-49 OU, it is especially important to recognize two aspects of DOE Order 5820.2A on Radioactive Waste Management (DOE 1988, 0074) that are pertinent to the RFI process. First, in regard to buried TRU waste in experimental shafts at MDA AB, Sec. II.3.i of this order identifies site characterization and closure requirements (see Section 5.3 of this OU work plan). Second, in regard to low-level radioactive waste that also is certain to exist at MDA AB, the order specifies requirements that may be applicable or may provide useful guidance for RFI assessment. The TA-49 work plan is designed to take these considerations into account.

2.9 Natural Resource Damage Assessment

The environmental restoration work at Los Alamos National Laboratory is performed in compliance with the Laboratory's RCRA Part B operating permit. However, this work also is performed in accord with applicable sections of CERCLA, as required by DOE Order 5400.4 (DOE 1989, 0078). The CERCLA Section 120 extends natural resource damage liability to federal facilities, which includes the Laboratory. The first part of the natural resource damage assessment is a Preassessment Screen governed by regulations in 43 CFR 11; the Preassessment Screen will be used to determine whether a full natural resource damage assessment is appropriate. The Preassessment Screen will be integrated with the CERCLA ecological assessment process for the TA-49 operable unit. A general description of the Preassessment Screen and the ecological assessment will be written for inclusion in the revised IWP. Any modifications of the general procedure that might be necessary for this OU will be described in future reports of progress pertaining to the TA-49 RFI. This is consistent with the ***Guidance for Natural Resource Trusteeship and Ecological Evaluation for Environmental Restoration at DOE Facilities, 1991.***

2.10 Voluntary Corrective Actions

Voluntary corrective actions (VCAs) will be taken in situations encountered during the RFI where it is obvious that simple removal of highly localized source terms can be accomplished conveniently and with less expense than required for extensive characterization. The extent to which VCA can be taken at Laboratory SWMUs is limited until the Laboratory's mixed waste treatment/disposal facility can be used (1996 at the earliest). However, two types of situations are anticipated during the TA-49 RFI for which limited VCA may be appropriate.

One situation arises when soil hot spots contaminated well above levels of concern are identified during field activities. If the contamination can readily be shown to be highly localized (as expected in most cases at TA-49), it may be desirable to simply remove the isolated contamination and to confirm its removal by sampling.

The TA-49 RFI work plan also proposes the removal of small amounts of contaminated piping and related near-surface debris that will interfere with the field characterization and that represent troublesome future source terms.

2.11 Modeling

In Chapter 4, site-wide and SWMU-specific conceptual models for the TA-49 OU are presented. These models are based on available information and are used in the development of the field characterization activities described in Chapters 6 and 7. As appropriate, the conceptual models will be revised as additional information is acquired during the RFI.

Computational models will be used to evaluate health-based environmental risk (following the RFI) and occupational risk (during RFI field work). Modeling of contaminant transport, particularly over long time frames, will be performed as part of the environmental risk assessment. The input required for conceptual and computational modeling are important considerations in establishing the DQOs for the RFI. Therefore, input for the models in part drives the development of the field characterization plans.

Representative examples and sources of the types of computational modeling codes that have been used in the DQO process, and that could be used during and after the RFI, include those listed below.

- Dose assessment: RESRAD (DOE)
CAP88 (EPA)
GEOEAS (EPA)
MILDOS (DOE)
- Geochemical/equilibrium: PHREEQE (USGS)
MINTEQ (EPA)
- Hydrologic transport: TRACER3D (DOE)
SESIL (EPA)
FEHMN
- Surface/air transport: CREAMS (USDA)
GLEAMS (USDA)
- Geostatistics/data analysis: GEOPAC (EPA)
GEOEAS (EPA)

2.12 Framework Studies

Laboratory-wide framework studies will be conducted as part of the Laboratory ER Program's programmatic activities. The Framework Studies group currently is conducting a pilot study on soils and the Bandelier Tuff to determine the background concentration range for a target list of metals and radionuclides. The investigation also will collect data on some physical and chemical parameters that control constituent mobility. Initial results of the study will be presented in the 1992 revision of the IWP and will be available in adequate time for use in data analysis.

2.13 Conditional Remedies

The concept of conditional remedies is addressed in Section 3.8 of the IWP. The conditional remedy of capping/stabilization accompanied by long-term monitoring and maintenance is likely to be appropriate for MDA AB because prompt remedial action probably is not required and because practical remedial alternatives are not available at the present time (see Section 5.4 of this OU work plan). Therefore, the field investigation for MDA AB focuses on obtaining information adequate to evaluate the effectiveness of the aforementioned conditional remedy.

As Section 3.8 of the IWP points out, in cases where the RFI concludes that a conditional remedy is the most appropriate remedial action, a formal CMS may not be required and the proposed remedy may be presented to the EPA as part of an RFI report. The conditional remedy may be declared the final remedy at that time, or the EPA may require further corrective action to supplement or replace the conditional remedy.

2.14 NFA Units

In this OU work plan, several units are addressed for which NFA is proposed. Chapter 8 presents the justification and documentation for the NFA recommendations. Upon EPA approval of the TA-49 OU work plan, the ER Program Office will file a petition for NFA at these units. This will be accomplished in the annual update to the IWP, wherein a petition will be presented for formal EPA approval of all proposed NFA units across the Laboratory's ER Program through a permit modification.

Chapter 2 References

DOE (US Department of Energy), September 26, 1988. "Radioactive Waste Management," DOE Order 5820.2A, Washington, DC. (DOE 1988, 0074)

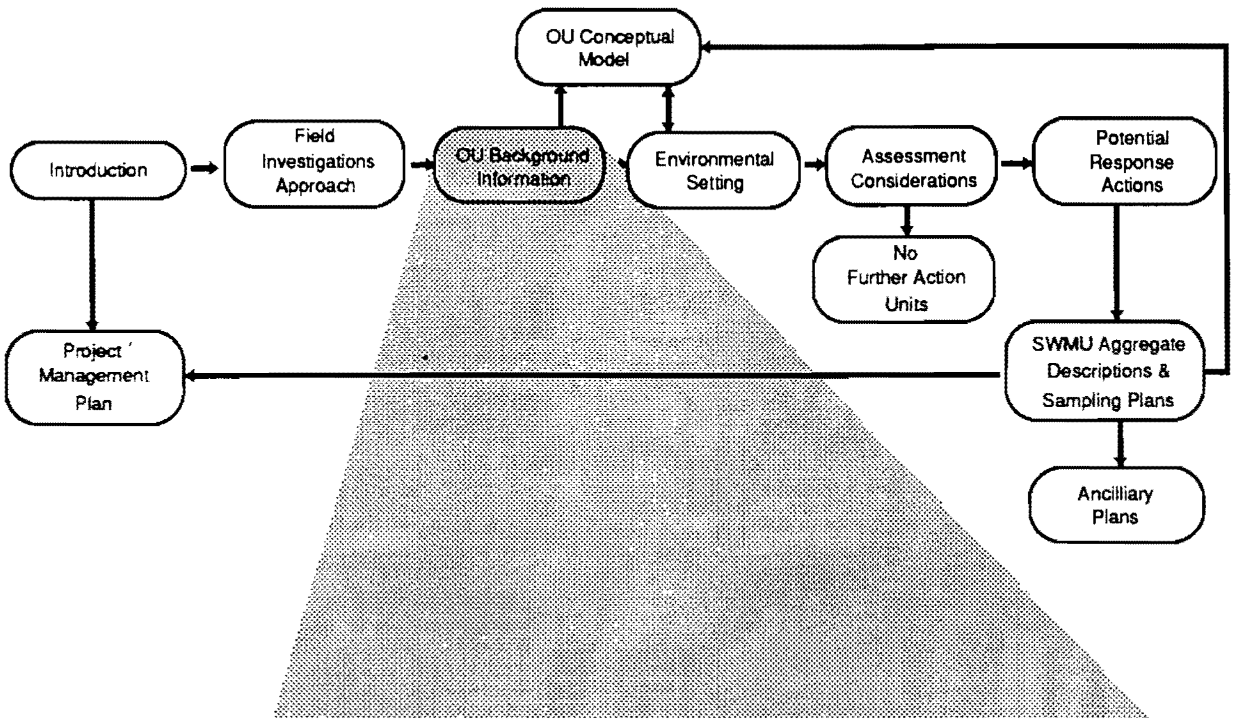
DOE (US Department of Energy), October 6, 1989. "Comprehensive Environmental Response, Compensation, and Liability Act Requirements," DOE Order 5400.4, Washington, DC. (DOE 1989, 0078)

EPA (US Environmental Protection Agency), March 1987. "Data Quality Objectives for Remedial Response Activities, Development Process," EPA 540/G-87/003, OSWER Directive No. 9355.0-7B, prepared by CDM Federal Programs Corporation, Washington, DC. (EPA 1987, 0086)

EPA (US Environmental Protection Agency), April 10, 1990. RCRA Permit No. NM0890010515, EPA Region VI, issued to Los Alamos National Laboratory, Los Alamos, New Mexico, effective May 23, 1990, EPA Region VI, Hazardous Waste Management Division, Dallas, Texas. (EPA 1990, 0306)

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

Chapter 3



Background Information for the TA-49 Operable Unit

- Location
- History
- Past Waste Management Practice
- Current Conditions
- Overview of SWMUs
- Sources of Information

3.0 BACKGROUND INFORMATION FOR THE TA-49 OPERABLE UNIT

This chapter presents a brief overview of past and current use of TA-49. Greater detail is contained in Chapters 6 and 7 where SWMU-specific field investigations are described.

3.1 Location

TA-49 is bounded by TA-15 to the north, State Road 4 to the south and west, TA-39 to the east, and TA-16 and TA-37 to the north and west. The relatively flat surface of Frijoles Mesa encompasses most of TA-49; Water Canyon traverses the northern site boundary, and Ancho Canyon, along with its primary tributary, originates within TA-49 boundaries. Chapter 4 provides additional information on the TA-49 environmental setting.

Figures EXEC-1 and EXEC-2 show the regional location of the Laboratory and the location of TA-49 relative to other Laboratory sites and perimeter properties. Figure EXEC-3, a site diagram of TA-49, indicates the location and nature of its associated SWMUs. A topographic map of TA-49 is contained in Appendix A. Detailed engineering drawings, site maps, survey coordinates for shafts and drill holes, and other information relevant to the TA-49 RFI are contained in Appendix B. Figure 3.1-1 (a - e) presents aerial photographs of TA-49 taken at various times since 1965. Recent photographs of TA-49 SWMU areas are given in Figure 3.1-2 (a – e).

3.2 History

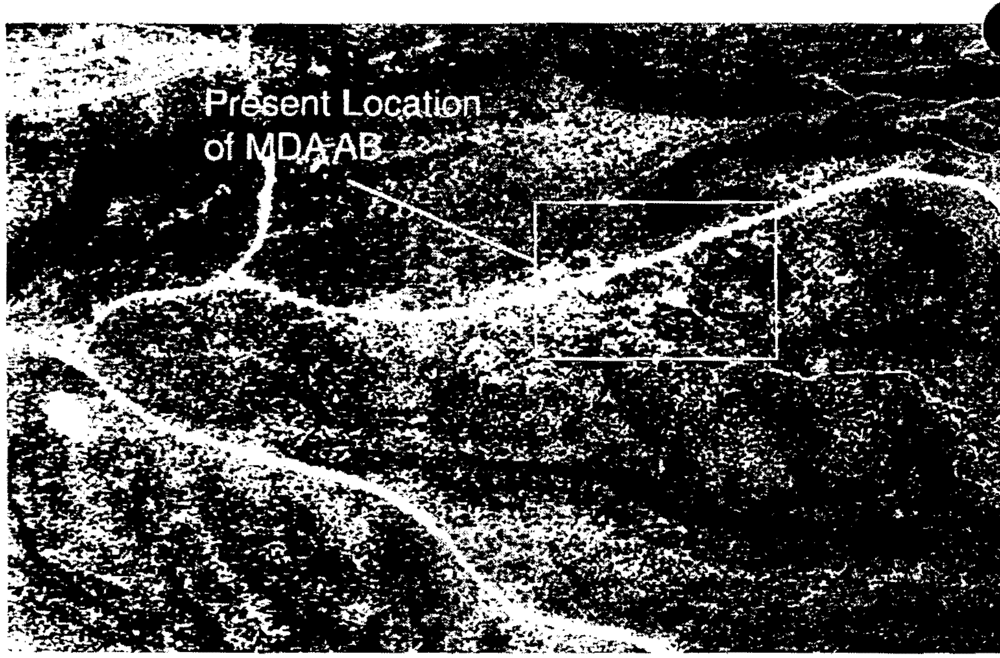
3.2.1 Prehistoric Use

Frijoles Mesa has seen extensive prehistoric use (Steen 1977, 0660; Steen 1982, 0659). Ruins and artifacts are widespread across the mesa top, including some SWMU areas. A NEPA-related survey is being carried out in conjunction with the TA-49 RFI to document this use and to assess the potential RFI impact on cultural resources (see Appendix I of this OU work plan). It is expected that a categorical exclusion for TA-49 RFI activities will be issued by DOE.

3.2.2 Early Uses and Laboratory Acquisition

Much of the Pajarito Plateau, including present-day TA-49, was part of the Ramon Vigil land grant. In the late 1800s and early 1900s the Pajarito Plateau, including portions of Frijoles Mesa, was used for ranching, farming, and timber production. Aerial photographs of TA-49 suggest that such uses of present-day TA-49 ceased well before 1935. Ruins of one homestead are still evident near the main landfill/open burning area (Steen 1977, 0659; Steen 1982, 0660).

(a)
May 1954 photograph, showing location of present day TA-49

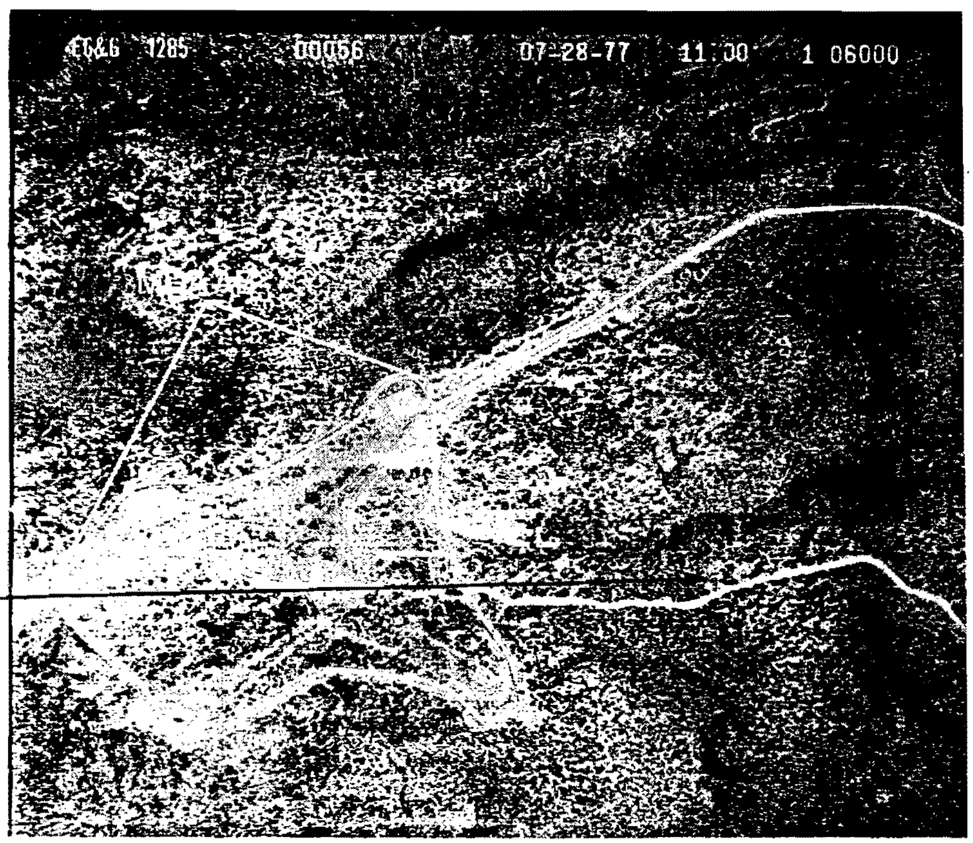


(b)
June 1965 photograph of the western portion of TA-49, including MDA AB

Figure 3.1-1 Aerial photographs of TA-49 from 1965 to the present.

(c)
July 1977 photograph showing landfill/open-burning area and open trenches

(d)
July 1977 photograph showing MDA AB



Former HE storage area

e)
September 1991 photograph of present day MDA AB.

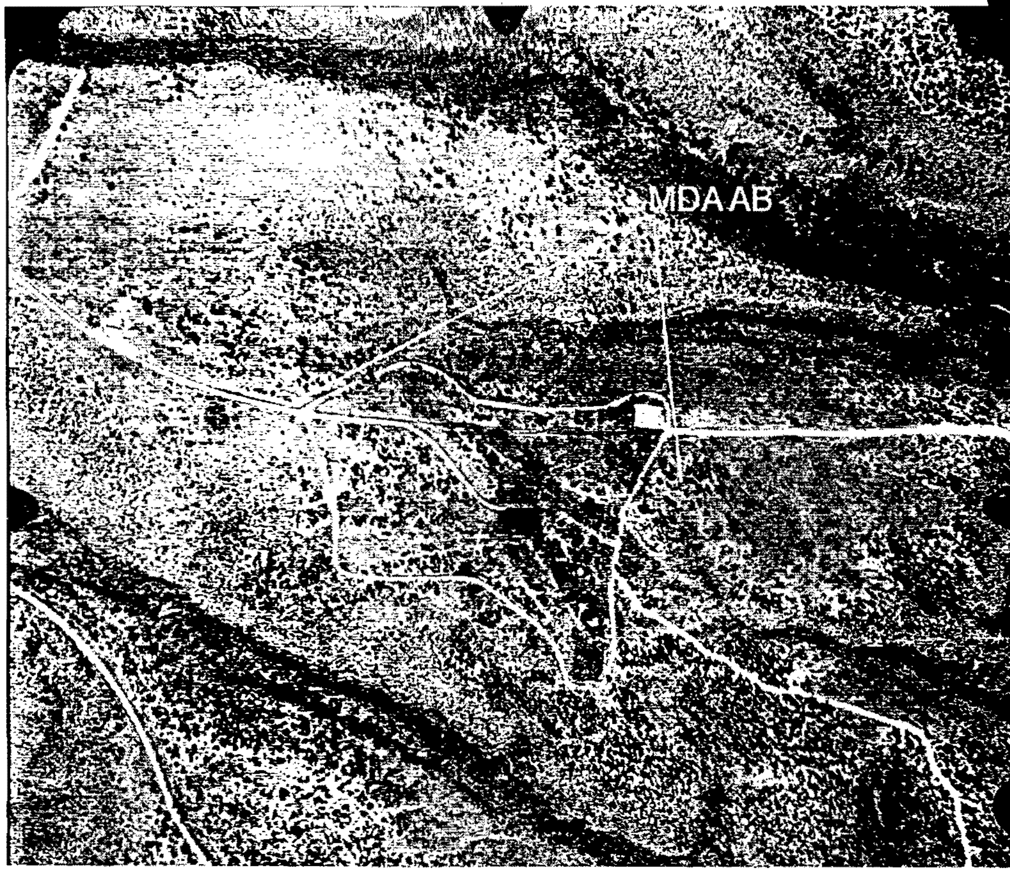
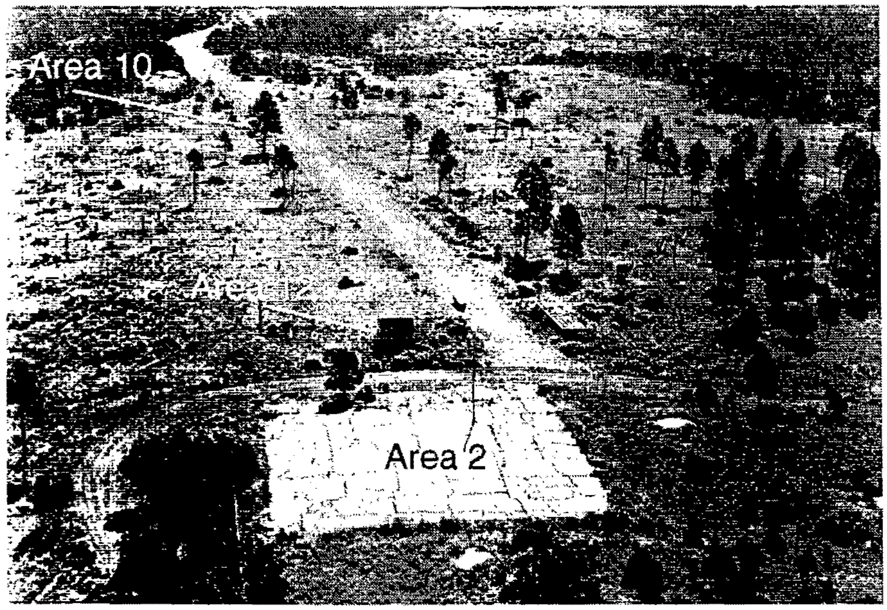
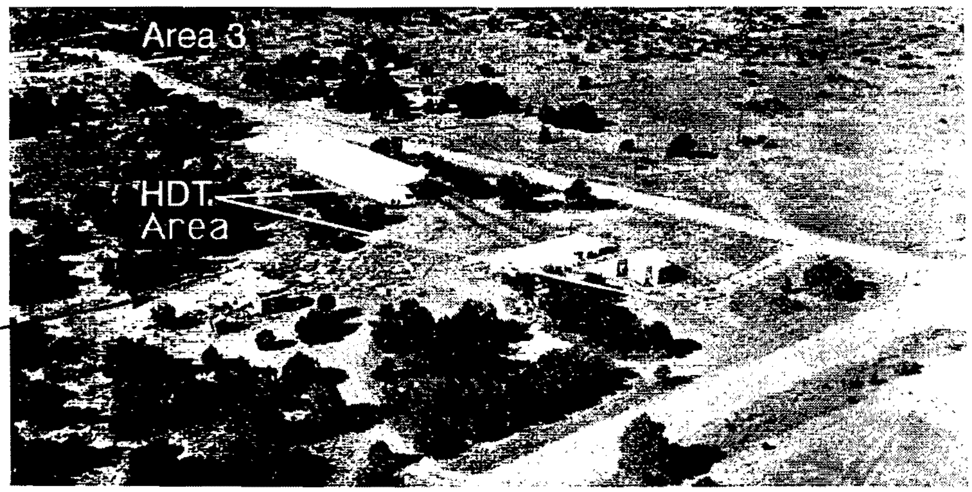


Figure 3.1-2 1991 low-altitude photographs of TA-49 SWMU areas

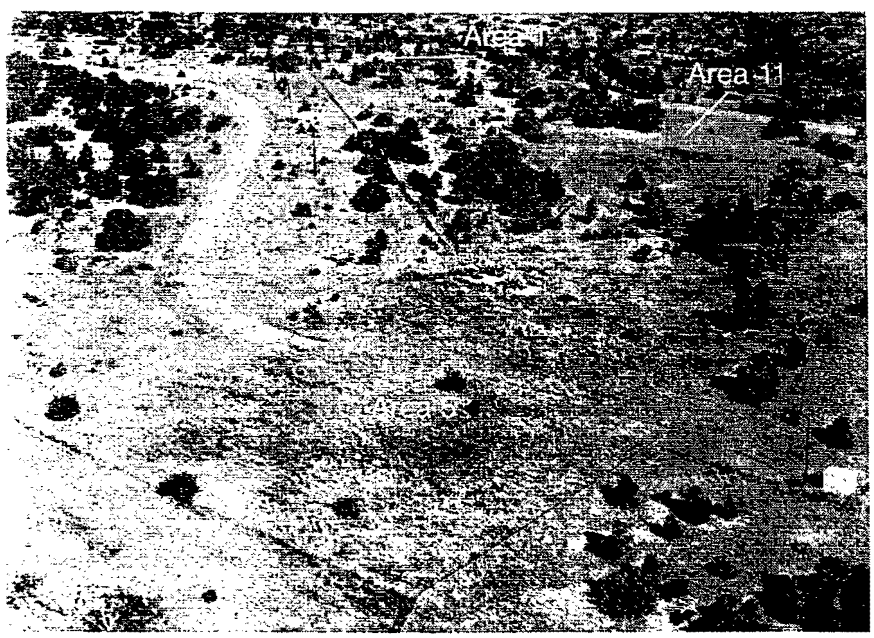
(a)
Areas 2, 12 and 10 (viewed to the East). The lines in the Area 2 pad represent cracks which were patched with asphalt in October of 1991.



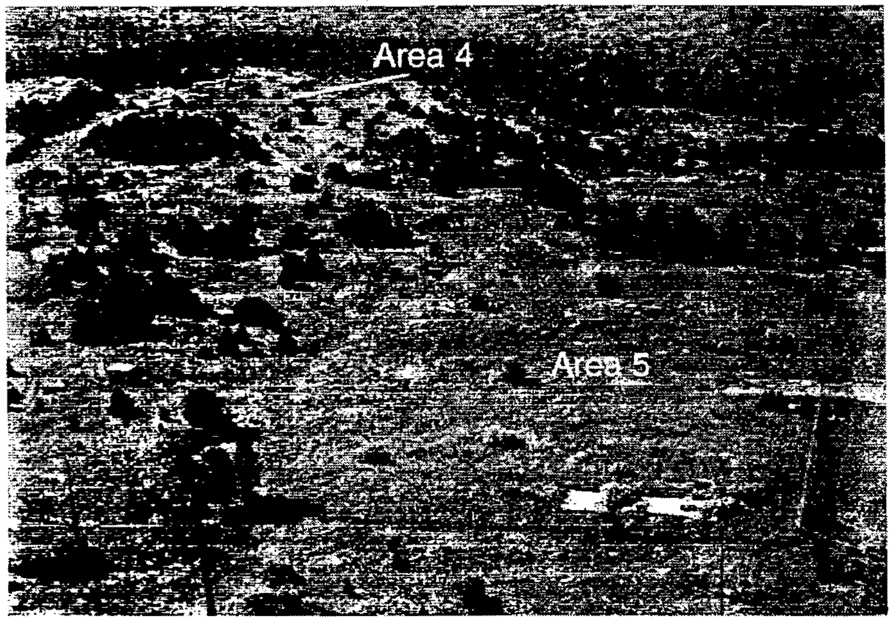
(b)
HDT Area and Area 3 (Viewed to the southwest).



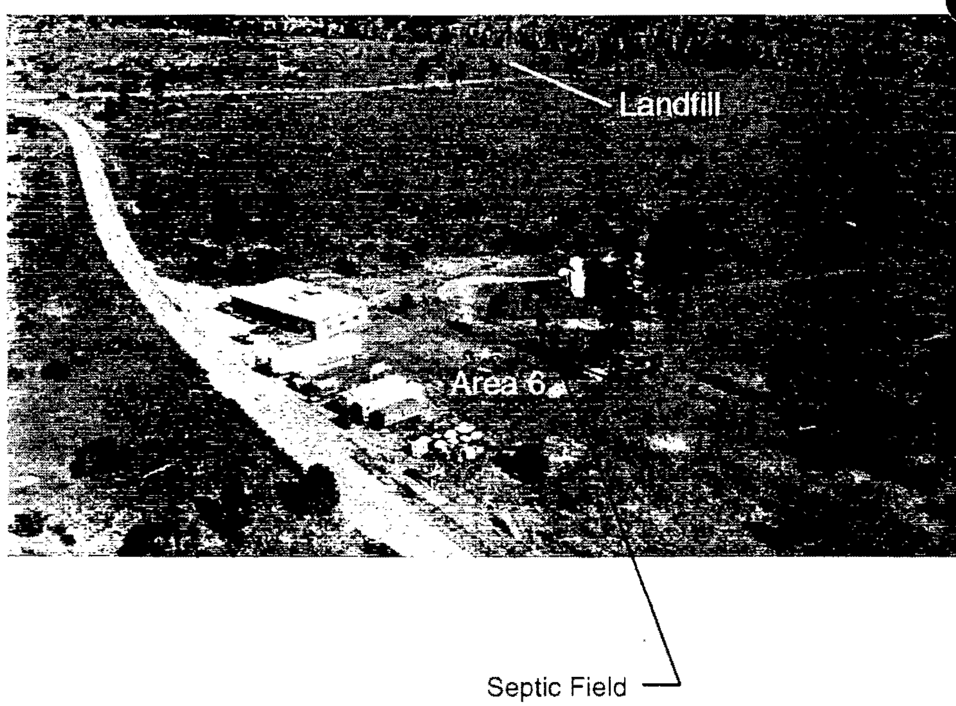
(c)
Areas 1, 5 and 11 (Viewed to the northwest).



(d)
Areas 4 and 5 (viewed to the southwest).



(e)
Area 6 and the open burning/landfill Area (viewed to the northwest).



Frijoles Mesa was added to the Santa Fe Forest Reserve along with the rest of the Jemez Section in 1915. The area encompassing present-day TA-49 was acquired from the US Forest Service (Santa Fe National Forest) in two parcels, as is documented by memoranda of understanding with the Manhattan Engineering District dated July 5, 1943 (544 acres) and April 14, 1948 (4506 acres) (ENG-R 1656 1968, 03-0029). The section between State Road 4 and the rim of Frijoles Canyon was transferred to the National Park Service by Presidential Proclamation on December 9, 1959, and thereby was included in Bandelier National Monument. An extensive archival search, examination of aerial photographs, and interviews of many former Laboratory employees indicate that the Laboratory has made no use of any kind of the land between State Road 4 and Frijoles Canyon.

From the time of its acquisition by the Laboratory in the 1940s to the present day, the portion of Frijoles Mesa north of State Road 4 has served as a shrapnel buffer zone for firing sites in adjacent TAs 15 and 39. Historical information strongly suggests that there was no other Laboratory use of Frijoles Mesa until 1959.

3.2.3 Site Selection for Hydronuclear Experiments

In 1959, potential safety problems with nuclear weapons, both in the design stage and in service in the US arsenal, were recognized through calculations at the Laboratory. These problems were related to the theoretical possibility of a significant nuclear yield as a result of accidental detonation of the device's high-explosive (HE) component.

To assess this potentially grave problem, underground hydronuclear and related experiments were designed. In an atmosphere of national urgency, the hydronuclear experiments received the necessary approval in late 1959 from President Eisenhower and in early 1960 from President Kennedy. Historical aspects of the decision to conduct the experiments are contained in a 1987 Laboratory report (Thorne and Westervelt 1987, 03-0014).

The US Geological Survey (USGS) was contracted in 1958 and 1959 to perform an intensive search for a Laboratory site suitable for the hydronuclear experiments from both operational and environmental viewpoints. Frijoles Mesa emerged as a leading candidate site, and the choice was confirmed after an extensive hydrogeologic study demonstrated that the lack of perched aquifers, lack of recharge waters, and great depth to the main aquifer (about 1200 ft at the main experimental area) made the potential for groundwater contamination negligible (Weir and Purtymun 1962, 0228). This early study greatly contributed to the present-day understanding of the Pajarito Plateau geohydrology. Data from these studies are described in detail in Chapter 4 of this OU work plan and were summarized in reports in 1962 (Weir and Purtymun 1962, 0228), 1986 (Purtymun and Ahlquist 1986, 03-0013), and 1987 (Purtymun and Stoker 1987, 0204).

The favorable environmental setting of Frijoles Mesa, combined with its relatively remote location and flat terrain that afforded desirable operational characteristics, led to its selection for the hydronuclear and related experiments. In the fall of 1959, TA-49 was created from TA-15, which had previously encompassed a portion of Frijoles Mesa. Experiments in underground shafts then were conducted at TA-49 from the fall of 1959 through August 1961.

A roughly rectangular central portion of TA-49 was devoted to the underground experiments (Figure EXEC-3). Four underground shaft areas (Areas 1–4, later augmented by Areas 2A and 2B) with a central control area (Area 5) were used for this purpose. These shaft areas now comprise Material Disposal Area AB (MDA AB). Supporting activities were carried out in Areas 6 (crafts area and open burning/landfill area), Area 7 (security station), Area 10 (underground calibration chamber), Area 11 (radiochemistry and small-scale shot area), and Area 12 (Bottle House area). Areas 8 and 9 were never created.

3.2.4 Hydronuclear and Related Experiments

Because the TA-49 experiments used limited quantities of SNM (special nuclear materials) (plutonium and uranium-235), sophisticated techniques were required to observe the nuclear reactions. The maximum fission energy release in any experiment was equivalent to only a few tenths of a pound of HE and was insignificant compared to the energy released by detonation of conventional explosives in the experimental assemblies. The experiments were carried out in underground shafts after preliminary experiments with conventional explosives determined the depths and backfilling methods required to ensure that contaminants were not vented to the surface.

The hydronuclear and related experiments were conducted in Areas 1, 2, 2A, 2B, 3, and 4 in backfilled shafts that varied from 31 to 142 ft in depth. Between January 1960 and August 1961, 41 hydronuclear and related calibration, equation of state, and criticality experiments involving SNM were conducted in the experimental areas. Of these experiments, 37 involved either plutonium or plutonium and uranium-235 SNM and 4 involved only uranium-235 as the fissile component. To test containment, other shaft experiments involved larger amounts of HE than were required in the hydronuclear experiments, and sample recovery procedures also were conducted during this period. Some experiments incorporated very small amounts of radioactive tracers, and many experiments with and without SNM used uranium-238. Additional details of these underground experiments are provided in Chapter 7.

An unusual aspect of the hydronuclear experiments is that the use of SNM required extremely close accounting of the quantities of uranium, plutonium, and beryllium, which are now the primary contaminants at TA-49 (as well as a large but imprecisely known quantity of lead). The quantities and locations of these contaminants are therefore known with an unusually high degree of precision, as is discussed in greater detail in Chapter 7 of this OU work plan and in a 1987 Laboratory report (Stoker and Purtymun 1987, 0204). Explosives used in the hydronuclear experiments consisted largely of TNT, RDX, HMX, and barium nitrate. It is highly likely that the explosives, except for the barium component, were essentially completely converted to innocuous products by the detonations. Based on the detailed historical information available, it is evident that other chemicals were used only in very limited quantities at TA-49, primarily for radiochemistry and photographic purposes, and probably only in Areas 5 and 11 to any significant extent.

Therefore, the substantial contaminant inventories at TA-49 are believed to be confined to the deep underground shafts in Areas 1, 2, 2A, 2B, 3, and 4. Much lower, but above-background, near-surface contamination is known to be present in and near Areas 2 and 11, but the potential for significant contamination in other portions of TA-49 is considered very low. The bases for these expectations are described in greater detail in Chapters 6 and 7 of this work plan, where individual SWMUs are described and SWMU-specific investigations are proposed.

The physical properties of the tuff and sand backfill appear to have efficiently absorbed the explosive energy released in the hydronuclear experiments and to have confined most materials to within a maximum radius of 10 to 15 ft from the point of detonation at the bottoms of the shafts. The lack of available water in the tuff makes it very unlikely that significant transport of contaminants has occurred from the shafts in the three decades since the experiments were terminated (see Chapters 4, 5, and 7 of this OU work plan for additional discussion of this important point).

3.2.5 Other Past Laboratory Activities at TA-49

Since the hydronuclear experiments were terminated in the summer of 1961, TA-49 has been used only lightly and sporadically for Laboratory purposes (DOE 1987, 0264). In 1962 and 1963, experiments performed in Area 10 involved firing assemblies ("squibs") to release pressurized gas that drove pistons against water in cylinders. In 1965, a Laboratory group studying atmospheric phenomena conducted lightning observation experiments using the photographic tower that remained in Area 5 after the hydronuclear experiments. In the early or mid 1960s, a cable-stretching facility with a powerful hydraulic ram system was built and used in Area 12.

Pulsed gas laser and shock tube experiments were conducted briefly in 1967 and 1968 in unidentified parts of TA-49. In 1968, explosively driven plasma gun experiments were conducted in Area 1 or 2 and lightning flash experiments using large capacitor banks were carried out in Area 12. In the early 1970s, additional atmospheric observation was conducted from the Area 5 tower and further shock tube work was carried out at an unidentified location at TA-49. In 1977, a seismic study of TA-49 was performed employing explosives in 37 shot holes drilled to a depth of about 6 ft in an area extending from Area 5 to Deep Test Well DT-9. No waste units were impacted by the seismic studies because SWMU areas were avoided and because the explosive quantities were very small.

The miscellaneous Laboratory activities conducted at TA-49 from late 1961 to 1977 appear to have involved no significant amounts of hazardous or radioactive materials (other than the small amounts of HE that were consumed in the experiments), and it is believed that these activities did not disperse pre-existing contaminants.

Little visible physical evidence remains of the 1961 to 1977 activities at TA-49. The only surface structures currently existing at TA-49 that were associated with the early site activities are the cable-stretching facility structure, the "Bottle House" used for containment experiments in Area 12, and a few portable concrete radiation shields scattered around the site. In 1977, the La Mesa forest fire burned over much of TA-49, destroying essentially all remaining combustible structures at the site.

3.2.6 Environmental Monitoring at TA-49

As described in greater detail in Chapter 4, site monitoring has been carried out at TA-49 on a continuing basis since the initiation of experiments at TA-49 in 1959. These results have been reported in the Laboratory's annual environmental surveillance reports and other special reports, which extend back to 1970 (for example, ESG 1990, 0497; Purtymun and Ahlquist 1986, 03-0013; Purtymun and Stoker 1987, 0204). Annual monitoring of the three deep test wells located at TA-49 has never suggested contamination in deep aquifer groundwater. (See Figure EXEC-3 for the locations of these wells and Chapter 4 for a discussion of their characteristics.) Likewise, measurable surface contamination attributable to TA-49 has never been found beyond the TA-49 boundary.

Radionuclide, lead, and beryllium contamination, above background but well below action levels discussed in Chapter 5, has been observed on a few occasions in surface samples from a few areas of TA-49. A few samples from locations at Areas 2 and 11, where low-level near-surface radionuclide releases are known to have occurred, have yielded individual soil samples with transuranic (TRU) concentrations above the action levels discussed in Chapter 5. However, averages over reasonable surface areas (exposure units) generally fall far below levels of concern. From past sampling, it appears that this contamination is highly localized and highly discontinuous in nature. Further details on the nature of this surface contamination are given in Chapters 6 and 7.

Evidence of surface, vadose, or groundwater contamination at TA-49 has only been observed in Area 2. In March 1975, a small portion of the asphalt pad over Area 2 was found to have collapsed, leaving an opening for water to infiltrate. As detailed in Chapter 7, it was subsequently found that the 500-ft-deep borehole near the center of Area 2 (Core Hole 2) contained standing water with very low levels of plutonium. A special study initiated to determine the source of the water concluded that meteoric water had infiltrated through the collapsed zone, through contaminated soils, and down the borehole (Purtymun and Stoker 1987, 0204). Eventually, the collapsed area was resealed and the borehole was bailed dry in 1980. The bailed water was disposed of in the Laboratory's radioactive waste water treatment facility. Periodic monitoring through 1987 indicated that the hole remained dry, but in the spring of 1991, standing water with a very low level of plutonium (0.2 pCi/*l* compared to about 6 pCi/*l* in 1975) again was detected.

In 1987, EPA and DOE used the EPA Hazard Ranking System (HRS) and the DOE-modified HRS to assess the potential for migration of chemical and radioactive contaminants (Purtymun and Stoker 1987, 0204). Despite the large radioactive source term in MDA AB, the maximum overall migration mode score was determined to be only 5.3 for plutonium. A slightly greater value of 6.7 was derived for beryllium. These scores reflect low potential for contaminant migration and are far below the score of 28.5 required for the site to be included in the National Priorities List (CERCLA "Superfund" list).

3.3 Past Waste Management Practices

Since 1960, radiological surveys at TA-49 have been carried out routinely with instruments for which the lowest practical detection limits for alpha radiation is 100 to a few hundred disintegrations per minute over a surface area of about 100 cm^2 (Penneman 1991, 03-0011; Eller 1992, 03-0002). These limits are used throughout the TA-49 work plan as the historical threshold for determining whether surveyed material is radiologically "uncontaminated" or "contaminated."

As described elsewhere in this OU work plan, by far the most significant wastes at TA-49 are contained in the shafts in Areas 1, 2, 2A, 2B, 3, and 4, which now make up MDA AB. At various times since 1961, additional soil has been added and drainage has been improved over and around the shaft areas. The tops of shafts containing significant radioactive contamination have been covered with concrete. A regular maintenance and inspection program is conducted by Laboratory's Environmental Management Group EM-7 to ensure the integrity of the protective soil and vegetative cover over the MDA.

By far the most significant unplanned contaminant release at TA-49 occurred in 1960, when shaft 2-M was drilled in Area 2. The release was caused by drilling into a subsurface region contaminated by a prior experiment in an adjacent hole containing SNM. No significant personnel exposure resulted, but contamination was dispersed around the surface of Area 2. In response, surface contaminated materials were collected and buried in the contaminated shaft; an elevated clay and soil cover was installed to reduce the infiltration of water and eventually an asphalt cap was added. The incident is described in greater detail in Chapter 7 of this OU work plan.

During the 1959 and 1961 time frame, nonradioactive TA-49 wastes were bumed or buried in trenches northwest of Area 6. This open burning/landfill area also was used for burial of uncontaminated wastes during general site cleanups in 1977 and 1984. As part of 1984 cleanup, two small areas (one east of Area 10 and one in Area 5) apparently were used as landfills to bury uncontaminated construction debris (DOE 1987, 0264; Weston 1989, 03-0015).

Virtually all radioactively contaminated surface debris from the various TA-49 cleanup campaigns was transported to the Laboratory's low-level radioactive waste disposal sites at TA-50 and TA-54. The one known exception to this generalization is the possible burning in Area 3 of several small structures with very low levels of alpha contamination (Eller 1992, 03-0002). Most radioactive and chemical wastes from TA-49 radiochemistry operations were collected in containers for off-site disposal. Very small quantities probably were drained into the Area 11 leachfield constructed for this purpose. Very small amounts of chemical wastes, primarily or exclusively photographic solutions, may have been dumped into one or more sumps in Area 5. Before 1987, latrines were used at TA-49 for sanitary wastes. In 1987, septic tanks were installed and were pumped periodically for off-site disposal. In 1990, the septic tanks were connected to on-site evapotranspiration fields.

3.4 Current Conditions at TA-49

The primary historic use of TA-49 as a buffer zone for activities at adjacent firing sites (TAs 15 and 39) is expected to continue indefinitely, according to the Laboratory long-range Site Development Plan (LANL 1990, 0655). Appendix A shows the location of existing structures at TA-49.

Currently, there is only small-scale on-site use of TA-49. The Laboratory's High-Power Microwave Group AT-9 occasionally uses the Day Room building (TA-49-115) and its immediate vicinity for equipment development and the roadway between Areas 10 and 12 as a microwave test range. The Laboratory's Hazardous Devices Team (HDT) uses the Hazardous Devices Team Training Facility (TA-49-113) and the associated HE magazine (TA-49-114) for small-scale explosives training exercises.

Building 113 also houses the Laboratory's Alternate Emergency Operations Center. This facility is equipped with extensive communications systems and computers. In addition, the building is used for routine classroom training and houses the HDT office. Laboratory group OS-4 conducts electrical grounding measurements in a small area immediately west of the HDT Training Facility.

The Laboratory also maintains the Bandelier Meteorological Station in the southeast portion of TA-49 as part of its network of meteorological stations.

These current activities use only small areas of TA-49 and do not involve hazardous or radioactive materials other than small amounts of conventional explosives for the HDT exercises. Sanitary wastes from structures associated with these activities are discharged to the existing permitted septic systems.

As discussed briefly above and in greater detail in Chapter 4, as part of the ongoing Laboratory Environmental Surveillance program, water samples are collected at least annually from the three deep test wells at TA-49. Fourteen soil and sediment stations around TA-49 and sediment stations downgradient in Water and Ancho Canyons also are sampled annually. Air and radiation monitoring stations are present at TA-49 near the State Road 4 gate and in Area 12. Environmental measurements over three decades have provided no evidence that contaminants attributable to past or present TA-49 operations have been transported beyond the TA-49 boundaries. A network of thermoluminescent detectors (TLD) around MDA AB and a second TLD network about one-half mile southeast of Area 4 has shown penetrating radiation levels in the range of regional backgrounds.

3.4.1 Site Access and Control

Access to TA-49 is controlled by the Emergency Management Office (EMO) and the EM Division Office of the Laboratory, and keys to the locked gates must be obtained from these organizations. A limited number of keys also are assigned to TA-49 operating groups and to the Laboratory's Facilities Maintenance Group (ENG-5). The accessible portion of TA-49 along State Road 4 is posted and fenced with sections of industrial chain link and barbed wire. In addition, EMO and EM Division Office verify whether activities scheduled in adjacent firing sites or in the HDT area require scheduled site evacuation.

The experimental areas now included in MDA AB Areas 1, 2, 2A, 2B, 3, and 4 are maintained by the Laboratory's Waste Management Group EM-7 as a Controlled Area under DOE Order 5480.11 (DOE 1988, 0076). These areas (except Area 3) and Areas 5 and 11 are enclosed within an additional locked security fence through which access is controlled by the EM Division Office. Access to and from Water Canyon is controlled by the Dynamic Testing (M) Division Office, which maintains control of keys to the canyon access road gate. Access to the HDT area is restricted by posting. A set of prehistoric ruins near Area 6 is also fenced and posted. Access, monitoring, and posting requirements for MDA AB are stipulated by EM-7 procedures (EM-7 1991, 03-0019). At this time, no further access restrictions or special maintenance/surveillance restrictions are applied to other areas (including SWMUs) at TA-49.

3.4.2 Migration Pathways

Because of the site's relatively remote location and existing institutional controls, the absence of known contaminant transport pathways of significance under current site conditions, and current land use in the vicinity of TA-49, no pathways or receptors are of short-term concern. Groundwater pathways are not of immediate concern, due to the great depth to groundwater and lack of transport mechanisms. Surface water and air pathways are not of immediate concern because the majority of TA-49 contaminants are buried in shafts.

In the context of this work plan, "short-term" will imply the 100-yr time frame assumed for institution control by DOE Order 5820.2A, which addresses management of buried TRU waste. However, if land use changes beyond this time frame (for example, through the loss of institutional control) or if dramatic climatic changes occur, exposure pathways of concern then would include:

- exposure of buried contaminants through erosion, followed by surface water run-off and sediment transport or aerial resuspension,
- artificial site disturbance,
- infiltration through the vadose zone, and
- biological transport.

The TRU wastes at TA-49 will remain hazardous for much longer than the 100 yr assumed for institutional control. However, the technical difficulties associated with the removal of buried TRU are formidable, as described in Chapter 5 of this OU work plan. For these reasons, the conditional remedy of capping/stabilization of the site, accompanied by long-term institutional control, monitoring, and maintenance, have been identified as the likely remedial actions to be taken at MDA AB. As part of this remedial strategy, additional corrective measures will be taken as required during the period of maintenance and monitoring. This approach is consistent with the conditional remedy concept described in Section 2.13 of this OU work plan and in Section 3.8 of the

IWP. Implementation of a conditional remedy for MDA AB requires confirmation by the RFI that significant waste migration from the MDA AB shafts has not occurred and is unlikely to occur over extended periods of time. Therefore, evaluation of the likelihood of waste migration from the hydronuclear shafts is a key aspect of the TA-49 RFI work plan.

3.5 Overview of SWMUs at the TA-49 OU

This section provides a brief overview of the 21 SWMUs addressed in this OU work plan. The locations of these SWMUs are indicated on Figure Exec-3 and on the topographic map contained in Appendix A.

Table 1.2-1 assigns these SWMUs to the investigation groups listed below. Detailed descriptions of the SWMUs and the corresponding field investigation plans are presented in portions of the work plan indicated.

- MDA AB (Areas 1, 2, 2A, 2B, 3, and 4) — Chapter 7
- Control area (Area 5) — Section 6.4
- Landfills, trenches, and Area 6 soil contamination — Section 6.3
- Experimental chamber (Area 10) — Section 6.5
- Radiochemistry and small-scale shot area (Area 11) — Section 6.2
- Bottle House area (Area 12) — Section 6.6
- No further action units — Chapter 8.

For the purpose of developing data quality objectives (DQOs) that underlie the proposed field investigations, the TA-49 SWMUs may be categorized alternatively as follows (see Chapter 5 of this OU work plan for a discussion of future land use and possible remedial alternatives at the TA-49 OU):

- ***MDA AB.*** Large source terms (uranium, plutonium, lead, and beryllium) exist in the hydronuclear shafts. Much smaller, highly localized source terms (soil and debris) above action levels exist near the surface at MDA AB. Several remedial options are conceivable for the near-surface contamination. However, because removal or treatment of the deeply buried wastes is likely to be impractical from technical, risk, and economic standpoints, and because the likelihood for contaminant migration is very low, this work plan considers the most likely remedial measure for MDA AB to be selected following the RFI/CMS is the conditional remedy of capping and stabilization accompanied by long-term institutional control, maintenance, and monitoring.

- ***Area 11 and Area 5.*** It is strongly suspected that the Area 11 leachfield contains a localized soil zone with TRU contamination above action levels but a small total contaminant inventory. Area 5 may contain a small inventory of photochemical wastes but is unlikely to contain other contaminants above levels of concern. Selective removal of contaminated soil is a possible remedial option for both areas. However, because these two areas are within the geographical area inscribed by individual areas of MDA AB that contain much larger source terms, they are almost certain to be managed with MDA AB whether or not contaminant levels of concern are present. Therefore, it is assumed that long-term institutional control also will be maintained over Areas 5 and 11 and that remedial decisions for these areas will be considered within the context of actions to be taken for MDA AB.
- ***All other areas.*** Based on available information, SWMUs other than those discussed above are unlikely to contain significant source terms and therefore the no further action (NFA) alternative is the likely recommendation from the RFI. Thus, the RFI is likely to show that these areas are suitable for unrestricted Laboratory use, subject to site-wide restrictions imposed by the use of TA-49 as a buffer zone for adjacent firing sites.

Because highly localized radiological, lead, and beryllium contaminants represent by far the most significant contamination at TA-49, they are the primary focus of SWMU-specific investigations. Other contaminants are known or suspected to exist at TA-49 only in very limited quantities and generally will be associated with the aforementioned contaminants. Thus, sampling plans take these factors into account to maximize the effectiveness of the RFI by focusing on a set of TA-49 indicator analytes, as follows:

- gross alpha/beta and gamma radioactivity,
- total uranium
- isotopic plutonium,
- RCRA-regulated metals (notably lead and beryllium), and
- gamma spectrometry (including gross gamma radioactivity, americium-241 and cesium-137).

On a SWMU-specific basis, analysis for potential minor contaminants such as semivolatile organic compounds (SVOCs) is proposed, as appropriate.

3.6 Sources of Information

Available environmental data for TA-49 were acquired by using current standard practices and methods. No attempt has been made to validate these data in the EPA sense of the term. These data are used in this document solely to guide RFI characterization and sampling.

Extensive use was made of direct interviews of many key personnel involved in hydronuclear activities from late 1959 to mid-1961. Of particular note in this group were the principal investigator for TA-49 hydrogeologic studies since 1959 and the supervisor responsible for all site activities conducted by the engineering contractor (the ZIA Company). The experimental test director, the director of radiochemistry operations, the health physics site supervisor, and dozens of individuals directly involved in day-to-day activities during the hydronuclear and related experiments also were interviewed. Access to these individuals, combined with the extensive historical documentation and environmental monitoring conducted since 1959, allows the status of this site to be described with an unusual degree of certainty and completeness.

Other information sources also have been used.

- Studies using the Laboratory's environmental monitoring network, which includes on-site stations as well as perimeter and regional stations that are not influenced by Laboratory operations. These studies are reported in annual reports of the Environmental Surveillance Group (EM-8).
- Special studies conducted at the Laboratory and in the region, which collect environmental data in areas unaffected by Laboratory operations. These studies are described in periodic Laboratory reports.
- General environmental data addressing the behavior of chemicals, elements, and radionuclides in natural systems. These data are available in peer-reviewed scientific literature.
- Unpublished internal Laboratory memoranda, reports, and drawings.

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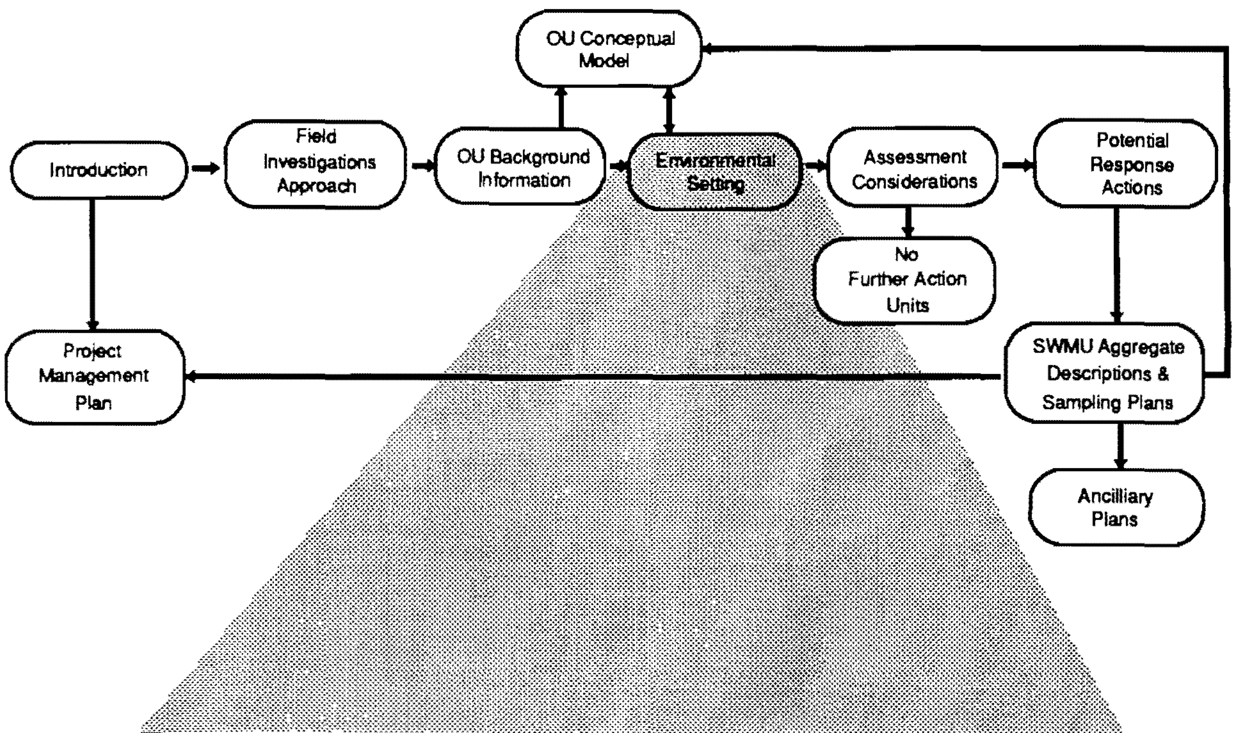
Chapter 4



Environmental Setting

- Topography
- Surface Deposits
- Geology
- Monitoring
- Conceptual Model
- General Data Needs
- Climate
- Hydrology
- Geochemistry
- Pathways
- Receptors
- Impacts

CHAPTER 4.0 ENVIRONMENTAL SETTING OF THE TA-49 OPERABLE UNIT

Chapter 4 is intended to build a detailed understanding of the environmental setting at TA-49, leading to a conceptual model on which the SWMU-specific characterization plans (Chapters 6 and 7) and the recommendations for no further action (Chapter 8) are based. Reference is made, as appropriate, to information given in Chapter 2 of the IWP (LANL 1991, 0553) which discusses the regional environmental setting.

Chapter 4 presents and interprets existing information relevant to TA-49 by section, as follows:

- 4.1 Location and topography
- 4.2 Climate
- 4.3 Surface Deposits
- 4.4 Hydrology
- 4.5 Geology
- 4.6 Geochemistry
- 4.7 Environmental Monitoring at TA-49
- 4.8 Potential Pathways of Contaminant Migration
- 4.9 Potential Receptors
- 4.10 Public Health and Environmental Impacts
- 4.11 TA-49 OU Site Conceptual Model
- 4.12 Summary of General Data Needs

Sections 4.1 through 4.10 provide a general foundation on which the conceptual model discussed in Section 4.11 is based. This model identifies the potential for contaminant migration at TA-49 using the environmental pathways and receptors that are addressed further in Chapter 5. Chapter 4 also identifies additional information needs related to: (1) expanding our conceptual understanding of the environmental processes at TA-49 and (2) assessing the magnitude and importance of potential exposure routes.

Chapter 4 also covers regional data on surface and groundwater quality, air quality, penetrating radiation levels, and the chemical and radiological concentrations in the soil at TA-49. The discussion includes environmental conditions beyond the range of immediate influence of past and present TA-49 operations, as needed, to provide the basis against which TA-49 specific data can be compared.

The development of general data needs and the site conceptual model in Chapter 4 are used to evaluate the nature, quantity, and quality of data required to support the purposes of the TA-49 RFI as summarized in subsequent chapters. These chapters address the primary objective of selecting remedial alternatives based on human health and environmental impact, implementability, and cost considerations.

The general data requirements and conceptual model identified in Chapter 4 also are used to develop the SWMU-specific field investigation plans presented in Chapters 6 and 7. As field results become available, an iterative process will begin in which the current conceptual model understanding will be updated, the sufficiency of the data for supporting the RFI objectives will be assessed, new data needs will be identified, and new investigations will be designed and carried out to fulfill those needs.

4.1 Location and Topography

TA-49 is located on the southern edge of the Laboratory and encompasses part of Frijoles Mesa. The mesa is centrally located on the Pajarito Plateau at an average elevation of approximately 7140 ft. The Plateau is roughly midway between the Jemez Mountains to the west and the White Rock Canyon of the Rio Grande to the east (see Figure 4.1-1 of this work plan and Figure 2-5 of the IWP).

The northern boundary of TA-49 is defined by the edge of Frijoles Mesa which overlooks Water Canyon, which also forms the southern boundaries of TA-15 and TA-37. State Road 4 forms the southwest boundary of TA-49 as well as the Laboratory's boundary with Bandelier National Monument (BNM). The southeast boundary of TA-49 is formed by TA-39.

Ancho Canyon and Water Canyon, the major canyons at TA-49, are characterized by their east-west orientation and steep walls (see the large topographic map in Appendix A).

Water Canyon originates on the flanks of the Sierra de los Valles and runs eastward to White Rock Canyon. Water Canyon is a major side canyon to White Rock Canyon and has cut deeply into the Tschicoma Formation, the Bandelier Tuff, and the Cerros del Rio basalt. (At TA-49, only the Bandelier Tuff is exposed). The drainage area of Water Canyon is approximately 13 mi^2, of which TA-49 makes up only a small fraction. Ancho Canyon originates within TA-49 and runs eastward to White Rock Canyon, cutting deeply into the Bandelier Tuff. Surface water flow in both Water and Ancho canyons is ephemeral and intermittent near TA-49. Surface drainage patterns from the mesa top generally are oriented to the east, north, and south; they feed into either Water Canyon or Ancho canyons, thereby contributing surface water runoff to the major drainage systems. Summer storm and snowmelt run-off in the major canyons occasionally reaches the Rio Grande.

Bandelier Tuff consists of volcanic ash deposits and comprises approximately 800 vertical ft of the bedrock column beneath Frijoles Mesa (see Appendix G and Section 4.5 of this work plan and Chapter 2 of the IWP). The groundwater lies at a depth of approximately 1170 ft in deep test well DT-5A within MDA AB, the main SWMU area of TA-49. Groundwater flows to the east and discharges in springs and seeps along the Rio Grande.

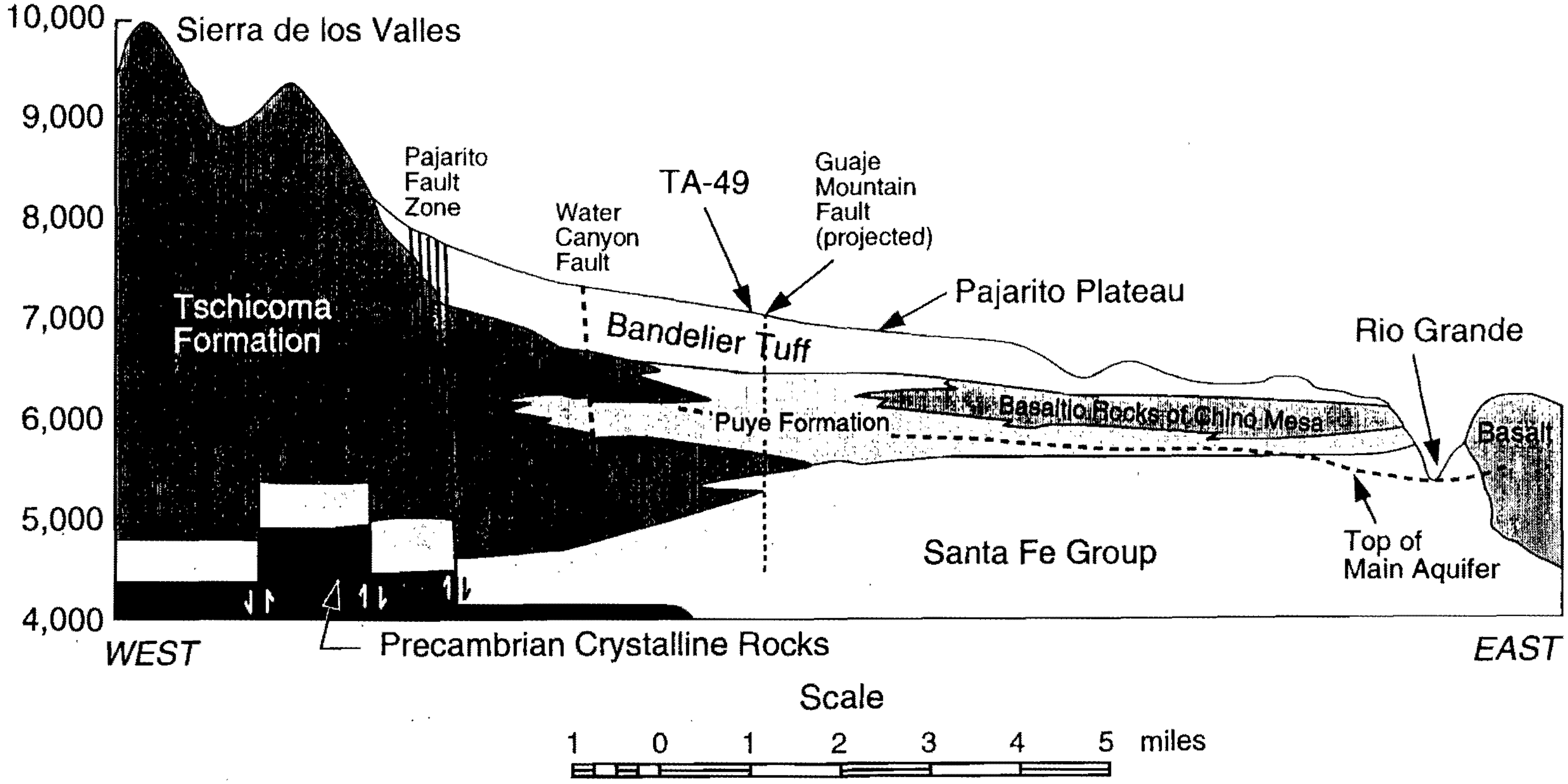


Figure 4.1-1 Geologic section showing the location of TA-49 with respect to stratigraphy and structure from the Sierra de los Valles across the Pajarito Plateau to the Rio Grande.

For the purposes of the TA-49 RFI, existing topographic data are generally adequate. Aerial photographs taken over TA-49 in September 1991 allow preparation of topographic maps with 2-ft contour resolution. Earlier topographic maps of TA-49 have 10-ft contour resolution. In Chapter 6 of this OU work plan, it is proposed that a topographic map with 2-ft resolution, based on 1991 aerial photographs, standard surveying techniques, and field observations, be prepared to show surface drainage and deposition areas near MDA AB. This map would facilitate surface sampling, evaluation of sampling analyses, and assessment of remedial alternatives as described in later chapters.

4.2 Climate

The climate at TA-49 is important because it can affect the transportation of contaminants. For example, the speed, frequency, direction, and stability of the wind can influence airborne transport of TA-49 contaminants. The form, frequency, intensity, and evaporation potential strongly influence surface water run-off and infiltration at TA-49.

Los Alamos County has a semiarid, temperate mountain climate which is summarized in Chapter 2 of the IWP. The Bandelier Meteorological Station, one of four meteorological stations around the Laboratory site, is located in the southeastern portion of TA-49 and has provided site climatological data since 1987.

Surface winds measured at the TA-49 meteorological station are generally light, with strongest winds usually occurring in the spring. The predominant direction for all winds is from the south (Figure 4.2-1). In 1989, wind speeds at TA-49 were less than 5.5 mph 34% of the time and greater than 11 mph 17% of the time (ESG 1990, 0497). These data imply that any airborne contaminants from TA-49 SWMUs should be dispersed mainly toward the interior of the Laboratory and away from Bandelier National Monument.

The average annual precipitation at TA-49 is approximately 16 in./yr (ESG 1990, 0497). About 50% of the precipitation on the Pajarito Plateau occurs as brief, intense thunderstorms during July and August, and often cause significant surface water run-off. The prevalence of short, intense precipitation events indicates that surface erosion of soils and run-off are potential mechanisms for the movement of surficial contaminants at the TA-49 OU. About 20% of the precipitation occurs as snowfall in December, January, and February, and the remaining 30% is distributed over the other seven months of the year.

Available climatological data are sufficient for the TA-49 RFI. Additional data will be collected on a continuing basis at the TA-49 meteorological station as part of the Laboratory's routine environmental monitoring program, thus enhancing the database.

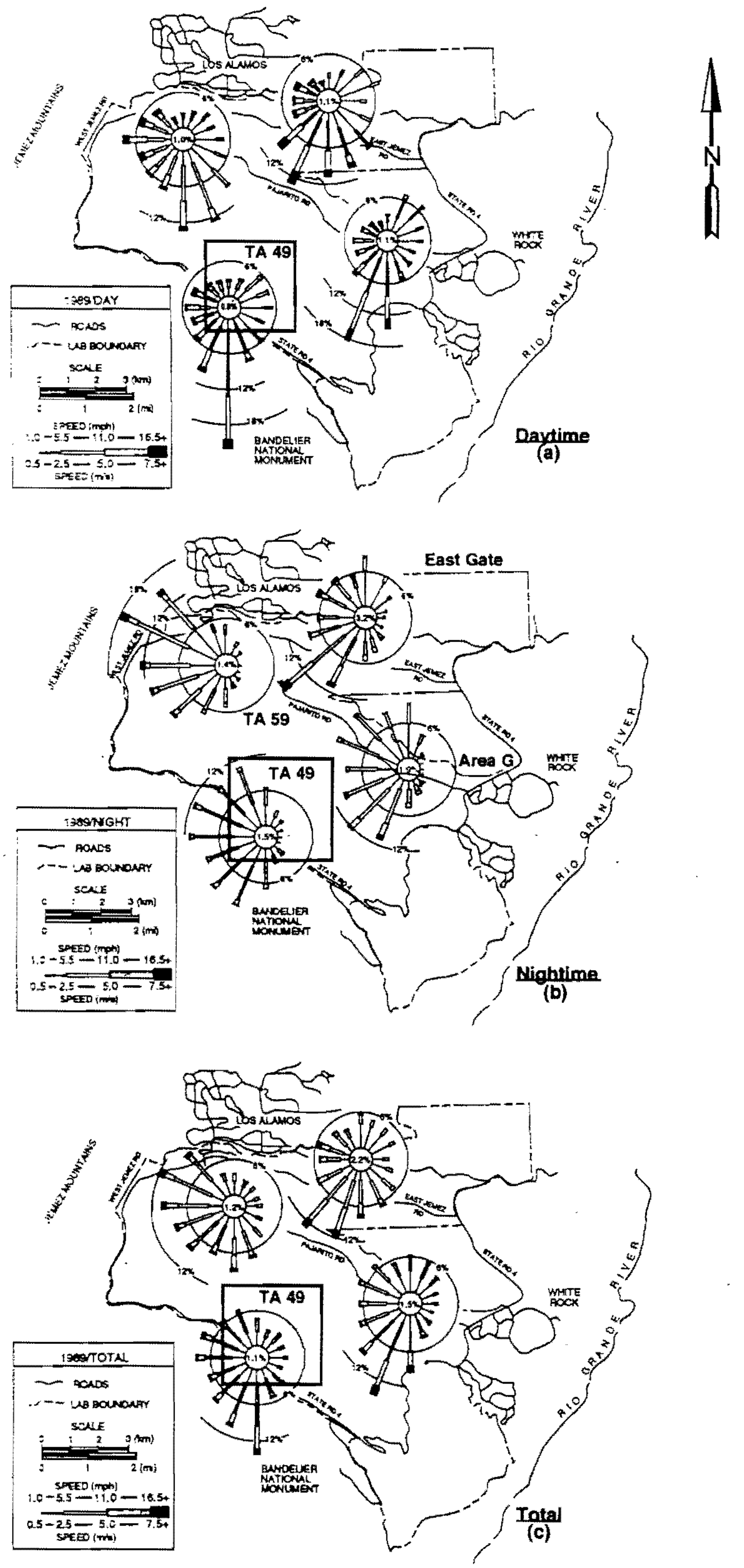


Figure 4.2-1 Wind roses at Laboratory stations during 1989 (from ESG 1990, 0497). Wind directions are indicated from the large to the small ends of the of the indicators.

4.3 Surface Deposits

4.3.1 Erosional Deposits

Erosional deposits at TA-49 consist mainly of alluvium, colluvium, and landslide deposits in drainage networks (channels and canyons), as well as sediments on mesa tops and slopes.

Erosion at TA-49 occurs by the following mechanisms:

- shallow runoff on the relatively flat parts of the mesa;
- deeper runoff in channels and canyons;
- rockfall, landslide, debris flows, and colluvial shedding from the mesa edges or canyon walls; and
- wind transport.

Given these mechanisms, estimating the rates of erosion and deposition is relevant to assessment of the long-term stability of TA-49. However, erosion/deposition rates for mesa top soils, canyon sediments, and the Bandelier Tuff are not well understood (see Subsection 2.6.2.5 of the IWP). It appears that cliff-forming units are eroded predominantly by lateral cliff retreat and block spallation rather than by vertical incision. Erosion rates are expected to vary greatly with gradient, vegetation, and slope orientation (for example, north vs south-facing locations).

Because of their slow rate and obvious nature, mass wasting processes such as rockfall are not considered credible threats to the integrity of TA-49 SWMUs over assumed institutional time frames (100 yr). For example, records for the last four decades indicate that, on average, TA-2 in Los Alamos Canyon is invaded only by about one boulder of 300 pounds or more every 2.4 yr (McLin, Eller 1992, 03-0010) A canyon retreat rate at this site of 2.5 cm/1000 yrs also was calculated based on this study. However, these low average rates are not relevant to massive cliff failure induced by a large seismic event.

Alluvial sands in Frijoles Canyon about 2 miles to the south of MDA AB, and Water Canyon to the north, of TA-49 are likely to be interbedded with fine-grain debris flows. Trenches dug in alluvium in Rendija Canyon, about 10 km north of TA-49, revealed that the Holocene alluvial sequence was less than 6000 yr old and that over 50% of the sequence was deposited during a period of rapid aggradation roughly 3000 to 4000 yr ago (Gardner et al. 1990, 0639). Gardner also reported a major unconformity in canyon-fill deposits between 6000 and 700,000 yr ago.

These observations are significant because drainages within the Laboratory boundaries may have been stripped of their unconsolidated sediment fill during extreme flood events more than 6000 yr ago and subsequently reaccumulated sediment. This scour and fill cycling of canyon alluvium might have occured in response to base level changes in the master Rio Grande or to climatic variations. The possibility of future cycling obviously exists. For TA-49, the significance is that such cycling could affect smaller tributaries and mesa-top erosion over long time frames, thus influencing sediment-contaminant transport by surface waters (Hakonson and Nyhan 1980, 0117). A comprehensive study of a major Pajarito Plateau watershed such as Water Canyon to quantify erosion rates, water budget, sediment sources and storage, and scour and fill cycles has never been performed.

For the TA-49 RFI, existing data on erosional and depositional processes is probably adequate except in the vicinity of MDA AB and Area 11. For these areas, a topographic map of erosion/deposition areas is desirable, as discussed earlier in Section 4.1.

4.3.2 Mesa Top Soils

Soils on the Pajarito Plateau, including TA-49, were mapped and described by (Nyhan et al.1978, 0161) and are discussed in IWP Chapter 2. Earlier studies by (Weir and Purtymun 1962, 0228) defined the mesa-top soil depths at TA-49. Figures 4.3-1 and 4.3-2 show the distribution, depths, and designations of soils at TA-49.

Different soil series occur on relatively flat portions of Frijoles Mesa and become intermixed with the Bandelier Tuff near the margins of the mesa tops. The soils were formed in a semiarid climate and are largely derived from weathering of the Bandelier Tuff bedrock. Predominant soils mapped in the vicinity of TA-49 SWMUs are generally poorly developed and are designated by (Nyhan et al. 1978, 0161) as fine-loamy Typic Eutroboralfs, Hackroy-Rock Outcrop Complex, Frijoles Fine Sandy Loam, and Rock Outcrop.

Typic Eutroboralf soils occur at the western portion of TA-49 (e.g., Area 6) and consist of deep, well-drained materials that formed in gravelly fan material close to the mountains. Other Eutroboralf soils at TA-49 consist of moderately deep, well-drained soils that formed in colluvium and material weathered from tuff. According to Nyhan et. al, these surface soils range in thickness from 95 to 135 cm.

The thickest soil zones at TA-49 are found along shallow, slow-draining ditches, streambeds, and relatively flat areas where water has collected (Weir and Purtymun 1962, 0228). The soil consists of about 20% quartz sand, 30% silt, and 30% clay and its thickness depends upon the amount of water available for weathering the underlying tuff. Soil thickness measured in shallow test holes in TA-49 arranged from 0.5 to 9 ft and the greatest thickness occurs in a flat area north of Area 6.

Soils at areas of MDA AB and at Areas 5, 11, and 12 generally have been disturbed but originally were Hackroy Series and Eutroboralf soils. Intermixed with these soils are patches of bedrock predominantly near the edges of the mesa east of developed TA-49 areas. Hackroy soils are classified as alfisols, in part reflecting the clayey subsurface horizons, and are described by (Nyhan et al. 1978, 0161) as follows:

"The surface layer of the Hackroy soils is a brown sandy loam, or loam, about 10 cm thick. The subsoil is a reddish brown clay, gravelly clay, or clay loam,

Figure 4.3-1
Distribution of soils at TA-49 (adapted from Nyhan et. al., 1978, 0161).

MDA AB

State Road 4

Soils Legend

FR Frijoles fine sandy loam
SE Seaby loam
HA Hackroy-Rock outcrop complex
NJ Nyjack loam
PG Pogna fine sandy loam
RF Rock outcrop, frigid
RS Rock outcrop, steep
TL Typic Eutroboralfs, fine loamy
TR Typic Ustorthents-Rock outcrop complex

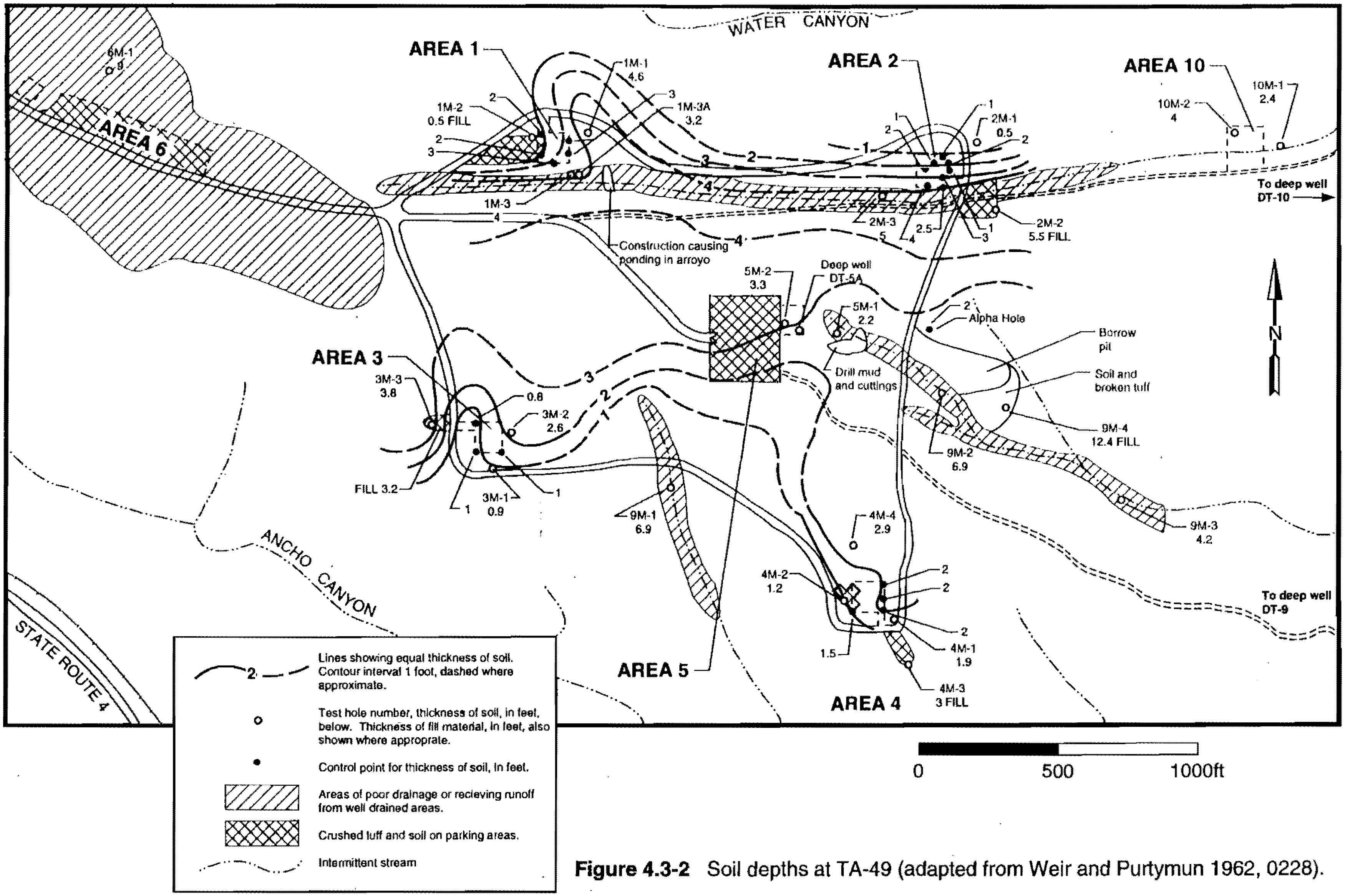


Figure 4.3-2 Soil depths at TA-49 (adapted from Weir and Purtymun 1962, 0228).

about 20 cm thick. The depth to tuff bedrock and the effective rooting depth are 20 to 50 cm."

Area 10 soils are classified as Frijoles Fine Sandy Loam. In Areas 2 and 10, a well-sorted pumice zone (El Cajete pumice) lies between the weathered tuff interface and the soil horizon.

A distinct clay layer often is observed at the soil-tuff interface on the Pajarito Plateau. This layer has been described as an effective seal against moisture infiltration into the underlying bedrock [see subsection 2.6.3 of the IWP and (Weir and Purtymun 1962, 0228)]. However, areas where soils have been removed or disturbed may not form as effective barriers against infiltration.

The apparent effectiveness of this clay barrier was established in part by water content measurements of the soil and upper Bandelier Tuff from 23 moisture-access holes at TA-49 in the early 1960s. A number of subsequent studies elsewhere at the Laboratory have supported the early TA-49 studies. These studies have described several distinct soil zones overlying the tuff, as follows:

- an uppermost zone from which most clay has been leached,
- an intermediate zone containing montmorillonite, and
- a lower transitional zone between the soil and unweathered tuff, with high clay content.

The results of the vadose-zone moisture content studies within the uppermost soil profile at TA-49 are described in more detail in Section 4.4 of this OU work plan.

Although the soil classifications of Nyhan et al. and the soil depths and characteristics reported by Weir and Purtymun are adequate on a site-wide basis, they do not provide all the hydrogeochemical parameters required to assess the potential for erosional and solutional transport of contaminants at Area 11 and MDA AB (as defined in the Laboratory's HSWA permit and as discussed in Chapters 6 and 7). These requirements relate to subsequent modeling of runoff and aerial resuspension processes. Thus, some additional but limited soil characterization is needed for soils from Area 11 and MDA AB, including:

- particle size distribution and surface area;
- mineralogical properties including chemical composition, ion exchange capacity, pH, contaminant retardation factors for indicator contaminants, and clay and organic content;
- hydraulic characteristics including permeability and conductivity; and
- vegetative cover characteristics.

Additional data also are needed about the spatial extent and level of soil contamination at TA-49 SWMUs, as addressed in Chapters 6 and 7. In addition, limited sampling away from SWMU areas is needed to verify that OU perimeter soil levels of indicator contaminants (particularly along the border with Bandelier National Monument) have not been impacted by TA-49 activities. This activity is discussed later in Section 6.1 and also is being addressed by the Laboratory-wide ER Framework Studies project on Laboratory-wide soils issues.

4.3.3 Soils in Canyon Walls and Bottoms

The slopes between the mesa tops and canyon bottoms have been mapped as mostly steep rock outcrops consisting of about 90% bedrock outcrop and patches of shallow, undeveloped soils (Nyhan et al. 1978, 0161). Soils in part of Water Canyon north of TA-49 are designated as Typic Ustorthents-Rock outcrop complexes formed on colluvial material mantling the lower slope (see Figure 4.3-1). The Ustorthents are deep, well-drained soils. The surface layers are a pale brown, stony or gravelly sandy loam about 5 cm thick. The substratum is about 150 cm thick and generally consists of a very pale brown, or light gray, gravelly loamy sand, or sand.

The bottom of Water Canyon north and east of TA-49 contains deep, poorly developed, well-drained soils of the Totavi series which formed in alluvium. The surface soil is a brown, gravelly loamy sand, or sandy loam, 150 cm thick or more, with about 15 to 20% gravel (Nyhan et al. 1978, 0161). Totavi soils are classified as entisols.

Existing canyon soil data appear to be adequate for the purposes of the TA-49 RFI. However, if Phase I of the RFI indicates that TA-49 contaminants could impact the canyons over a long period, mapping of canyon soil/sediment horizons may be necessary in subsequent investigations.

4.4 Hydrology

As discussed elsewhere in Chapter 4, the groundwater pathway is not likely to be of immediate significance at the TA-49 OU because of the great depth to the main aquifer and the current belief that credible pathways do not exist. This statement is based on the absence of large liquid waste discharges at TA-49 in the past, and the low likelihood for significant infiltration, as shown by numerous previous studies at TA-49 and other Laboratory locations. Nevertheless, vadose zone characterization below the known depth of contamination in MDA AB is very important for the TA-49 RFI because of the magnitude of the source term and the uncertain source of water in Core Hole 2, as discussed in Chapter 7.

It is likely that a conditional remedy consisting of capping-in-place with *in situ* stabilization accompanied by long-term institutional control, monitoring, and maintenance will be the most reasonable remedial alternative to be identified by the RFI/CMS. This approach further drives the need for vadose zone study beneath MDA AB. These studies will directly test the hypothesis that significant contaminant migration has not occurred since the time of their implacement, and is not likely in the future. In addition, vadose zone studies will provide information required for transport modeling over long time frames.

The significance of small liquid radioactive releases into the Area 11 leachfield also needs to be investigated, primarily to identify the vertical and lateral extent of contamination.

4.4.1 Surface Hydrology

The most significant aspects of surface hydrology at TA-49 are run-off and infiltration. These mechanisms are the predominant ways in which contaminants could be mobilized and transported off-site (see Sections 4.8 through 4.11of this chapter). Surface hydrology aspects relevant to TA-49 SWMU areas include:

- areas and pathways of surface water run-off and sediment deposition,
- rates of soil erosion, transport, and sedimentation,
- locations and sizes of areas of disturbed and undisturbed surface soils in drainages,
- infiltration vs run-off ratios,
- presence and effectiveness of sorptive media and/or hydraulic properties in retarding infiltration of water-borne contaminants, and
- fate of infiltrating water on mesa tops and in canyons.

4.4.1.1 Surface Water Run-Off

Run-off potentially can carry contaminants into surface waters that drain off-site and potentially concentrate surficial contamination downstream. Surface run-off from Frijoles Mesa flows either northward into Water Canyon, eastward into a tributary canyon to Ancho Canyon, or southward into Ancho Canyon (see Appendix A). There is no evidence for hydraulic connection of surface water and groundwater at TA-49 (see Section 2.6 of the IWP; Purtymun and Ahlquist 1986, 03-0013; Weir and Purtymun 1962, 0228). Permanent alluvial aquifers are unknown in canyons adjacent to TA-49, but run-off occasionally may recharge shallow ephemeral alluvial systems.

Pajarito Plateau run-off from summer storms typically reaches a maximum discharge in less than 2 hr and generally has a duration of less than 24 hr (Purtymun et al. 1990, 0215). The high discharge rate carries large masses of suspended and bed load sediments as far as the Rio Grande.

Spring snowmelt occurs over a period of several weeks to several months, typically at a low discharge rate (Purtymun et al. 1990, 0215). The long duration of flow from snowmelt results in the net movement of greater masses of sediments through the canyons than during summer run-off events. However, proportionately more mesa top erosion occurs during the intense summer run-off events than during snowmelt. Most infiltration occurs during the longer periods of snowmelt as a result of the length of the process and the lower rates of evaporation.

In Ancho Canyon, only intermittent and ephemeral flow caused by runoff occurs, except during snowmelt and storm events. Water Canyon stream flow is intermittent and ephemeral in the vicinity of, and down-gradient from, TA-49. The Water Canyon drainage system receives input from permitted discharge points upgradient of TA-49. Permitted discharges to Water Canyon and its tributary Valle Canyon include boiler blowdown from steam plants, non-contact cooling water, and waste water from HE and photographic operations areas. None of these discharges contain hazardous or toxic materials.

As mentioned above, a comprehensive study, including water and sediment budgets, of surface run-off from a major mesa top/canyons watershed on the Pajarito Plateau has never been conducted. A limited study of surface contaminant transport in Potrillo Canyon north and east of TA-49 was completed recently (Becker 1991,0699). Experimental data from a rainfall simulator study at TA-51, approximately 5 miles north of TA-49 (Nyhan and Lane 1986, 0156) indicates that run-off is more than three times greater from an area of backfilled soil than from natural vegetated areas. Even over very long time frames, surface erosion rates at TA-49 almost certainly will not be great enough to directly affect the deeply buried waste in MDA AB, which comprises almost all of the TA-49 contaminant inventory.

Surface water quality data has been collected for about 30 yr at the Beta Hole surface water station in Water Canyon (about 2000 ft north of MDA AB), in Water and Ancho canyons at State Road 4, and sporadically in drainages leading from MDA AB following intense rainfall events. The surface water chemistry results over this period have shown that contaminant levels are almost always at detection or background levels and show no evidence that detectable contaminant transport from TA-49 has occurred. Appendix D tabulates representative surface and groundwater analyses collected at TA-49.

4.4.1.2 Surface Water Infiltration (Soils and Upper Tuff)

Surface water infiltration provides a potential mechanism by which contaminants may move into the subsurface and allow contaminants to reach aquifers.

Section 2.6 and Appendix P of the IWP summarize a number of studies that have addressed the rate of surface water infiltration into the Pajarito Plateau. In general, these studies indicate that for native soil profiles, infiltration of water into the tuff bedrock is not significant on mesa tops. However, the magnitude of the source term in the MDA AB shafts and the appearance of water in Core Hole 2 point out the need for further testing of this hypothesis for MDA AB, where extensive soil disturbance has occurred.

Surface water infiltration pathways at TA-49 include:

- native or disturbed soils,
- intact tuff,

- backfilled shafts,
- fracture systems, and
- boreholes.

Even with a persistent surface water source, moisture transfer to the Bandelier Tuff is limited by the strong evapotranspiration processes characterizing the region. In addition, the naturally low moisture content and high porosity of the underlying tuff provides a huge storage capacity for infiltrating fluids. Relevant points which apply generally to mesa tops of the Pajarito Plateau (including TA-49 SWMU areas) and which are specifically addressed in Chapter 2 of the IWP are listed below.

- Infiltrating water is lost quickly through evapotranspiration in naturally vegetated areas.
- A continuous supply of water to a pit dug in soil above the natural clay layer did not significantly increase the moisture content of the underlying tuff below a depth of about 8 ft. Where the soil cover is undisturbed, precipitation moisture typically does not penetrate deeper than about 10 to 20 ft into the tuff.
- Many joints and fractures in the Bandelier Tuff contain caliche, brown clay, or limonitic material that strongly impede flow along fractures. However, the existence of these filling materials at depth also demonstrates that fracture flow has occurred in the past.
- Little moisture passes through undisturbed soil profiles, whereas a greater amount of infiltration penetrates to the tuff in areas where the soil has been disturbed. Moisture from single storm events penetrates as deep as 6.5 ft through disturbed fill but is rapidly depleted by evaporation. Seasonal moisture fluctuations were detected in both the bedrock tuff and fill, but only to a depth of about 13 ft.
- Tests at TA-50 involved the injection of 335 000 gal. of water into the Tshirege member of the Bandelier Tuff and subsequent study over a period of about 1 yr. The test results led the investigators to conclude that Bandelier Tuff is highly effective in arresting the movement of contaminants and liquids. A sufficient and nearly continuous water supply would have to be available before water-borne contaminants could completely penetrate the unsaturated zone.

Studies have been carried out at TA-49 to address surface water infiltration, as summarized below.

In 1960, 23 test holes were drilled at TA-49 around MDA AB to determine the thickness and distribution of moisture in soils and upper tuff (Weir and Purtymun 1962, 0228; Abrahams et al. 1961, 0015). Neutron moisture probe data from the 23 holes are summarized in Table 4.4-1 and Figure 4.4-1. In general, the moisture content was found to increase from the surface to a depth of several

TABLE 4.4-1

RESULTS OF MOISTURE CONTENT STUDY IN SOILS AND UPPER BANDELIER TUFF AT TA-49
(from Weir and Purtyman 1962, 0228).

	Thickness of Soil (ft)		Depth at which moisture content was less than 10% (ft)		Depth at which moisture content was less than 5% (ft)	
	Range	Average	Range	Average	Range	Average
15 test holes in well-drained areas	0.5-12.4	3.5	2.5-9.0	4.7	7.0-14.0	
8 test holes near arroyos and ditches and in poorly drained areas	2.2-9.0	5.3	4.0-19.0+	9.5		

Moisture content does not decrease significantly below 5%; the holes range in depth from 19 to 49 ft.

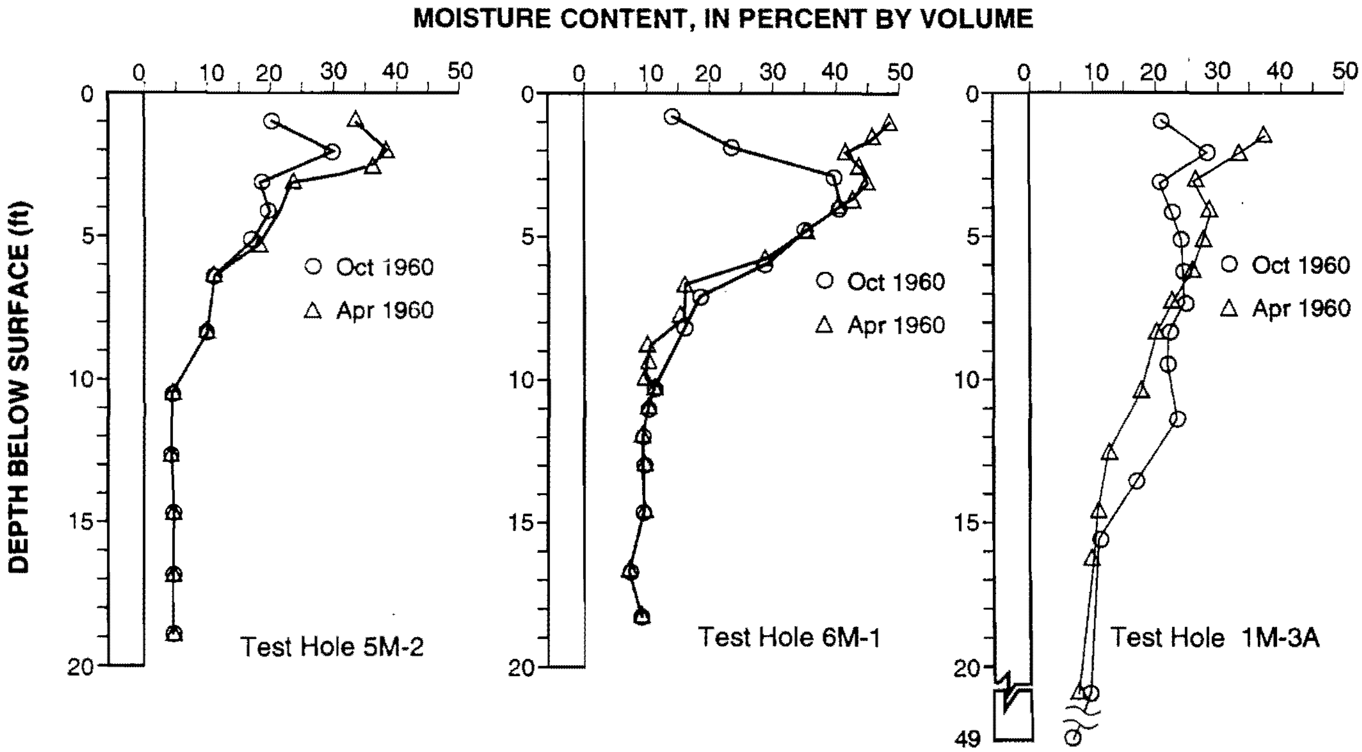


Figure 4.4-1 Moisture measurements in selected test-holes at TA-49. Test Holes 5M-2 and 6M-1 were in well drained areas. Test Hole 1M-3A was in a disturbed soil area which collected water (adapted from Abrahams, et al. 1961, 0015).

feet and then decrease rapidly from a depth of about 4 to 12 ft. Below a depth of about 15 ft, the moisture content of the tuff was about 5% or less by volume and remained almost unchanged at greater depths.

Results from this study showed the moisture content in the upper 5 to 6 ft of TA-49 soil was highest in March and April as a result of late winter snow and decreased to a minimum in October because of high evapotranspiration rates during the summer and early fall. There were some variations, however, that apparently were related to drainage and soil thickness.

Test holes near arroyos, ditches, and poorly drained areas that received or retained water during periods of storm runoff are represented in Figure 4.4-1. In particular, construction near test-hole 1M-3A caused 2 to 4 in. of water to pond during wet periods, resulting in greater moisture content at a depth of 6 to 13 ft. Between 13 and 20 ft, a small increase in moisture content is suggested, but below about 20 ft, the moisture remained about 6 to 8%.

Despite the conclusions of past studies indicating that water infiltration is generally insignificant through Pajarito Plateau mesa tops, there are several reasons to consider further the issue of surface water infiltration at TA-49. The most important reason is the uncertain source of water that has appeared on at least two occasions in Core Hole 2. In addition, (Weir and Purtymun 1962, 0228) report plant roots in fractures as deep as 58 ft and alteration of the tuff along fractures in the test shafts. Also a "white alteration material" (probably amorphous silica or calcite) as well as clay was found to line some MDA AB test shaft fractures. These observations are clearly indicative of past water infiltration along the fractures that were revealed during drilling of shafts.

In summary, the soil and tuff moisture profile information for areas of TA-49 other than MDA AB and Area 11 of TA-49 is adequate for the purposes of the TA-49 RFI. However, soil and tuff moisture will be measured routinely during all future TA-49 drilling operations in the vicinity of MDA AB because of the large underlying source term. These data are needed to evaluate infiltration depths at the highly contaminated shaft areas at MDA AB and the source of standing water in Core Hole 2. Some moisture profile data also are needed for the Area 11 leachfield to evaluate the significance of small liquid releases in the past.

4.4.2 Vadose Zone Hydrology (Deep Formations)

An adequate understanding of the deep vadose zone beneath MDA AB is important because it encompasses both potential primary barriers and conduits for the movement of liquids. Past studies of the hydrogeologic properties and the movement of fluids through unsaturated Bandelier Tuff are discussed in Section 2.6 of the IWP and are mentioned briefly in the preceding section of this chapter. Although past hydrologic characterization of the Bandelier Tuff at most Laboratory study sites has concentrated on the top 100 ft, these studies overwhelmingly support the general concept that the thick unsaturated tuff provides substantial impedance to downward movement of fluids. Features of the unsaturated tuff relevant to contaminant transport include:

- physical properties (density, porosity, specific gravity);
- geohydrologic properties (saturated and unsaturated permeabilities, hydraulic conductivities, and moisture characteristic curves);
- fractures and joints (frequency, orientation, degree of interconnectedness, and filling materials);
- flow paths or barriers at unit contacts or paleo-surfaces;
- geochemical properties (specific surface area, ion exchange capacity, retardation factors, and mineralogy); and
- depth to groundwater.

The subsurface hydrology at TA-49 is dominated by unsaturated conditions. The top of the saturated zone occurs approximately 1170 ft below the surface of the mesa at deep test well DT-5A near the center of MDA AB. About 800 ft of this vertical distance is within the Bandelier Tuff.

Four boreholes were drilled to depths of 300 to 500 ft at the main experimental area of TA-49 (now MDA AB) during 1959 and early 1960. In addition, more than 50 experimental holes were drilled as deep as 142 ft in Areas 1, 2, 2A, 2B, 3, and 4 from 1959 to 1961. The locations and characteristics of TA-49 boreholes deeper than 150 ft are indicated in Table 4.4-2 and Figure 4.4-2. In no case was perched water encountered and, with the exception of Core Hole 2 (CH-2) to be discussed in detail in Chapter 7, the holes apparently have remained dry since they were drilled.

In the logging of CH-2, a significant amount of drilling fluid was lost below a depth of about 300 ft, indicating the presence of a highly permeable formation in stratigraphic Unit 1A and 1B of Weir and Purtymun (1962, 0228) (Purtymun, Eller, 03-0028). In the drilling of deep test well DT-5A, air circulation was lost at about 285 ft (near the Unit 1b/Unit 2 contact). In the unsuccessful attempt to regain circulation, an estimated 2.5-10 million gallons of drilling fluid was expended in this hole. Another stratigraphic unit of concern for vadose zone transport is the permeable surge deposit (Unit 5 of Weir and Purtymun) described subsequently in Section 4.5 of this OU work plan.

Natural fractures that formed during the cooling of freshly deposited tuff, as well as fractures generated during underground detonations, potentially have created vertical and lateral networks in the vadose zone beneath TA-49. Weir and Purtymun (1962, 0228) reported that fractures in experimental holes in Area 2 were conduits for air movement. Weir and Purtymun also examined the walls of an experimental shaft following a large detonation in a shaft 50 ft away. They discovered that fractures had opened and that fracture fillings had been expelled as a result of the shot concussion. In other studies at TA-49, (Purtymun et al. 1974, 0651) measured substantial air volumes taken in or exhausted from the Alpha and DT-9 boreholes in response to barometric changes. The observation of air movement in boreholes indicates the existence of a substantial underground open fracture system that is sealed to a significant degree from the surface. However, these observations do not necessarily imply that the fractures interconnect to great depth (that is, cross cooling unit boundaries).

TABLE 4.4-2

CHARACTERISTICS OF TA-49 BOREHOLES DEEPER THAN 150 FT[a]

Well	Location	Logs[a]	Comments; Depth (ft)
DT-5P	11131.61 S 9435.54 E	None	Depth 692 ft; hole plugged and abandoned
DT-5	11099.42 S 9303.06 E	IND, GRN, TEMP	Depth 927 ft; hole cased 0-180; 180-927 ft open
DT-5A	11147.97 S 9302.77 E	LL, IND, ML, SL GRN, TEMP	Depth 1821 ft; cased 1821 ft; pump
DT-9	14280.74 S 13127.35 E	IND, GRN, SL TEMP, LL	Depth 1,501 ft; cased 1,501 ft; pump
DT-10	11327.10 S 12994.48 E	IND, GRN, TEMP SL	Depth 1409 ft; cased 1409 ft; pump
1-200 (alpha)	11098.83 S 9875.97 E (SE of Area 2)	IND, GRN, VL	Depth 189 ft; 24-in dia.' hole; cased 0-7 ft; open hole 7-189 ft.
OSO (beta)	8363.00 S 9189.00 E (Water Canyon)	VL	Depth 180 ft; 24-in dia. hole; cased 0-13 ft; open hole 13-180 ft.
CH-1 (Area 1)	10497.43 S. 8436.65 E	GR	Depth 501 ft; cased 0-500 ft.
CH-2 (Area 2)	12.5 ft E of hole M, Area 2	EL, GRN, TEMP	Depth 507 ft; cased 0-570 ft.
CH-3 (Area 3)	11494.23 S 8206.40 E	GR	Depth 300 ft; cased 10-300 ft.
CH-4 (Area 4)	12032.82 S 9568.74 E	GR	Depth 303 ft; cased 0-303 ft.

[a]Geologic logs are available for all holes. Other borehole logs which are available include:

IND = Induction/Electrical and Spontaneous Potential.
LL = Lateral
SL = Sonic
TEMP = Temperature
GRN = Gamma Ray Neutron
ML = Microlog
EL = Electrical
GR = Gamma Ray
VL = Video

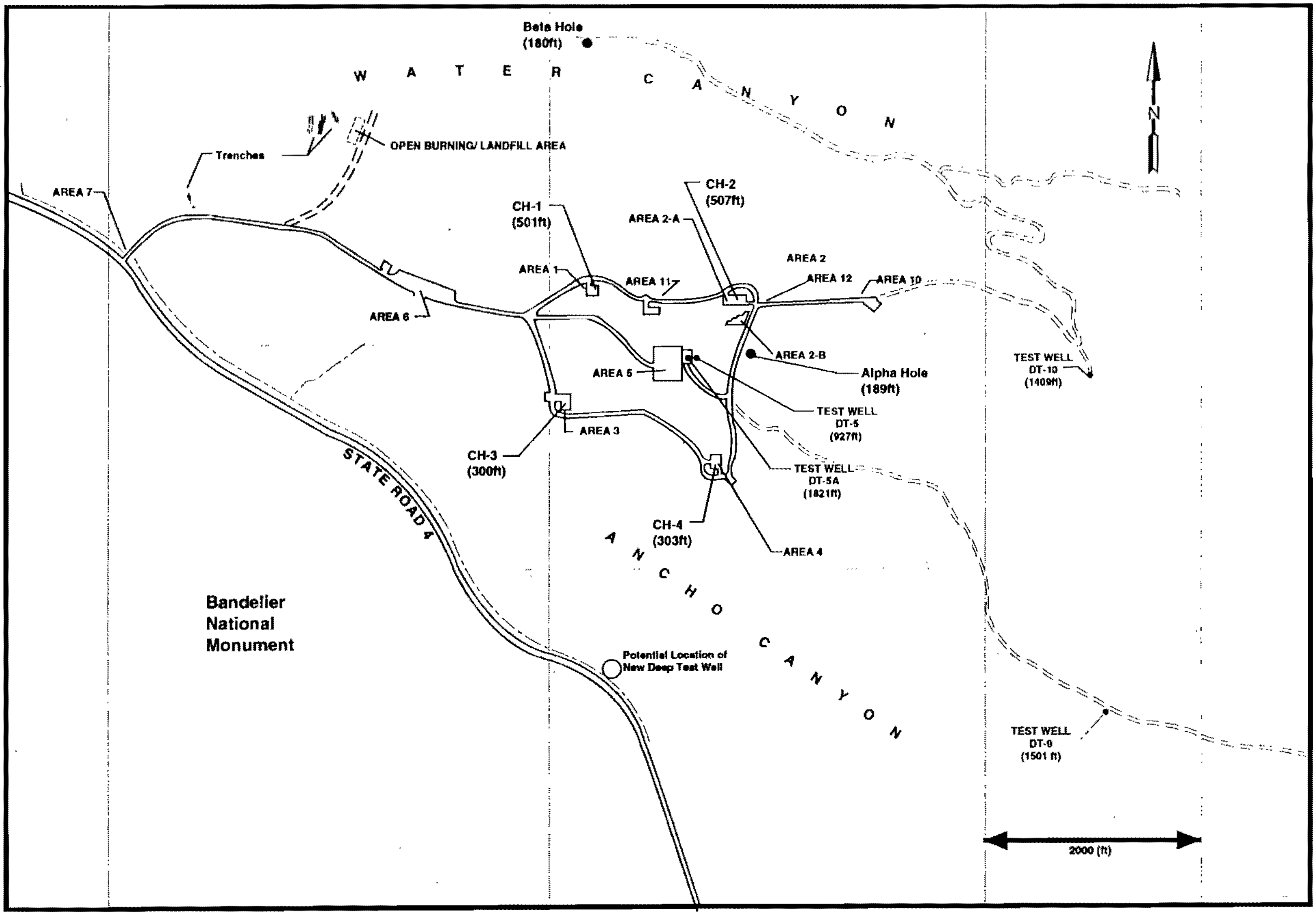


Figure 4.4-2 Location of existing TA-49 boreholes deeper than 150 ft.

In summary, the significance of natural and explosively-induced fracture systems at MDA AB needs to be evaluated further. The lateral variability of potential transport zones, such as cooling fractures, fault zones, and surge deposits, needs further study (see Subsection 4.5.1 for discussion of bedrock stratigraphy). Information on the variability of potential retarding media beneath MDA AB, such as highly impermeable or sorptive zones, also should be evaluated further. Data needs include the measurement of key retardation factors, hydraulic properties, water content, and data on chemistry and isotopic content of pore fluids. These data are required as input for mathematical and conceptual models to evaluate rates of surface recharge and subsurface fluid movement.

4.4.3 Saturated Zone Hydrology

4.4.3.1 Alluvial Aquifers

Surface water infiltration creates small, localized saturated zones in the alluvial fill of the canyon bottoms of the Pajarito Plateau (see Subsection 2.6.4 of the IWP). Surface water apparently infiltrates through the alluvium until the downward movement is impeded by less-permeable layers. Depletion by evapotranspiration and movement into the underlying rock also limits the size of saturated zones.

Although available information suggests that canyon alluvial aquifers are unlikely to be important to the TA-49 RFI in general, they could be of significance if Phase I unexpectedly indicates the potential for contaminant movement into the main canyon systems. In that case, alluvial aquifers would be of concem for several reasons.

- Contaminated surface water from TA-49 potentially can recharge alluvial aquifers and be available for uptake by biota.
- Alluvial aquifers are potential zones for infiltration into the underlying tuff. They also are sources of water that could move toward the much deeper groundwater or to spring outlets in White Rock Canyon.

Details of three shallow monitor wells installed in Water Canyon downgradient from TA-49 are shown in Appendix M of the IWP. These wells encountered no perched water when they were drilled in the summer of 1990, but ephemeral alluvial aquifers probably occur in the lower portion of Water Canyon. It is not known if an appreciable alluvial aquifer occurs in Ancho Canyon, although it is likely that at least a limited, and perhaps ephemeral, zone of saturation is present from recharge to the alluvial sediments from runoff events.

Springs and seeps are known in the lower reaches of Water and Ancho canyon far downgradient from TA-49 (near the Rio Grande), but none are known within the boundaries of TA-49.

Lateral groundwater flow is controlled by stratigraphic permeability barriers within the Bandelier Tuff. Lateral discharge from canyon walls or canyon bottoms theoretically provides a potential transport path for contaminant migration. However, tests and transport calculations described earlier in Chapter 2 of this OU work plan indicate that for this pathway to be significant, quantities of water tremendously greater than those currently known to be available beneath any mesa top of the Pajarito Plateau would be required.

4.4.3.2 Deep Groundwater

The deep groundwater beneath TA-49 is part of the main aquifer that serves all the municipal and industrial water use in Los Alamos county (Purtymun 1984, 0196). As discussed earlier in Chapter 4 and in Chapter 2 of the IWP, the groundwater pathway is not likely to be important at the TA-49 OU over the 100-yr time period assumed for institutional control. Figure 4.4-3 shows generalized contours of the top of the main aquifer beneath TA-49. Figure 4.4-4 shows TA-49 surface and groundwater sampling locations in relation to stations elsewhere at the Laboratory.

Data to date suggests that, in general, there is little if any recharge through mesa tops of the Pajarito Plateau to the main aquifer (Chapter 2 of the IWP). However, recent field studies and a recent hydrogeologic review of existing information suggest that the existing database is insufficient to exclude this possibility categorically (Goff et al. 1990, 0557; Goff 1991, 03-0008; Kearl et al. 1986, 0652).

Groundwater gradients of the main aquifer along the southern boundary of the Laboratory have been established by extrapolation between a cluster of 3 deep test wells at TA-49, spring discharge points in White Rock Canyon, and 19 water supply wells and 7 test holes along the northern boundary of the Laboratory. The three deep test wells at TA-49 were drilled into the main aquifer in 1959 (Weir and Purtymun 1962, 0228; Purtymun and Ahlquist 1986, 03-0013). As Figures 4.4-2 and 4.4-3 indicate, well DT-5A is located in Area 5 in the center of the MDA AB areas and DT-9 and DT-10 are located generally downgradient of DT-5A. Well DT-9 is approximately 0.5 miles south of DT-10 and 1 mile southeast of well DT-5A. Perched water was not detected during the drilling of these or other wells at TA-49.

The elevation of the potentiometric surface of the aquifer rises westward from the Rio Grande through the Tesuque Formation, the lower part of the volcanics, and sediments beneath the central and western part of the Pajarito Plateau (Figures 4.1-1 and 4.4-3). Beneath TA-49, the potentiometric surface lies completely within the Puye sediments and the Tschicoma volcanics. The groundwater moves eastward and discharges into the Rio Grande through seeps and springs (see Chapter 2 of the IWP; Purtymun et al. 1980, 0208).

The gradient on the upper surface of the aquifer is 40 to 60 ft/mile beneath the western and central part of Frijoles Mesa in the volcanic-sedimentary section and probably increases to 80 to 120 ft/mile within less-permeable sediments of the Tesuque Formation (Purtymun and Johansen 1974, 0199). Movement of groundwater generally is parallel to the dip of the potentiometric surface in unfractured rock, as at TA-49. Known groundwater flow beneath TA-49 is restricted to the lower portion of the volcanics and sediments and the upper portions of the siltsone and silty sandstone formations.

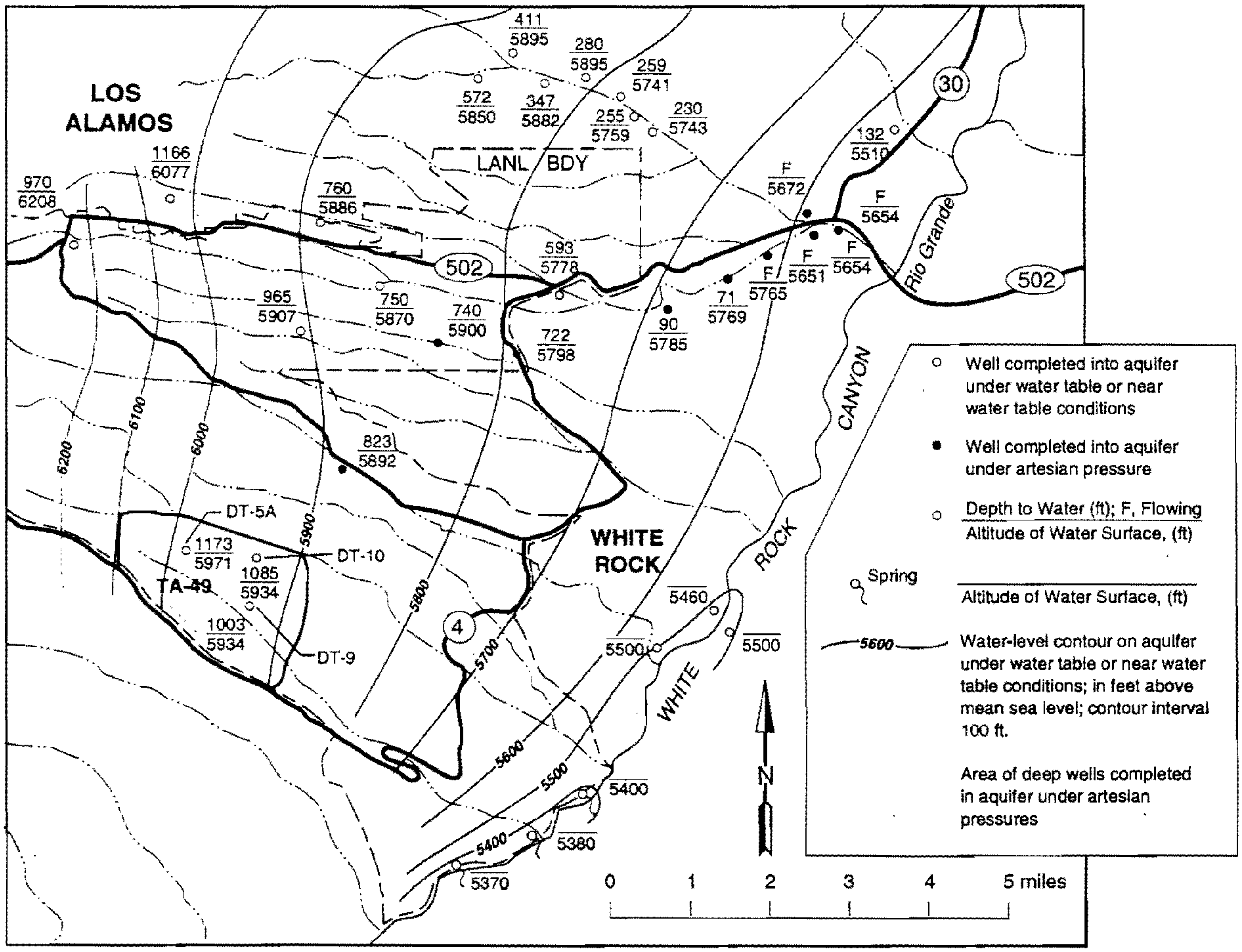


Fig. 4.4-3 Generalized contours on top of the main aquifer (adapted from Purtymun and Johansen 1974, 0199).

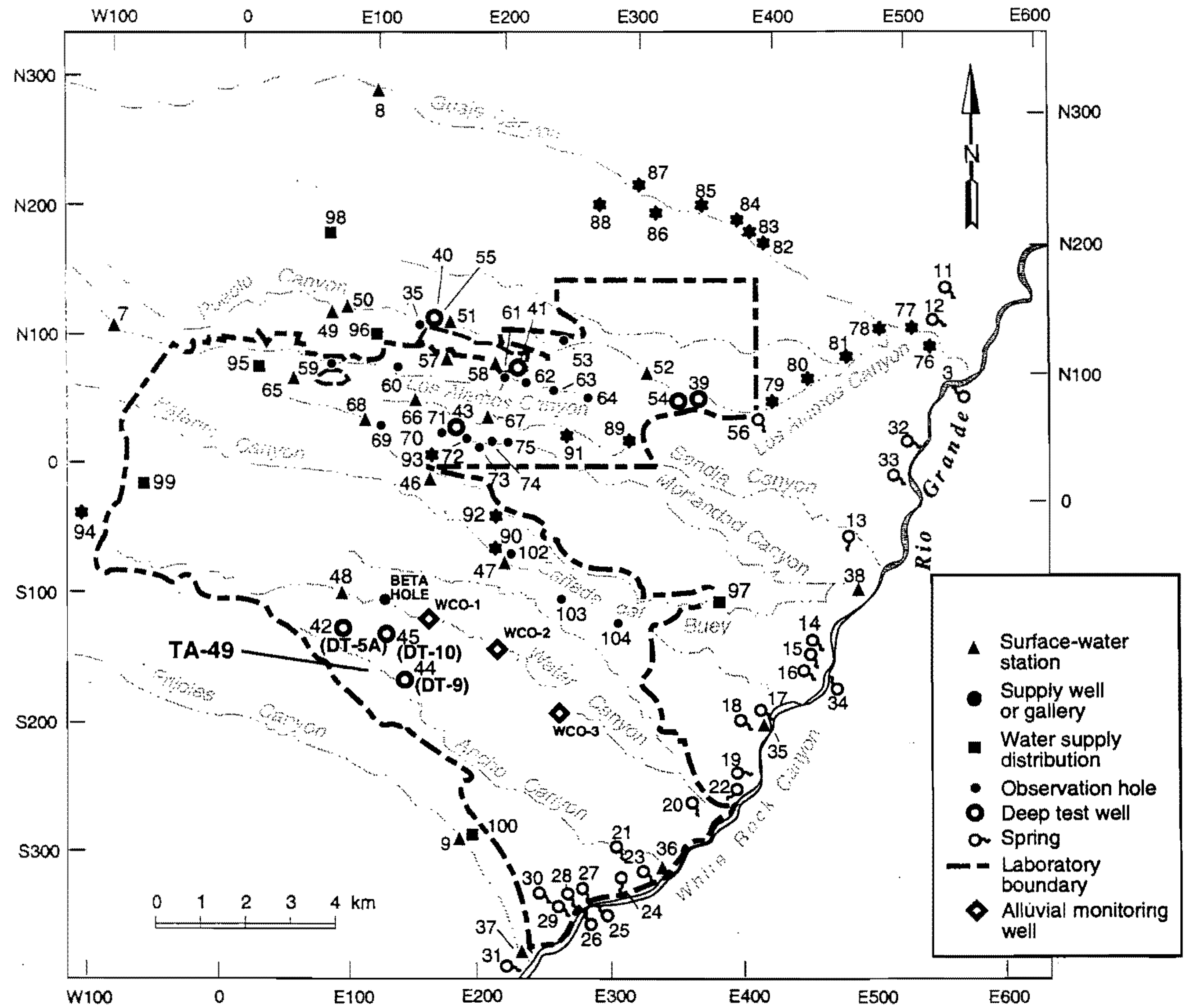


Figure 4.4-4 Surface and ground-water sampling locations within and near the Laboratory.

Aquifer performance tests were performed on the three deep test wells at TA-49 (Table 4.4-3). The average groundwater flow velocity in the upper 490 ft of the aquifer beneath TA-49 (calculated using average values for thickness and coefficient of permeability) is approximately 345 ft/hr (Purtymun and Ahlquist 1986, 03-0013).

Water-level measurements at well DT-5A from 1960 to 1964 indicated a water-level decline of about 4 ft (Purtymun and Ahlquist 1986, 03-0013). Regional water-level declines are believed to result from pumping of supply wells located to the north. Well DT-5A was equipped with a pump in 1970 to facilitate collection of water samples for chemical and radiochemical analyses. Water pumped from DT-5A and DT-10 at low discharge rates did not affect water levels in DT-9. Well DT-9 was equipped with a water-stage recorder from 1960 to 1968 and again from 1970 to 1982. The water levels in the well declined from a depth below land surface of 1003 ft in 1960 to 1006 ft in 1982. At DT-10, the water level declined about 4 ft/yr from 1960 to 1967. According to Purtymun and Ahlquist, this reflects the normal deep ground water-level trend for the region. Well DT-10 was equipped with a pump in 1979 to facilitate sampling for water.

Water from wells DT-5A, DT-9, and DT-10 is of a sodium-bicarbonate type and is similar for all three wells (Purtymun and Ahlquist 1986, 03-0013; ESG 1990, 0497). Total dissolved solids (TDS) concentrations range from 124 to 142 mg/L. Radiochemical analyses of groundwater since 1960 has indicated no detectable contamination of the main aquifer. Typical water chemistry analyses from these wells are presented in Appendix D.

4.4.3.3 Tritium Levels in the Main Aquifer

Weir and Purtymun (1962, 0228) reported low-level tritium analyses for three groundwater samples from two of the deep test wells at TA-49 (one sample from DT-5A and two samples from DT-9). Samples were collected from DT-5A at a depth of 1821 ft and from DT-9 at depths of 1325 and 1501 ft. The results, presented in Table 4.4-4, show a tritium content ranging from about 8 to 12 pCi/l vs about 320 to 6500 pCi/l for regional meteoric water during the period 1955 to 1965 (Goff 1991, 03-008). The tritium content in meteoric water in northem New Mexico peaked in 1962 at about 20,000 pCi/l (Vuataz and Goff 1986, 0390).

With the assumption that the deep aquifer beneath TA-49 was neither enriched in tritium by local recharge nor diluted by older aquifer water, the ages of groundwater samples from wells DT-5A and DT-9 were calculated to be about 20, 13, and 15 yr, respectively. The ages apparently are correlated with the collection depth (Weir and Purtymun 1962, 0228). Weir and Purtymun postulated that groundwater deeper in the aquifer moves more slowly and is older than shallower groundwater in the main aquifer, thus accounting for the older age calculated for the sample collected deepest in the aquifer. They also speculated that the two shallower samples could be relatively younger waters that are mixtures of water originating near the water table and deeper waters.

Weir and Purtymun also pointed out that the calculated water ages could imply local recharge from Water Canyon. The Pajarito fault zone, located approximately 3.7 miles to the west (upgradient) of TA-49, was indicated as one

TABLE 4.4-3

SUMMARY OF AQUIFER PERFORMANCE TESTS OF DEEP TEST WELLS
AT TA-49 [a]

	Well		
	DT-5A	DT-9	DT-10
Depth (ft)	1,821	1,501	1,409
Depth of main aquifer below land surface(ft)	1,178	1,006	1,091
Saturated thickness (ft)	643	498	324
Discharge rate (gal./min)	81	88	78
Specific capacity (gal./min/ft)	5.7	22	16
Transmissivity (gal./day/ft)	11,000	61,000	36,100
Field coefficient of permeability (ga./day/ft)^2	17	122	111

[a]Data are from Purtymun and Ahlquist (1986, 03-0013). Average groundwater velocity beneath TA-49 is approximately 345 ft/yr.

Table 4.4-4

Summary of Low-Level Tritium Analyses of Groundwater
from TA-49 Deep Test Wells. Data are from (Weir and Purtymun 1962, 0228)
and (Goff 1992, 03-0008)

Well No.	Date Collected	Date Analyzed	Sampling Depth Below Land Surface (ft)	Tritium content (pCi/l)	Computed Ages of Samples (yr)
DT-5A	5-1-60	11-60	1821	8.4	20
DT-9	2-16-60	11-60	1325	12.3	13
DT-9	5-7-60	11-60	1501	11.3	15
DT-5A	10-23-91	1-92	pumped	0.00	>15 (piston-flow) >10,000 (well-mixed)

possible recharge zone. A groundwater flow velocity of about 1260 ft/yr was calculated, based on an average groundwater age of 16 yr and a distance of 20,000 ft to the recharge zone. This flow rate contrasts with the average groundwater flow velocity beneath TA-49 of 345 ft/yr as determined from TA-49 aquifer performance tests. Using this information, the approximate distance to a possible local recharge area was calculated as 6300 ft, possibly along Water Canyon east of the Pajarito fault zone.

Many assumptions underlie the derived ages in Table 4.4-4 and one of the original investigators has expressed concern about inadvertent contamination of the groundwater sample during sample collection and analysis or during storage with higher activity samples unrelated to TA-49. However, the ages by Weir and Purtyman inferred are near the younger age limits (8 yr for DT-9 and 15 yr for DT-5A) calculated with a piston flow model and much younger than the 250 to 350 yr ages calculated with a model that assumed extensive mixing (Goff 1991,03-0008).

A sample of DT-5A water collected in October 1961 contained no measurable tritium, implying that:

- The Weir and Purtyman samples of 1961 indeed were contaminated by the sampling and analysis procedure,
- Local recharge and hydrology around the D-5A well is variable or has changed since 1961, or
- The reported tritium numbers are analytical artifacts.

Calculated ages from the 1991 sampling are >50 yrs (piston-flow model) and >10,000 yrs (well-mixed model) (Goff 1991, 03-0008). In any case, if the present water contains a component from very recent recharge, it is not large.

Additional hydrogeologic characterization relevant to evaluating the potential for vadose zone transport beneath MDA AB is proposed in Chapter 7. Specifically, analyses of pore water and groundwater for isotope ratio (oxygen-16/oxygen-18 and deuterium/hydrogen) and low-level isotope contents (tritium, plutonium, carbon-14, and chlorine-36) will be performed to define the origin, age, and recharge flux of water beneath MDA AB. Chapter 7 also proposes additional studies regarding potential flow across fault boundaries, fault zones, fracture systems, and other geologic structures in the vadose zone beneath MDA AB.

In Phase II of the TA-49 RFI, additional studies may be proposed to better define vertical mixing within the saturated zone, presence of multiple aquifers within the Santa Fe Group, source(s) and origin of groundwater, possible perched zones, and flux of recharge to the main aquifer. If necessary, additional hydrogeochemical studies also may be proposed to determine aquifer mixing and to evaluate chemical and isotopic changes as a function of depth.

As discussed earlier in Chapter 4, an additional deep well along the southern boundary of the Laboratory in the vicinity of TA-49 may be proposed in Phase II. In addition to the purposes mentioned previously, this well also would refine groundwater flow directions in the vicinity of TA-49. Additional aquifer performance tests also may be needed on existing TA-49 deep test wells to further define groundwater flow velocities and potential hydraulic boundaries across fault zones that may be present in the vicinity of TA-49.

Further evaluation of the presence of potential alluvial aquifers within Water and Ancho canyons near TA-49 is not needed for the TA-49 RFI if, as expected, Phase I investigations confirm that TA-49 contaminants have not (and are not likely to) enter the major canyon systems.

4.4.4 Hydrogeologic Properties of Bandelier Tuff

Hydrogeological properties of Bandelier Tuff such as porosity, saturated and unsaturated permeability, moisture content, hydraulic conductivity, and moisture characteristic curves are required for modeling the movement of fluids in the vadose zone beneath MDA AB. Geochemical data, including multiparameter absorption properties, particle surface area, vadose zone chemistry, and mineralogical characterization, are required for geochemical and solute transport modeling.

Most available data of these types are for crushed tuff and are from a variety of locations across the Laboratory. Little data on *in situ* properties at TA-49 are available. Of course, the accuracy with which data on crushed tuff, or from studies at other locations, can be extrapolated to TA-49 is subject to some uncertainties. The Framework Studies technical team currently is assessing the magnitude of this uncertainty.

Injection well studies at TA-50 (as described in Subsection 2.6.3 of the IWP) determined that four different forms of moisture movement can occur through moderately welded Bandelier Tuff with a typical effective porosity of about 38% by volume. Conclusions from this study include the following:

- No significant movement of moisture occurs at moisture contents below 6% by volume.
- Fluid movement is governed by diffusion in the moisture range 6 to 12% by volume.
- Movement is controlled primarily by capillary forces in the range 13 to 24% by volume. At the higher end of this range, gravity begins to supplement capillary forces.
- At 24 to 38% moisture content by volume, gravity is the dominant force driving the movement of moisture.

During the injection well tests, it was found that considerable pressure was required to inject water continuously into the tuff. In addition, it was found that while tuff near the injection point did become saturated, farther from the injection point the three slower, unsaturated-flow mechanisms dominated and limited the rate of movement of fluid (both horizontally and vertically). Further, it was found that when injection ceased, the zone of saturation was gradually depleted as unsaturated flow mechanisms dispersed the fluid from the point of injection. With time, the system stabilized and moisture content became sufficiently low that further moisture movement essentially ceased.

Two aspects of this model of water movement in the Bandelier Tuff are important for TA-49. First, the tuff effectively resists the rapid influx of water, supplementing the clay layer in the lower soil profile in restricting infiltration to the low rates that have been observed in field studies. Second, fluids accepted by the tuff are not transmitted rapidly down through the tuff, but rather are retarded strongly and dispersed outward through the tuff from the point of injection.

The following discussion summarizes existing information on hydrogeologic properties specifically relevant to TA-49.

4.4.4.1 Porosity

The various units of the Bandelier Tuff tend to have relatively high porosities. At TA-49, porosity ranges from 19 to 55% by volume for cooling Units 2, 3, 4, and 6, as designated by Weir and Purtymun. Porosity ranges from 30 to 60% by volume on other tuff samples collected within the Laboratory, generally decreasing for more densely welded tuff (see Subsection 2.6.3 of the IWP). The effective porosity, indicating the interconnected or fluid-accessible porosity, ranges from 18 to 52% for Bandelier Tuff.

4.4.4.2 Permeability

Permeability refers to the potential for fluid movement through porous or fractured media. Permeability values for the Tshirege member at TA-54, which were determined using in situ vacuum and water injection tests and laboratory analyses of cores, ranged from 0.1 to 0.6 darcies (Kearl et al. 1986, 0135; Stoker et al. 1991, 0715).

4.4.4.3 Moisture Content

The moisture content of tuff beneath the mesa top at TA-49 is low, generally ranging from 0.2 to 9 % by volume (Weir and Purtymun 1962, 0228; Subsection 2.6.3 of the IWP). Tuff moisture content was measured as 13 to 36% by volume in Beta Hole, a 180-ft test hole through alluvium in Water Canyon north of MDA AB. Even though this hole is located within about 20 ft of the stream channel, over a period of 30 yr it has never been found to contain standing water, even after prolonged periods of runoff. Infiltration into the borehole obviously is minimal even under conditions that would seem optimal for infiltration. The lack of infiltration apparently is related to sealing of infiltration routes by sediments and other native materials. Video logs appear to show that many fractures in the tuff at Beta Hole are filled with secondary deposits, whereas many fractures at Alpha Hole (189 ft deep, on the mesa top between Area 2 and 4) remain open below the soil zone.

As discussed in Subsection 4.4.1 of this work plan and in Chapter 2 of the IWP, numerous studies at TA-49 and other Laboratory sites have shown that tuff moisture content beneath mesa tops varies little below a depth of about 15 ft. The specific retention of the upper Bandelier Tuff at TA-49 ranges from 11 to 27% by volume, indicating a considerable field capacity for holding moisture (Weir and Purtymun 1962, 0228).

4.4.4.4 Hydraulic Conductivity

Hydraulic conductivity quantifies the permeability of the medium to fluids. Saturated Bandelier Tuff has a hydraulic conductivity ranging from 0.02 cm/hr for welded tuff to 1.1 cm/hr for nonwelded tuff (see Subsection 2.6.3 of the IWP). *In situ* hydraulic conductivity values measured at TA-54 ranged from 1.6 to 4.4 cm/hr as determined from air injection and vacuum tests, respectively (Kearl et al. 1986, 0135).

The hydraulic conductivity of unsaturated Bandelier Tuff varies with moisture content and has values 2 to 5 orders of magnitude lower than for saturated tuff (2 x 10-4 to 2 x 10-7 cm/hr for welded tuff and 0.011 to 1.2 x 10-5 cm/hr for nonwelded tuff) (Stoker et al., 1991, 0715). Based on the measured hydraulic conductivities, mass transfer rates calculated for the Tshirege member of the Bandelier Tuff at TA-49 range from 0.04 to 22 gal./day/ft^2 for consolidated samples and from 34 to 59 gal./day/ft^2 for unconsolidated samples (Weir and Purtymun 1962, 0228).

4.4.4.5 Moisture Characteristic Curve

One of the key relationships in describing the movement of water in unsaturated porous media is the water characteristic curve that relates water content of the solid phase to suction, tension, or negative pressure head. The moisture characteristic curve also is used to determine the relative hydraulic conductivity so that flux values can be calculated for water contents below saturation.

There have been numerous moisture characteristic determinations performed on crushed Bandelier Tuff but little *in situ* data are available, particularly for the low water content generally found in Bandelier Tuff (e. g., Abeele 1984, 0002). The applicability of crushed tuff data to intact tuff is open to some question. Moisture curves for intact cores from Mortandad Canyon have been reported (Stoker et al. 1991, 0715. Abrahams (1963, 0011) compared values for cores and cuttings from MDA T at TA-21 and concluded that cuttings could not be used to determine physical properties other than the water content. Similar conclusions were reached by Kearl et al. in a study at TA-54 (1986, 0135).

4.4.4.6 Hysteresis

The moisture characteristic curve for Bandelier Tuff is hysteretic, meaning that it has a different shape when the matrix is wetting than when it is drying. If a system exhibits significant hysteresis, the time history of wetting and drying will be required in order to predict pressure head from water content values.

Abrahams (1963, 0011) found that samples from MDA T at TA-21 exhibited hysteresis. For example, the tuff water content at a 333-cm pressure head had a value of 22% by volume on the wetting curve vs a value of 14 % by volume on the drying curve. Additional hydrologic information is given in Section 2.6 of the IWP and in reports on Mortendad Canyon tuff studies (Stoker et al. 1991, 0715).

4.4.4.7 Summary

The recent hydrogeologic review recognized the need for comparison of hydrogeologic results from laboratory and *in situ* methods on a Laboratory-wide basis (Kearl et al. 1991, 0652). The review also recommended further investigation of recharge processes involving the alluvial and main aquifers on a Laboratory-wide basis. Additional studies of this type currently are being carried out by the ER Framework Studies and Environmental Surveillance groups.

The presence of joints, fractures, and erosional surfaces at unit contacts at TA-49 in the Bandelier Tuff raises issues of interception and diversion of vertical flow by less-permeable horizontal surfaces, and enhanced flow across lithologic unit boundaries by fracture systems. Mapping of subsurface structure and hydrogeologic characteristics of the tuff beneath MDA AB is proposed in Chapter 7 to address these issues. The mapping will extend to at least a depth of 700 ft to ensure that the Tshirege-Otowi contact, a potential perching zone, is encompassed.

Moisture content will be measured and correlated with geologic features during all future TA-49 coring operations.

Although no springs or seeps are known or suspected at TA-49, during the TA-49 RFI, standard field geologic observation techniques will be used by site personnel to detect their possible presence. If springs or seeps are discovered, an evaluation may be needed of the potential for hydraulic connection to alluvial or perched aquifers or to the main aquifer.

4.5 Geology

Section 2.6 of the IWP and earlier sections of the TA-49 work plan discuss the regional setting and general geology of the Pajarito Plateau. The following discussion pertains to the geology in the immediate vicinity of TA-49.

4.5.1 Bedrock Stratigraphy

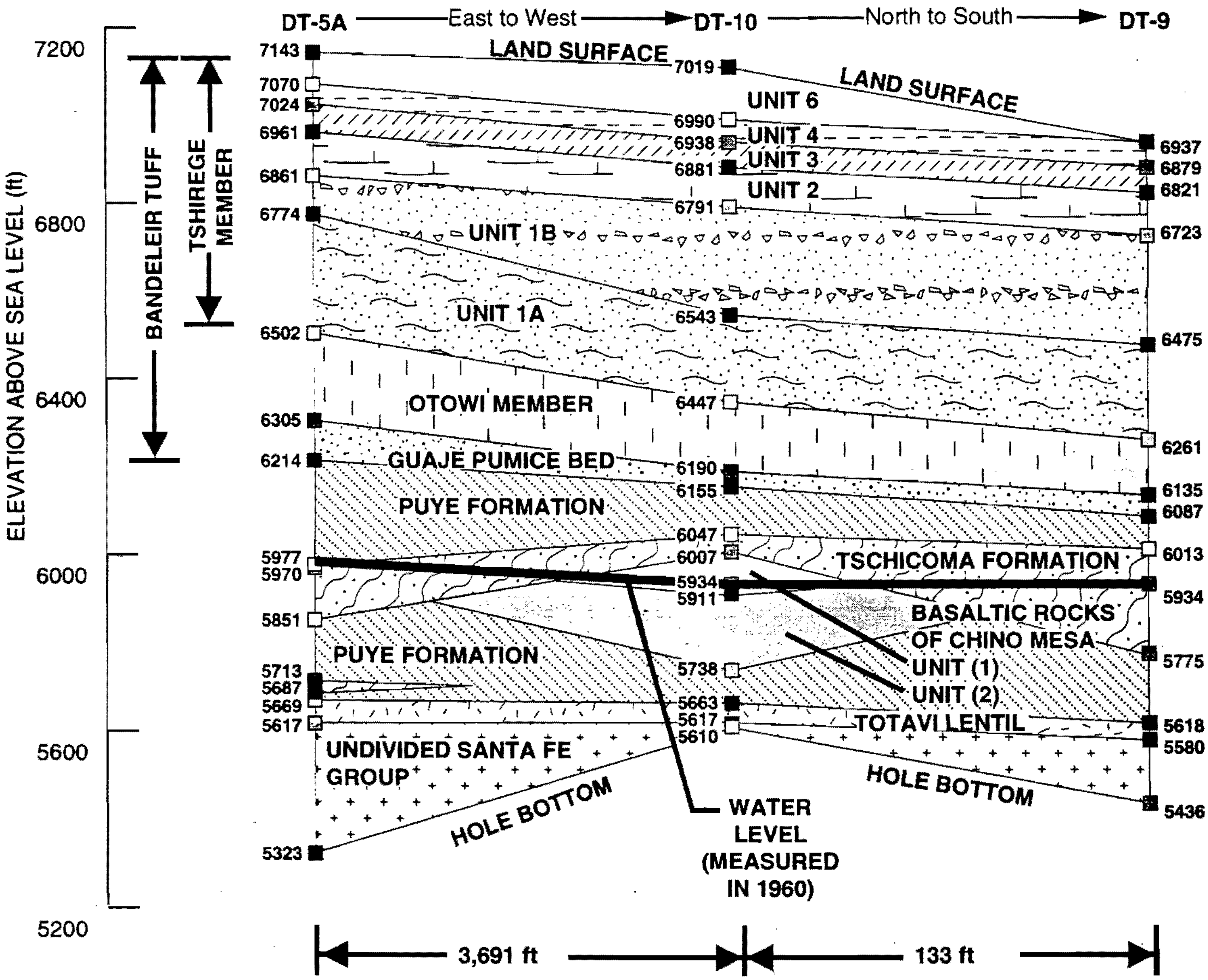
TA-49 lies on the east flank of the Jemez Mountains volcanic field and on the west margin of the Espanola Basin of the Rio Grande rift (see Figure 4.1-1). Factors that may affect the actual geometry and distribution of subsurface units beneath TA-49 include abrupt lateral and vertical facies variations in rock units, significant relief on paleotopographic surfaces on which rock units were deposited, and fault offsets in the older units that are masked by younger rocks which themselves show little or no displacement.

The rocks exposed in the area of TA-49 are entirely of the Tshirege Member (1.1 myr) of the Bandelier Tuff. Two relatively detailed geologic maps of the Bandelier Tuff exist for the TA-49 vicinity (E. Baltz in Weir and Purtymun 1962, 0024, Vaniman and Wohletz 1990, 0541). Each of these maps divides the Tshirege Member into units that are based mainly on physical characteristics imparted by the cooling history of ignimbrite flow units. A version of the Weir and Purtymun map is shown in Appendix G.

In 1959, the stratigraphy beneath TA-49 was mapped from the three deep test holes discussed earlier in this chapter. A surface map also was prepared that correlates TA-49 borehole data with surface geology. Schematic diagrams, compiled from logs for the three deep test wells and Core Holes 1 through 4, are shown in Figures 4.5-1 and 4.5-2. Additional borehole log data are contained in Appendix D. The rock column (from youngest to oldest) beneath TA-49 consists of:

- approximately 640 to 670 ft of the Tshirege Member of the Bandelier Tuff, which Weir and Purtymun divided into six units, based mainly on physical and mineralogical characteristics imparted by cooling. These units include multiple rhyolitic ignimbrite flow units; a widespread pyroclastic surge bed up to several feet thick; and numerous thin discontinuous surge deposits.
- approximately 200 ft of the Otowi Member of the Bandelier Tuff, which apparently includes two rhyolitic ignimbrite flows (Purtymun and Stoker 1987, 0204), but data and descriptions are sparse. The Otowi Member also includes up to 91 ft of the Guaje Pumice bed. Note that earlier workers (eg., Weir and Purtymun 1962, 0228; Griggs and Hem 1964, 0313; Purtymun and Stoker 1987, 0204) distinguish the Guaje Pumice as a separate "member" of the Bandelier Tuff.
- approximately 500 to 600 ft of deposits consisting of interbedded Puye Formation conglomerates and Tschicoma Formation latites and quartz latites.
- approximately 50 to 90 ft of the Totavi Lentil conglomerate (of the Puye Formation) with characteristic quartzite cobbles and other typical Precambrian lithologies.
- an undetermined thickness (at least 290 ft) of undivided siltstones and sandstones of the Santa Fe Group.

Inconsistencies exist in stratigraphic subdivisions of the Bandelier Tuff among various reports (Weir and Purtymun 1962, 0228; Baltz et al. 1963, 0024; Crowe et al. 1978, 0041; Vaniman and Wohletz 1990, 0541). Many of the stratigraphic discrepancies are caused by variations in nomenclature for different units. The TA-49 work of Weir and Purtymun was the first attempt to divide and correlate various Bandelier Tuff units, and their nomenclature is used in this work plan. However, as discussed below, Weir and Purtymun's 1962 hydrogeological report on TA-49 describes what now appear to be unusual stratigraphic relations given the current understanding of the stratigraphy of the area.



Units 2, 3, 4, and 6 were not noted in the log for well DT-5A so their thicknesses were extrapolated using the log for well DT-5P (located about 50ft from DT-5A).

Also note that the horizontal axis is not to scale.

Figure 4.5-1 Schematic of TA-49 stratigrapy compiled from logs of deep test wells DT-5A, DT-9, and DT-10 (adapted from Weir and Purtymun, 1962, 0228).

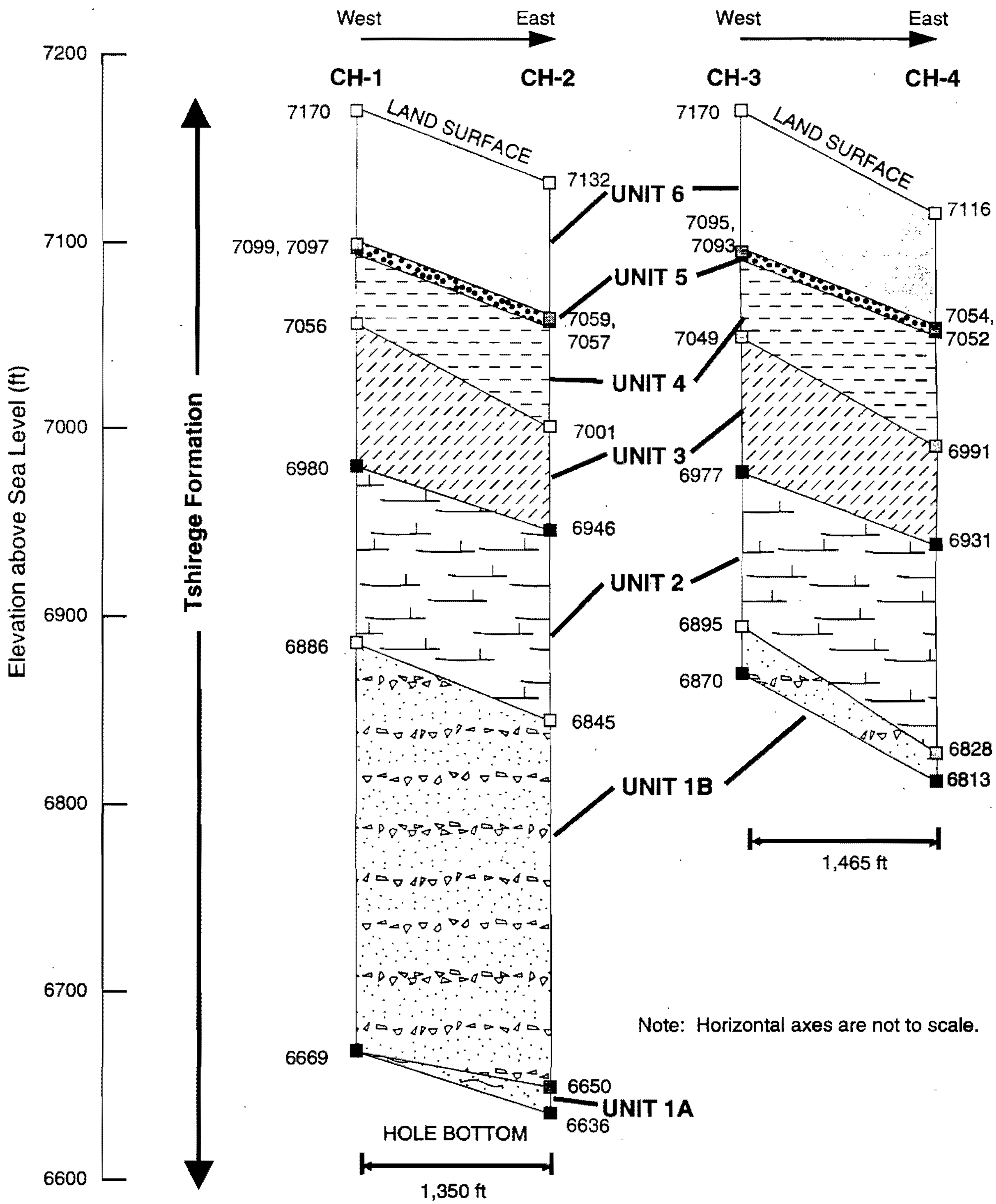


Figure 4-5.2 Schematic of stratigraphy beneath MDA AB from logs of Core Holes 1-4 (adapted from Weir & Purtymun, 1962, 0228).

Weir and Purtymun described the Guaje Pumice Bed in the DT-5A borehole as being 91 ft thick. Such a thickness at TA-49 is surprising because it is far thicker (by 60 ft) than at localities along the dispersal axis of the pumice fall (Griggs and Hem 1964, 0313; Self et al. 1986, 0375). If the Guaje Pumice beneath TA-49 is as thick as reported, it could strongly impact hydrologic behavior in the deep unsaturated zone beneath TA-49.

Other surprising features in the Weir and Purtymun logs are the relations of "Tschicoma Formation quartz latites and latites." With one possible exception in deep well DT-9, all of the "quartz latite or latite" flows encountered in the TA-49 wells are about 30 ft thick, and one is described as overlying basalts of Chino Mesa (Griggs and Hem 1964, 0313). Gardner et al. (1986, 0310) showed that the "quartz latites and latites" of earlier workers in this area are, in fact, dacites, which are relatively low temperature, high-viscosity lavas. Sequences of flows as thin as 30 ft for such lavas would be unusual. On the other hand, andesites are much more fluid lavas and typically form thin flow sequences.

A major center of Paliza Canyon Formation andesitic (with minor basaltic) volcanism lies about 6 km southwest of TA-49. Andesite flows are exposed within about 2 km of TA-49 (Goff et al. 1990, 0557). It is improbable that Tschicoma Formation rocks overlie basalts of Chino Mesa because the most recent Tschicoma volcanism occurred around 3 to 4 million yrs ago and most volcanism of the Cerros del Rio basalt field, which includes Chino Mesa, occurred around 2 to 2.5 million yrs (Gardner et al. 1986, 0310).

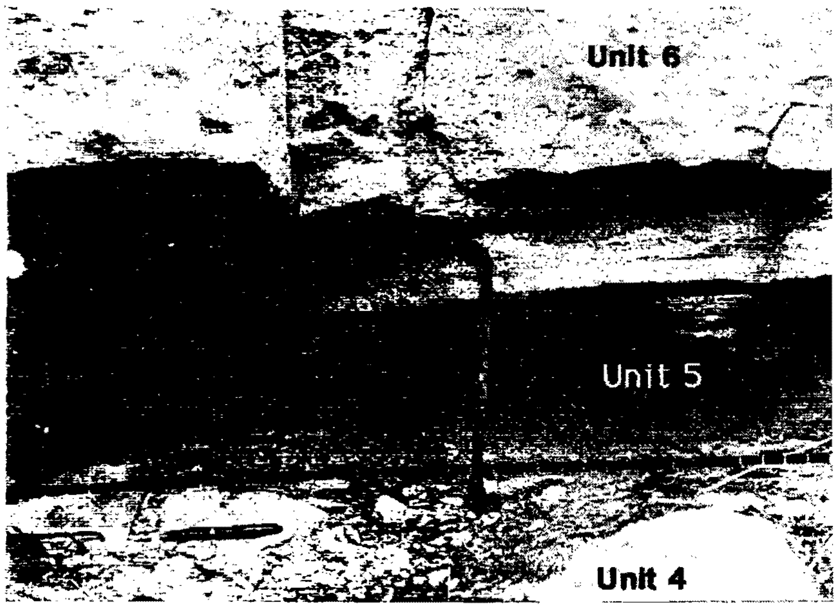
Whether or not the lavas penetrated by the TA-49 deep test wells are Paliza Canyon Formation, Tschicoma Formation, and/or Cerros del Rio basalts could be significant because the sources of these volcanics would lie to the south-southwest, west, and/or east of the site, respectively. Thus, depending on the direction to the volcanic source, the dips of the volcanic and volcaniclastic units could vary dramatically. The dips of these units could influence flow directions and, possibly, the recharge sources in the main aquifer.

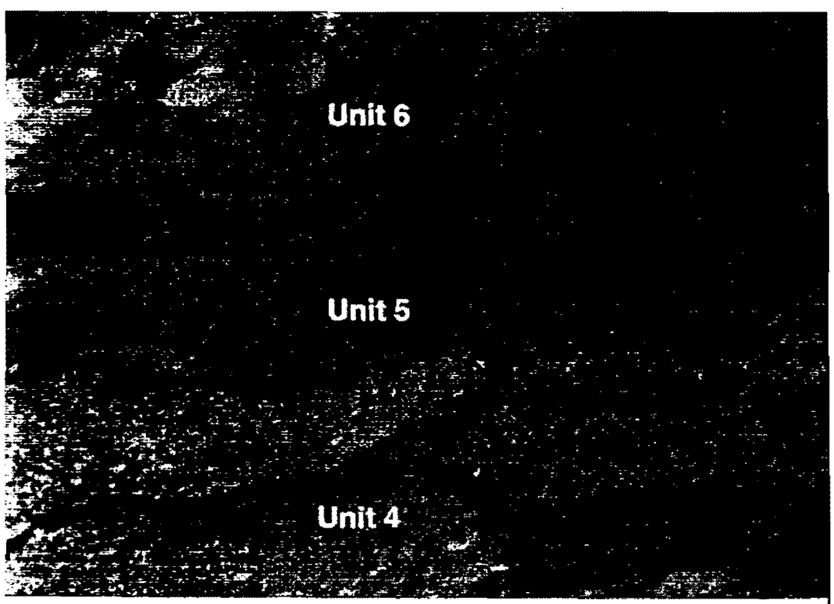
Noteworthy within the upper portion of the Tshirege Member at TA-49 is a widespread pyroclastic surge bed (designated as Unit 5 by Weir and Purtymun) which exists at a depth of about 60 to 80 ft beneath MDA AB . This bed is well exposed along the road from TA-49 to Water Canyon; it was mapped in the Area 10 Calibration Chamber shaft and in numerous experimental shafts in Areas 1 through 4 that were drilled from 1959 to 1961.

Figures 4.5-3 and 6.5-4 show the surge deposit in the Water Canyon outcropping and in the Area 10 calibration shaft. Previously described as a fluvial, crossbedded sandstone (Purtymun and Stoker 1987, 0204), this surge bed provides a useful site-wide stratigraphic marker. Of much greater significance is its potential as a migration pathway, because its permeability is much greater than that of the surrounding tuff and because its location is near the highly contaminated zone of many experimental holes in MDA AB, as described in Chapter 7 of this OU work plan.

Tuffaceous sediments of the Cerro Toledo rhyolite were deposited between the upper and lower members of the Bandelier Tuff throughout the Frijoles Mesa area. The Tsankawi Pumice is above the Cerro Toledo sediments and is distributed widely. The sediments include intercalated lenses of coarse boulder,

Figure 4.5-3 Ashflow units 4 and 6 and surge deposit unit 5 of the Tshirege Member of the Bandelier Tuff at TA-49 (adapted from Purtymun and Stoker 1987, 0204). The upper photograph shows the outcropping of Unit 5 one quarter mile northwest of well DT-9. The lower photograph shows units penetrated by the calibration shaft at Area 10 at a depth of about 60 ft below the surface.





conglomerates and undulating channel fill that may provide permeable horizontal pathways for fluid migration. Fluvial sedimentary rocks of the Puye Formation (which includes the Totavi Lentil) and the Santa Fe Group form the major hydrogeologic units beneath the Bandelier Tuff. Porous and permeable horizons within these sedimentary units are potential transport pathways. These rock units do not crop out at Frijoles Mesa, but excellent exposures occur in Los Alamos, Pueblo, Guaje, and White Rock canyons.

Uncertainties about the thicknesses, ages, and identities of deep stratigraphic units beneath TA-49 need to be resolved and correlated with data for other parts of the Laboratory. Resolution of stratigraphic uncertainties will lead to better understanding of the entire vadose zone beneath MDA AB. This activity will be facilitated by detailed documentation (including geologic mapping) of the physical and chemical properties of the Bandelier Tuff in both canyon exposures around TA-49 and boreholes beneath MDA AB, as proposed in Chapters 6 and 7. Two and three-dimensional representation and interpretation of existing TA-49 data and new data from the RFI, will be used to assist this evaluation.

As mentioned earlier, implacement of an additional deep borehole in the vicinity of TA-49 may be considered in Phase II of the TA-49 RFI. Continuous core samples to at least 1500 ft would allow the classification of stratigraphic relations and provide samples for petrographic and radiometric dating studies, as well as ensuring additional confidence in the shape of the piezometric surface beneath TA-49 and providing an additional deep monitoring well.

An additional deep borehole along the southern boundary of the Laboratory also would be useful for further constraining Laboratory-wide correlations of subsurface units and their geometries and attitudes. Therefore, siting and other requirements of an additional deep borehole will be coordinated with Framework Studies and Laboratory Environmental Surveillance groups and with future development of other OU work plans.

4.5.2 Geologic Structure

TA-49 is on the Pajarito Plateau, which lies at the western margin of the Espanola Basin of the Rio Grande rift, a major regional tectonic feature (Figure 4.1-1). The Pajarito fault system forms the western margin of the Espanola Basin and has experienced Holocene movement and historic seismicity (Gardner and House 1987, 0110; Gardner et al. 1990, 0639).

In addition to the main trace of the Pajarito Fault, other faults rupture the surface of the Bandelier Tuff near the Laboratory. The Water Canyon fault breaks the Bandelier surface west of TA-49. The Guaje Mountain fault has been mapped as far south as TA-55, about 2 miles north of TA-49 (Figure 4.5-4). This fault is projected to pass directly beneath TA-49. The Rendija Canyon and Guaje Mountain faults, exposed north of Los Alamos Canyon, are characterized by zones of gouge and breccia up to several meters wide, where there is visible offset of stratigraphic horizons.

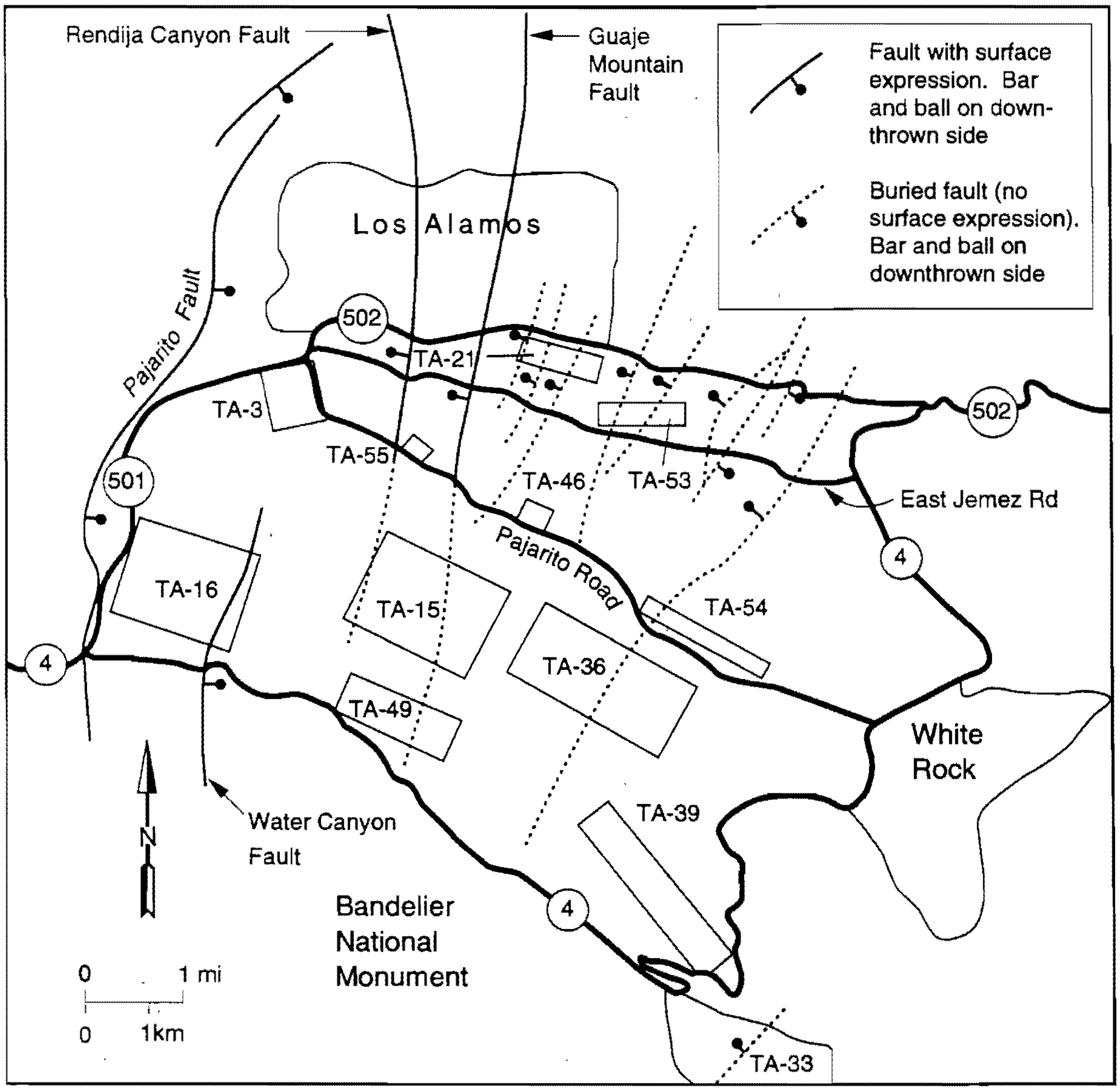


Fig. 4.5-4 Faults at selected Laboratory Technical Areas, Los Alamos, White Rock, and major roads (modified from Dransfield and Gardner (1985, 0082) and Gardner and House (1987, 0110).

A variety of data was integrated (Dransfield and Gardner 1985, 0082) to produce structure contour and paleogeologic maps of the pre-Bandelier Tuff surface beneath the Pajarito Plateau (Figure 4.5-4). Their maps reveal that subsurface rock units are cut by a series of down-to-the-west faults. The overlying Bandelier Tuff is not obviously displaced by these buried faults, showing that most displacements predate tuff deposition at least in the uppermost ashflow units.

Displacement of Bandelier Tuff on the Guaje Mountain and Rendija Canyon faults apparently decreases south of Los Alamos Canyon, and discreet faults are replaced by wide zones of intense brecciation and fracturing superimposed on the network of cooling joints in the Bandelier Tuff (Vaniman and Wohletz 1990, 0541).

Detailed fracture studies of the Pajarito Plateau have shown that fracture abundances and apertures increase along fault projections in the Bandelier Tuff. Unlike cooling joints, these tectonic fractures cross lithologic boundaries. Thus, tectonic fractures may provide more continuous and more deeply penetrating flow paths for groundwater migration than cooling joints can. Dransfield and Gardner (1985, 0082) estimate that about 140 ft of down-to-the-east offset on the pre-Bandelier Tuff surface exists along the projection of the Guaje Mountain fault near well DT-5A at TA-49.

The position of the Guaje Mountain fault at TA-49 is poorly constrained, and it is not known if the fault manifests as a tectonic fracture zone at TA-49. If the Guaje Mountain fault exists beneath TA-49, it could have a significant influence upon the site's vadose and saturated zone hydrology and thus would be important in the evaluation of infiltration pathways.

As discussed further in Chapters 5 and 7, the locations and character of subsurface faults and tectonic fracture zones in the vicinity of MDA AB should be determined because these structures are potentially important pathways for local recharge and contaminant transport through the vadose zone to groundwater.

Existing data from TA-49 boreholes, along with data from proposed boreholes around and under MDA AB (see Chapter 7), will be used for stratigraphic, hydrologic, and structural characterization. Unit correlation among boreholes and fracture analyses will better constrain the locations and character of faults that may exist beneath MDA AB. Correlation techniques will include mineralogical and geochemical fingerprinting and radiometric dating of volcanic units, as necessary.

As proposed in Section 6.2, fracture analysis will be carried out for artificial and natural exposures to identify and locate tectonic fracture zones. The approach used by Vaniman and Wohletz (1990, 0541) addresses all fractures and provides methods for distinguishing cooling and tectonic fractures. Systematic aerial photograph mapping of all fractures at a scale no less detailed than 1:1000 will complement the field studies. These studies will incorporate data from the detailed analysis of fracture maps of experimental shafts in MDA AB reported by (Weir and Purtymun 1962, 0228). If possible, the open shaft in Area 10 will be re-entered for characterization of fractures and the surge deposit (Unit 5 as designated by Weir and Purtymun) will be characterized. Studies of fractures and rock alteration will be carried out to evaluate the significance of fluid infiltration.

If required as part of Phase II of the TA-49 RFI or Framework Studies activities, a shallow east-west trench about 2000 ft in length may be proposed to supplement surface and core studies at TA-49. This trench would provide data on the geological variability at TA-49, including soil characteristics, structural geology, contact zones between different soil series and the Bandelier Tuff, as well as other geological information of value to both the TA-49 RFI and the Laboratory-wide ER program.

4.5.3 Seismicity and Volcanism

TA-49 lies within a region that possesses a rich geologic history including Late Pleistocene volcanic and very recent tectonic activity. Volcanism began in the Jemez Mountains volcanic field more than 13 myr ago and continued without significant hiatus until 130,000 yr ago (Gardner et al. 1986, 0310). Reports of questionable reliability describe what apparently were phreatic explosions and possible associated earthquakes within the volcanic field around 100 yr ago, as reported in the Santa Fe Daily New Mexican on October 15, 1882.

Given the long history of spatially focused, continuous volcanic activity, future volcanism may be expected in the region. Examination of the area's tectonic history indicates that future volcanism would likely occur some tens of kilometers north of TA-49 (Gardner and Goff 1984, 0719; Gardner 1985, 0721; Self et al. 1986, 0375). Although volcanic activity directly affecting TA-49 is very unlikely over time periods of interest, sufficient data to quantify the probabilities and nature of future volcanism are lacking.

Seismic studies are relevant to the TA-49 OU because of its proximity to major fault zones of the Pajarito Plateau. Future seismic activity affecting TA-49 is likely, but quantification of probabilities is beyond present capabilities. Recent work has shown that three faults in Los Alamos County are seismically active and capable of generating Richter magnitude-7 earthquakes (Gardner and House 1987, 110; House and Cash 1988, 0132; Gardner et al. 1990, 0639; Gardner and House 1991, 0720). However, it is not known how frequently these and smaller earthquakes occur, nor what the potential is for generating surface rupture and mass wasting within the confines of the Laboratory. In a recent TA-21 safety analysis, the likelihood of a Richter magnitude-5 earthquake was estimated to be about 1/100 yr (Rhyne et. al. 1991, 0742)

The evaluation of future volcanism that could affect TA-49 and other portions of the Laboratory would require a very large effort. An ongoing Laboratory study apart from the ER program is currently evaluating the probabilities of future seismic activity that may affect the Laboratory. This work, combined with TA-49 field studies proposed in Chapters 6 and 7 of this OU work plan, will facilitate evaluation of surface rupture and seismically induced mass wasting at this site. Because such research is already under way, there is no immediate reason to initiate a separate study for the TA-49 RFI.

4.6 Geochemistry

Principal contaminants of geochemical concern at TA-49 are beryllium, lead, uranium, plutonium, and americium. Because all of these contaminants are expected to sorb strongly to the site soils and sediments, physical transport is expected to dominate over solutional transport (Nyhan and Lane 1986, 0159). The general insolubility of TRU contaminants under environmental conditions and low moisture conditions of the OU also minimize the potential significance of solutional transport. Uranium is expected to be in the hexavalent state at the surface of the OU, but in MDA AB shafts uranium could be present in either the tetravalent state or the more soluble hexavalent state. Lead and beryllium are expected to be present in the divalent state and to have relatively greater solubility than the actinides will have.

There is a wealth of data related to radionuclide transport in volcanic tuff available from investigations of the proposed Yucca Mountain high-level waste repository, but few studies have been conducted on the Bandelier Tuff (e. g., see Thomas 1987, 0697). The Yucca Mountain data can be used to provide crude estimates of TA-49 retardation factors, even though the tuff of Yucca Mountain generally is much more highly welded than that of the Pajarito Plateau. General literature also is available on retardation factors for radionuclide, lead, and beryllium with porous materials. Examples of available retardation data for Yucca Mountain tuff are given in Table 4.6-1.

The limited existing data on retardation factors for tuff, soils, and sediments of the Pajarito Plateau are summarized in Section 2.6 of the IWP. No values are available for lead and beryllium (two key TA-49 contaminants), and only a few measurements have been made for radionuclides for any sorptive media collected at Laboratory locations. No retardation factors are available for sorptive media collected at TA-49.

The only cation exchange datum for any TA-49 medium is the ion exchange capacity for plutonium on TA-49 tuff (unit unspecified), which is reported to range from 0.5 to 4.0 meq/100g (Purtymun and Stoker 1987, 0204).

Some additional mineralogical and chemical characterization of soils, sediments, upper Bandelier Tuff, and fracture filling materials are needed for Area 11 and MDA AB to obtain geochemical data necessary for solutional transport modeling. It is particularly important to obtain estimates of hydraulic parameters and retardation factors for the principal TA-49 contaminants of concern (plutonium, uranium, lead, and beryllium).

4.7 Environmental Monitoring at TA-49

The Laboratory's routine environmental surveillance program is described in annual reports published by the Environmental Surveillance Group (EM-8). Data specific to Laboratory and regional background characterization of surface water, groundwater, soil and sediment, air quality, and ambient penetrating radiation levels are provided in the ESG reports. Three categories of monitoring stations have been defined.

TABLE 4.6-1

TYPICAL SORPTION RATIOS FOR YUCCA MOUNTAIN TUFF (ADAPTED FROM THOMAS 1987, 0697) AND OTHER SOURCES[a].

ELEMENT	SORPTION RATIO, R_d
Americium	>1000
Cesium	200-1200
Neptunium	5
Plutonium	300-1600
Strontium	20-80
Uranium	5

The sorption ratio, R_d, is used as a measure of sorption as a function of many parameters. It is defined as

$$R_d = \frac{\text{activity in solid phase per unit mass of solid}}{\text{activity in solution per unit volume of solution}}$$

and is expressed in units of m*l*/*g*. This ratio is often referred to as the distribution coefficient, K_d. Los Alamos prefers not to use this term, which implies equilibrium, because reversible equilibrium is usually not attained. If equilibrium is attained, then K_d is related to a retardation factor, R_f, in a uniform flowing system by

$$R_f = K_d\,(p/e) + 1,$$

where p is the bulk density and e is the porosity of the rock. Oxidizing conditions are assumed.

(1) Regional stations are used to establish regional background at some distance from Laboratory operations. The regional stations are located within the five counties surrounding Los Alamos County at distances up to 50 miles from the Laboratory.

(2) Perimeter stations are located closer to the Laboratory boundaries. These stations are not expected to be affected by routine Laboratory operations, although unexpected releases could affect these stations. They are used to confirm that any releases beyond the Laboratory boundary are evaluated and remain minimal, and to establish background closer to Laboratory operations.

(3) On-site stations are in proximity to Laboratory facilities and monitor the effect of releases close to the source. Such on-site stations at TA-49 are described in this section.

4.7.1 Bandelier Meteorological Station

As discussed in Section 4.2, the Bandelier Metereological Station located in the southeastern portion of TA-49 has provided data on air quality and meteorology since 1987.

4.7.2 Radiation Monitoring

Background neutron and total gamma fluxes are measured by detectors at a permanent monitoring station located at the main gate to TA-49 along State Road 4 (Air Monitoring Station 23). Levels of airborne radionuclides (tritium, uranium, plutonium, and americium) also are measured at this location and at a similar station located 100 ft northeast of Area 2 (Air Monitoring Station 32 within Area 12). During more than 10 yrs of operation, the State Road 4 station has indicated above-background radionuclide levels only for tritium, and then, only on a few occasions (e.g., see ESG 1989, 0308; ESG 1990, 0497; Purtymun and Stoker 1987, 0204). These events involved tritium levels far below any existing air quality guidelines and are attributable to releases elsewhere at the Laboratory. Station 32 has indicated levels of airborne plutonium and americium slightly above background only during one quarterly monitoring period. As discussed in greater detail in Chapter 7, the levels were far below DOE action guidelines and no doubt are associated with known surface soil contamination in Area 2.

A series of thermoluminescent dosimetry (TLD) stations located around MDA AB and a second array of background TLDs near well DT-9 have measured penetrating radiation levels at TA-49 for many years. The annual Environmental Surveillance reports indicate that doses at TA-49 are indistinguishable from regional background levels.

4.7.3 Surface and Groundwater Monitoring

As discussed elsewhere in this OU workplan, groundwater from deep test wells DT-5A, DT-9, and DT-10 has been sampled at least annually since 1960 as part of the Laboratory's environmental surveillance program, with no indication of contamination from the TA-49 OU.

Routine annual sampling of surface water from Water and Ancho Canyons is conducted at least annually at stations near State Road 4 approximately 2 miles downstream from TA-49 (Chapter 2 of the IWP), near Beta Hole in Water Canyon, and in springs and seeps along White Rock Canyon. Surface run-off is sampled in minor drainages around MDA AB on an opportunistic basis following intense precipitation events.

No contamination of surface and groundwater by TA-49 contaminants (except for Core Hole 2, as discussed in Chapter 7) has been indicated in the 30 years of monitoring. Typical analyses for water samples collected at TA-49 are given in Appendix D.

4.7.4 Soil and Sediment Monitoring

Two soil stations, one near well DT-9 and one across State Road 4 from TA-49, are sampled annually as part of the Laboratory's ongoing environmental surveillance program. Sediment stations, which also are sampled annually, are located near Beta Hole in Water Canyon, downgradient where Water and Ancho canyons are intersected by State Road 4, and at springs and seeps near the Rio Grande. Levels of radionuclides and selected metals measured at these monitoring stations over many years consistently are below detection limits or close to regional background (e.g., see ESG 1990, 0497). Appendix D contains representative results.

In 1975, an annual sediment sampling program was initiated at TA-49 as part of the Laboratory's routine environmental surveillance program. The location of soil and sediment stations at TA-49 are shown in Figure 4.7-1. The TA-49 sediment stations are sited in all the significant drainage channels from the main experimental areas now comprising MDA AB. Eleven stations were established in 1975 and a twelfth was added in 1981 when the surface drainage was modified.

Analytical results from the annual sampling program at TA-49 are available in Laboratory memoranda from 1975 to 1986 and in annual ESG reports since 1987. Plutonium data for two representative years (1983 and 1984) are summarized in Table 4.7-1 and other data are given in Appendix D of this work plan. Results are discussed in detail in relation to individual SWMUs in Chapters 6 and 7.

In summary, past soil sampling at TA-49 has shown that radionuclide and metal levels are slightly above regional background at a few sampling locations associated with Area 2 or Area 11 (e.g., station A-3). However, the data strongly indicate that contaminants are derived only from near-surface contamination and not from waste buried in the MDA AB shafts (for additional discussion of this important point, see Chapters 6 and 7 and the following references: Soholt

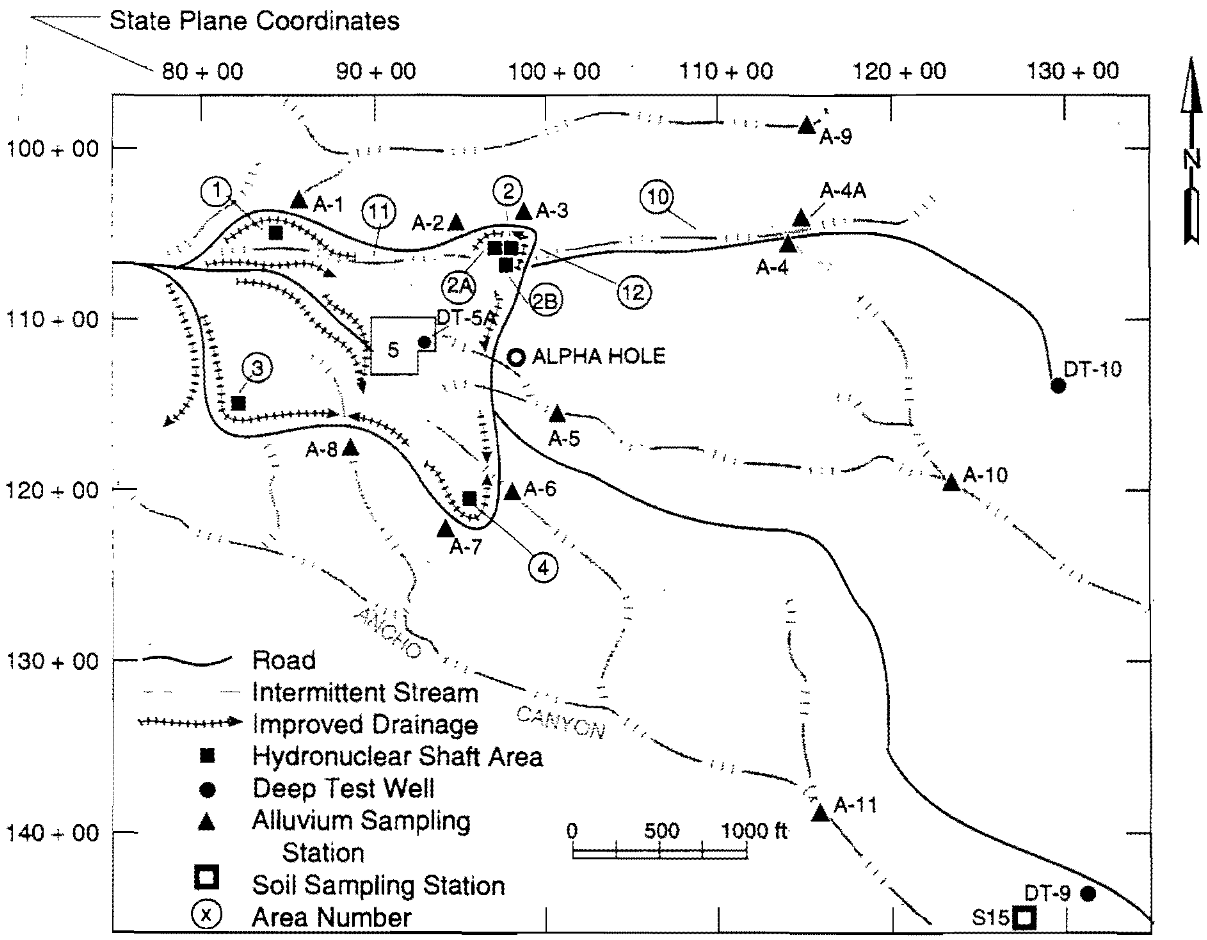


Figure 4.7-1 Locations of experimental areas, deep test wells, and soil/sediment sampling stations at TA-49 (adapted from ESG 1989, 0308).

1990, 0698; Purtymun and Stoker 1987, 0204; Purtymun and Ahlquist 1986, 03-0013; ESG 1990, 0497. The surface soil contaminant distribution appears to be highly localized and highly discontinuous and, in almost all cases, contaminant levels are found to be well below action levels pertinent to unrestricted site use (see Chapter 5).

Data from the entire network of routine surveillance stations at TA-49 and in adjacent canyons have given no indication that detectable levels of any contaminants have migrated beyond the OU boundaries.

4.7.5 Periodic Intensive Survey of MDA AB

As part of DOE's management of MDAs containing buried radioactive waste, an intensive study of surface soils and vegetation at MDA AB and several other areas of TA-49 was conducted in 1987 (Soholt 1990,0698). Results of this survey, referred to as the "A-411 survey," are discussed in detail in Chapters 6 and 7. Another intensive survey is scheduled for MDA AB in 1993 or 1994. The TA-49 RFI work plan has been designed to serve the purposes of the next

4.7.6 Foodstuff Monitoring

Honey and bees from a hive maintained at the TA-49 meteorological station were sampled in 1988 for radionuclides and a few heavy metals (ESG 1989, 0308). No levels significantly above regional background were found .

4.7.7 Special Studies

Special hydrogeologic and radiological studies of TA-49 have been carried out over the past 30 yr with emphasis on MDA AB and other SWMU areas. These are discussed on an individual-SWMU basis in Chapters 6 and 7.

4.8 Potential Pathways of Contaminant Migration

The principal potential migration pathways for surface units at TA-49 SWMUs over the assumed period of institutional control (100 yr) are surface erosion (water and air) and exhumation by burrowing animals (notably at Area 2), as will be discussed further in Section 4.11 and Chapter 7. For deeply buried wastes at MDA AB, infiltration and human intrusion are identified as potentially important scenarios over very long time frames.

4.9 Potential Receptors

This section identifies receptors for contaminants which potentially could be released from TA-49 SWMUs, based on pathways described in Subsection 4.9.3. Generic receptor scenarios for the Laboratory as a whole are being developed programmatically for inclusion in the 1992 IWP.

Table 4.7-1

PLUTONIUM RADIOCHEMICAL ANALYTICAL RESULTS FOR SOIL AND SEDIMENTS AT TA-49 IN 1983 AND 1984

Location	Year	^{238}Pu (pCi/g)	$^{239,240}Pu$ (pCi/g)
Soils			
TA-49/Bandelier boundary	1984	0.000 ± 0.002	0.024 ± 0.006
Near DT-9	1984	-0.006 ± 0.010	0.035 ± 0.010
Sediments			
Water Canyon at State Road 4	1984	0.002 ± 0.003	0.003 ± 0.004
Water Canyon at Rio Grande	1984	-0.001 ± 0.002	0.001 ± 0.002
Ancho Canyon at State Road 4	1984	0.003 ± 0.003	0.008 ± 0.004
Ancho Canyon at Rio Grande	1983	-0.003 ± 0.008	-0.001 ± 0.004
Frijoles at Bandelier	1983	0.001 ± 0.000	0.0011 ± 0.000
Frijoles at Rio Grande	1984	-0.002 ± 0.004	-0.003 ± 0.004
Sediments in TA-49			
Station 1	1983	0.004 ± 0.002	0.125 ± 0.016
Station 2	1983	0.006 ± 0.002	0.356 ± 0.036
Station 3	1983	0.086 ± 0.014	3.10 ± 0.240
Station 4	1983	0.001 ± 0.002	0.004 ± 0.002
Station 4A	1983	0.003 ± 0.002	0.009 ± 0.004
Station 5	1983	0.002 ± 0.002	0.041 ± 0.010
Station 6	1983	0.000 ± 0.002	0.018 ± 0.006
Station 7	1983	0.000 ± 0.000	0.000 ± 0.000
Station 8	1983	0.005 ± 0.004	0.007 ± 0.004
Station 9	1983	0.005 ± 0.004	0.071 ± 0.012
Station 10	1983	0.003 ± 0.002	0.006 ± 0.004
Station 11	1983	-0.005 ± 0.002	0.017 ± 0.006
Station 1	1984	-0.001 ± 0.004	0.003 ± 0.005
Station 2	1984	-0.001 ± 0.004	0.009 ± 0.005
Station 3	1984	0.012 ± 0.006	0.535 ± 0.062
Station 4	1984	-0.002 ± 0.036	0.007± 0.007
Station 4A	1984	0.000 ± 0.001	0.078 ± 0.017
Station 5	1984	0.001 ± 0.004	0.013 ± 0.007
Station 6	1984	-0.001 ± 0.004	-0.002 ± 0.004
Station 7	1984	0.002 ± 0.005	0.006 ± 0.006
Station 8	1984	0.001 ± 0.005	0.027 ± 0.010
Station 9	1984	-0.001 ± 0.003	0.001 ± 0.004
Station 10	1984	-0.001 ± 0.003	-0.004 ± 0.002
Station 11	1984	-0.004 ± 0.004	0.008 ± 0.009
Regional Background (sediments, maximum values)	1989	0.006	0.006

(a) TA-49 data from Purtymun and Ahlquist (1986, 03-0013). ± values represent twice the uncertainty term for that analysis. Negative results represent samples for which the net experimental count rate (sample rate - background) was less than zero. Background data are from Table G-32 of the 1989 ESG report (ESG 1990, 0497).

4.9.1 Local Populations

Section 2.5 of the IWP describes the population distribution within a 50-mile radius of the Laboratory. The IWP presents a table documenting population density at 9 distance intervals for 16 compass directions, based on 1989 projections from 1980 census data. Newer data from the 1990 census gives the total number of residents within the 50-mile radius of the Laboratory as 213,000. The closest residents to TA-49 are about 2 km to the southeast in Bandelier National Monument (BNL). About 50 people normally reside at BNL. BNL operates a remote radio transmitter near the main gate to TA-49, but no other use (including hiking trails) is currently made (or is planned) of BNL property south of TA-49 to Frijoles Canyon. Most people at Bandelier are visitors who spend only a few hours at the Monument. Visitation to BNL in 1990 was about 350,000 people.

The next closest residents to TA-49 are located 6 km to the east in the residential area of White Rock, which includes the developments of Pajarito Acres and La Senda. The town of Los Alamos lies approximately 7 km to the north. The 1990 census gives the population of White Rock as 6800 and of Los Alamos as 11,400.

State Road 4 is a lightly used, publicly accessible road along the southern boundary of TA-49. According to the Laboratory's Engineering Division, yearly average traffic on this road in the vicinity of TA-49 is about 700 vehicles per day. The point of closest public contact to a TA-49 SWMU (Area 3) is about 1500 ft.

The Laboratory currently has no employees who spend full time at TA-49. However during normal working hours, there usually are some employees on site. The site receives occasional use by a small number of employees (typically 10 or fewer) involved with high-power microwave and electrical grounding experiments, operation of the Bandelier Meteorology Station, Alternative Emergency Operations Center activities, and Hazardous Devices Team training. None of these activities are conducted in areas where significant contamination is expected. Laboratory service, environmental surveillance, and restoration personnel as well as other incidental visitors also are on-site on an occasional basis.

The nearest Laboratory site with continuous use is the TA-15 Phermex facility about 1 mile north of MDA AB. According to the TA-15 operating group leader, Phermex currently has about six regular employees present during a normal working day. About 70 workers typically work at the rest of TA-15.

4.9.2 Land Use

Current uses of TA-49 are as a buffer zone for adjacent firing sites and for the limited purposes described in the preceding section. The possibility that the area encompassed by MDA AB and its immediate vicinity might revert to the general public is very unlikely under foreseeable circumstances. Other portions of TA-49 conceivably could revert to the National Park Service (BNM) or the US Forest Service (Santa Fe National Forest). In this case, possible exposure of recreational users would need to be considered by risk assessment before land transfer or alternative use occur. Future residential use of TA-49 is specifically not considered a credible future land use scenario for the purposes of this OU work plan.

Land use in and around the Laboratory is described in Section 2.5 of the IWP. The likelihood is high that future land use in the vicinity of TA-49 will not change significantly over the 100-yr period assumed for institutional control. Also, land use outside the Laboratory boundary and in the vicinity of TA-49 also are expected to remain stable for the indefinite future. No significant changes in land use at the adjoining portions of BNM or in White Rock are expected. Thus, site workers will continue to represent the maximally-exposed population at the TA-49 OU.

4.9.3 Routes of Exposure and Pathway-specific Receptors

For each contaminated TA-49 medium identified in Section 4.11, exposure routes for potential receptors are identified. As new data are obtained and assessed in the TA-49 RFI, the focus on particular exposure scenarios may need to be reconsidered.

present, the most critical human populations exposed to TA-49 contaminants are on-site workers. In the case of contaminated surface soils, inhalation, dermal contact, and incidental ingestion are identified as the most likely human exposure scenarios that need to be considered. Less plausible exposure scenarios involve the ingestion of and dermal contact with contaminated water.

Workers in adjacent TAs, BNM visitors, State Road 4 travelers, and area residents are much less likely to be exposed to TA-49 contaminants than are on-site workers. Intruder scenarios are assumed to be unimportant in the near term at TA-49 because of existing controls at the site and the distance to points of public access. Likewise, the food chain scenario is assumed to be insignificant for TA-49 while institutional control is maintained.

In the absence of Laboratory control, the exposed on-site human population is assumed to be connected with recreational use by BNL. In addition to the above scenarios, ingestion of contaminated soil and vegetation then becomes a potential exposure mechanism. Human intrusion scenarios (for example, deliberately or accidentally drilling into or excavating MDA AB) also would have to be considered if institutional control is lost.

Exhumation and dispersal of contaminated soils by burrowing animals presently occurs at Area 2 of TA-49, and thus burrowing animals are known biological receptors. Uptake and dispersion of TA-49 soil contamination by plants also can occur at areas of TA-49 with known soil contamination. In addition, such biological activity potentially can lead to enhanced human exposure through direct contact, inhalation, or ingestion.

No significant direct human exposure routes (other than those created by deliberate excavation of the wastes during remediation) over institutional time frames were identified for contaminants held in deeply buried waste units at TA-49. Over longer time frames, surface water infiltration to groundwater and intrusive scenarios must be considered because of the magnitude of the source term in MDA AB.

4.10 Public Health and Environmental Impacts

TA-49 SWMUs represent no imminent threat to human health or environment, according to an assessment of currently available data. This statement is supported by the low Hazard Ranking System (HRS) and modified HRS scores that were derived by DOE and EPA during CEARP Phase I when TA-49 was considered under the prioritization process specified by CERCLA and DOE Order 5484.1A (Purtymun and Stoker 1987, 0204). The overall derived migration mode scores are 6.7 (based on beryllium) and 5.3 (based on plutonium). These values reflect relatively low potentials for contaminant migration and are far below the minimum cutoff score of 28.5 set for inclusion on the National Priority List (NPL).

As part of the Laboratory's annual environmental surveillance activities, estimates are made of radiation exposures and consequent health risks presented by Laboratory operations to local populations. These estimates are based on known releases from operating facilities and on data collected at monitoring stations within and around the Laboratory. Locations of radiation monitoring stations at or near TA-49 are discussed earlier in Chapter 4. Although annual risk assessments prepared for the surveillance program are performed for the Laboratory as a whole, they are summarized here to provide a perspective on potential risks related to TA-49, which is a small part of the Laboratory.

The environmental surveillance report for studies in 1989 (ESG 1990, 0497) indicates that the DOE Radiation Protection Standard (RPS), under which the Laboratory operates, limits incremental radiation doses (effective dose equivalent) from all Laboratory operations to 100 mrem/yr from all pathways. In addition, the air pathway exposure route is limited to 10 mrem/yr in accordance with EPA requirements. For comparison, the average background radiation exposure to individuals living in Los Alamos is approximately 336 mrem/yr from all sources. TA-49 radiation monitoring stations have never measured radioactivity levels more than 1% of applicable DOE or EPA guidelines.

The ESG report for environmental surveillance during 1989 estimates that the maximum incremental risk of cancer from radiation to Los Alamos residents as a result of all 1989 Laboratory operations is about 1×10^{-8} (ESG 1990, 0497). Of that risk, the contribution from TA-49 is exceedingly small.

New data relevant to TA-49 collected during the RFI will be used to further evaluate public health and environmental impacts for the near-and long-term time frames. It is anticipated that for all potential release sites except MDA AB and possibly Area 11, the RFI will show that contaminant levels are below action levels appropriate for unrestricted site use.

4.11 TA-49 OU Site Conceptual Model

4.11.1 Development of the Conceptual Model

In this section, a site conceptual model of potential contaminant release, transport, and routes of exposure for the TA-49 OU is summarized. The model is based on present understanding of the TA-49 OU and considerations developed earlier in this work plan. The generalized model is presented diagramatically in Figure 4.11-1 and in summary form in Table 4.11-1. Figure 4.11-2(a-d) summarizes conceptual models for the specific categories of SWMUs existing at TA-49, and Figure 4.11-3 shows a site conceptual model for the hydronuclear shafts at MDA AB. The relationships between contaminated media, pathways, and receptors are illustrated in Figures 4.11-4 and 4.11-5. Key elements in these models include the sources, release mechanisms, receptors, transport pathways, and resulting exposure scenarios for each pathway. These issues are developed in further detail in portions of Chapter 5 and in Chapters 6 and 7 where individual SWMUs are described in detail and SWMU-specific field investigations are developed.

The SWMU-specific field investigations outlined in Chapters 6 and 7 are based on the conceptual models. Data acquired from Phase I of the RFI will provide information needed first to assess current conditions at each SWMU, and thereafter, to refine the conceptual models. Phase I data then provides the basis for initial risk assessment, preliminary modeling of contaminant distribution and transport, and design of Phase II investigations (when required), and ultimately leads to corrective measures selection. It is expected that assessment of Phase I data for the TA-49 OU will allow the current SWMU list to be reduced to a smaller number that includes only those SWMUs from which contaminant release above action levels actually has occurred, or which have source terms with unacceptable potential for migration and consequent risk to human health and environment. The field investigations also will identify the magnitude of past contaminant transport along each pathway and will allow the relative importance of future transport to be evaluated.

At present, the model for the TA-49 OU is conceptual and serves to focus the initial RFI investigation on contaminant sources and environmental factors that can influence transport. When the assessments discussed in the preceding paragraph have been made, the need for application of quantitative mathematical models to describe contaminant transport will be evaluated.

Because MDA AB contains by the far the great preponderance of site contaminants, it forms the primary focus for the investigation. If data acquired in the initial phase of the RFI demonstrates that a different focus is appropriate, the conceptual model will be revised and investigations in subsequent phases will be planned accordingly.

4.11.2 Elements of the Conceptual Model

Key considerations in the TA-49 site conceptual model are summarized in the following paragraphs. These considerations are addressed for each SWMU in Chapters 6 and 7.

<u>Land use/time frame assumptions:</u> Under current land use patterns in the vicinity of TA-49, no pathways or receptors are of significant concern over the 100-yr time frame limit for institutional control specified by 40 CFR 191 and DOE order 5820.2A. However, if land use patterns change in the future (for example, as a result of land transfer to Bandelier National Monument), or if dramatic climatic changes occur, long-term exposure pathways such as

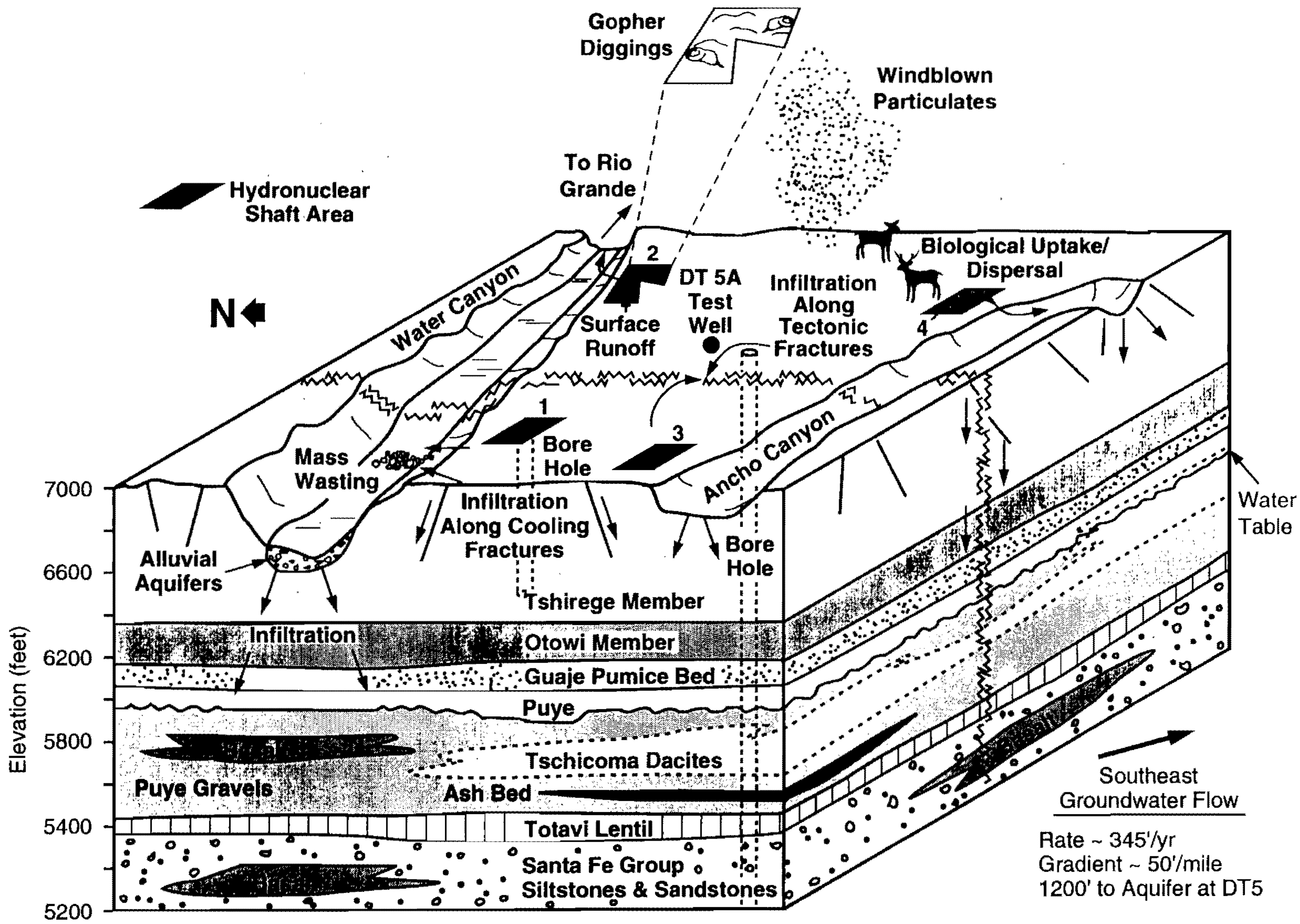


Figure 4.11-1 Generalized conceptual model diagram of the TA-49 operable unit

TABLE 4.11-1

SUMMARY OF TA-49 SITE CONCEPTUAL MODEL ELEMENTS

Pathway/Mechanism	Concepts/Hypotheses
Atmospheric Resuspension	• Entrainment is limited to contaminants in surface soils and sediments. • Entrainment and deposition are affected by soil properties. • Atmospheric conditions affecting entrainment, dispersal, and deposition include wind speed, direction, and stability.
Surface Water Run-Off	• Precipitation that does not infiltrate will become surface run-off, evaporate, or transpire. • Surface run-off is concentrated by natural topographic features or man-made diversions. • Local topographic lows can cause water to pond on the mesa top, but most surface water will flow into canyons. • Solutional contaminant transport by surface run-off can occur, but mass movement by suspended particles or local bed sediments will dominate. • At the present time, surface run-off is unlikely to carry contaminants above action levels beyond the TA-49 boundary or into major side canyons.
Soils/sediments	• Surface soil erosion and sediment transport is a function of run-off intensity, vegetation, topography, and soil properties. • Contaminant movement will be retarded by sorption onto natural organics, clays, and other highly sorptive phases. • Contaminants dispersed on surface soils can be transported by run-off and concentrated in sedimentation areas of drainages. • Erosion of drainage channels can extend back to the source area.
Alluvial Aquifers	• Ephemeral alluvial aquifers may exist in Water and Ancho Canyons but are unlikely to receive detectable contaminants from TA-49. • Surface run-off in canyons may infiltrate into sediments of channel alluvium. • Flow in alluvial aquifers under saturated conditions will be down-channel and can be represented by a porous medium continuum model. • Water in alluvial aquifers may enter the underlying tuff. The process will depend on the properties of the interface between the saturated alluvium and unsaturated tuff.

Vadose Zone Transport/Infiltration	• Infiltration into surface soils depends on the rate of rainfall or snowmelt, antecedent soil water status, depth of soil, rate of transpiration, antecedent soil and tuff water content, and soil and tuff hydraulic properties. • Infiltration into the tuff depends on the unsaturated hydraulic properties of the tuff. • Joints and fractures in the tuff may provide additional pathways for infiltration to enter the subsurface regime. • Unit contacts and unit characteristics (e.g. surge unit) can strongly affect lateral flow. • Movement of contaminants by liquids in the unsaturated zone would occur primarily by suspended solids. • Fractures may affect liquid transport. Their role is dependent upon soil water content. Above a critical water content, fractures are expected to facilitate flow and transport. Below the critical water content, only unsaturated flow is significant and rock matrix properties will dominate the hydraulic response.
Saturated Flow	• Significant saturated flow in tuff is unlikely to be a factor at TA-49. • Transient rather than steady state conditions may describe the hydraulic character of the near surface, but equilibrium conditions prevail at depths below about 20 ft. • Liquid flow in tuff under ambient conditions can be represented by a porous medium continuum model. • A non flowing condition exists below the influence of transient surface moisture effects. • Contaminant movement will be retarded by sorption onto natural organics, clays, and other sorptive media in the soils and tuff.
Vapor Transport	• Vapor-phase processes are not important for any TA-49 contaminants; volatile TA-49 contaminants are present only in very limited quantities.
Lateral Flow at Unit Contacts	• Contrast in hydraulic properties between stratigraphic units may divert flow laterally, or cause a perched water zone to develop. • Laterally diverted flow may find surface expressions as springs or seeps. • Perched water zones may provide localized areas where saturated flow conditions occur.
Erosive Exposure/Soil Erosion	• The erosion of surface soils is dependent on soil properties and vegetative properties, slope and aspect, exposure to wind, and run-off intensity and frequency.

	• Erosion is controllable by natural and artificial surface features. • Depositional areas as well as erosional areas are determined by the above factors.
Mass Wasting	• The loss of rock from canyon walls is a discontinuous, observable process. • The present rate of mass wasting is too slow to be significant at TA-49, even on a very long time frame.
Biological Transport	• Burrowing animals (mainly pocket gophers) represent the primary biological dispersal mechanism for TA-49 contaminants. • Biologically exhumed material can be dispersed subsequently by surface water, aerial resuspension and vegetation.
Receptors	• On site workers represent the maximally exposed populations while institutional control is maintained. • Recreational users are assumed to represent the maximally exposed population if institutional control is lost.
Containment Release Mechanisms	• Surface erosion (run-off and resuspension) and burrowing animals represent the most significant (low-risk) current release mechanisms. • Over very long time frames, infiltration and human intrusion scenarios must be considered.

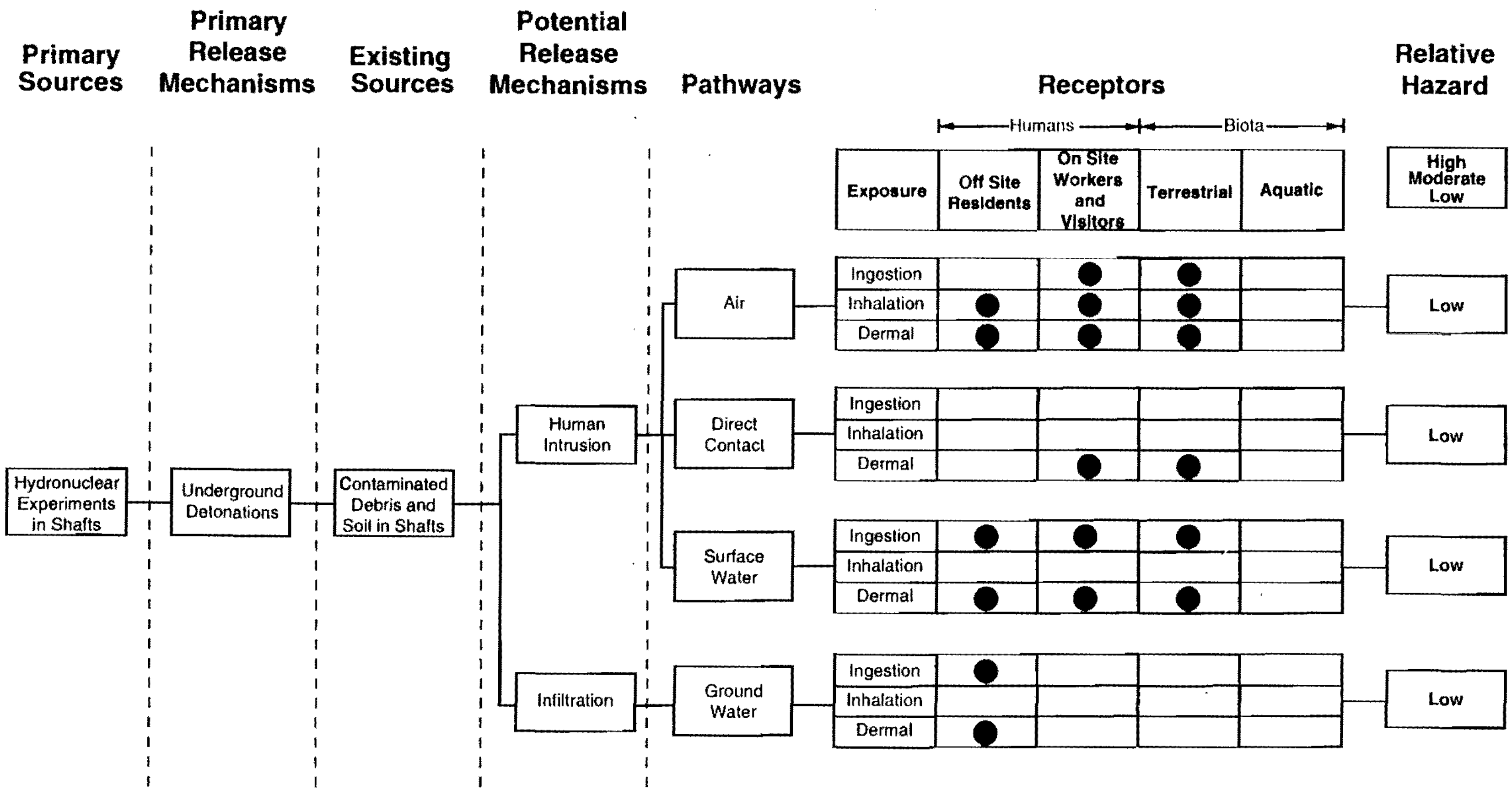


Figure 4.11-2 (a) TA-49 SWMU-specific conceptual models. Hydronuclear shafts. The relative hazards are judgementally based on available information and assume institutional control.

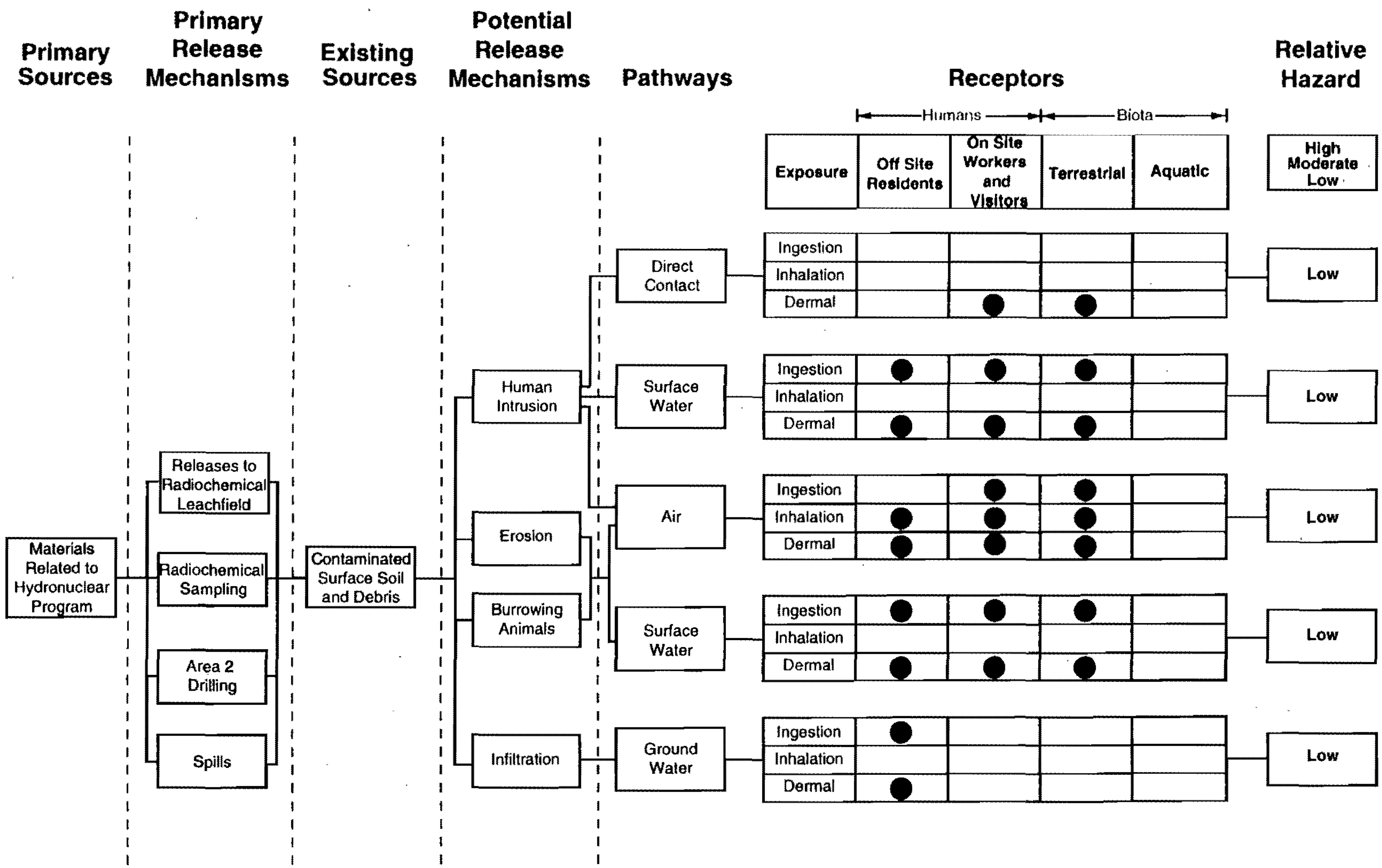


Figure 4.11-2 (b) Surface Soil Contamination. The relative hazards are judgementally based on available information and assume institutional control.

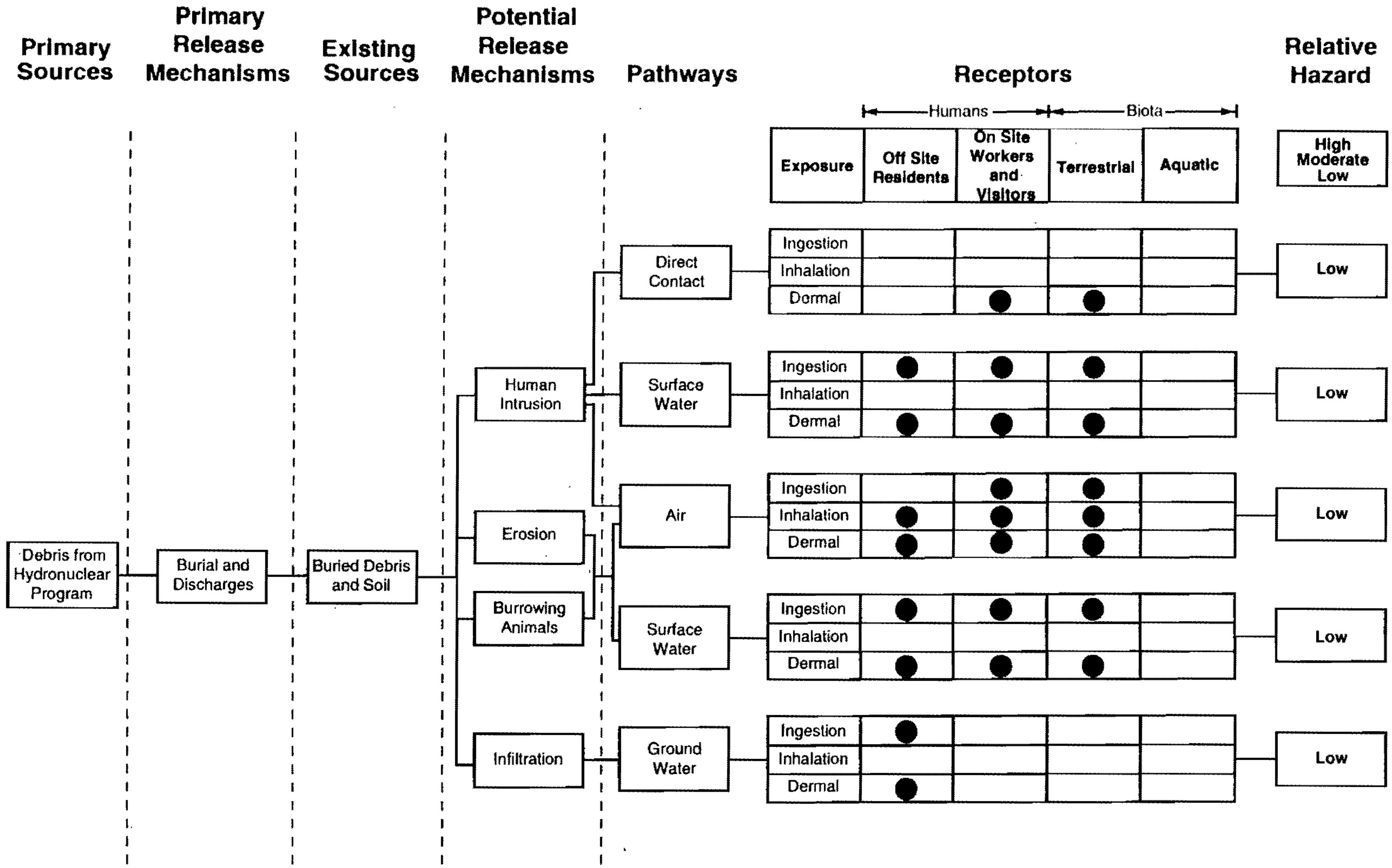


Figure 4.11-2 (c) Landfills and sumps. The relative hazards are judgementally based on available information and assume institutional control.

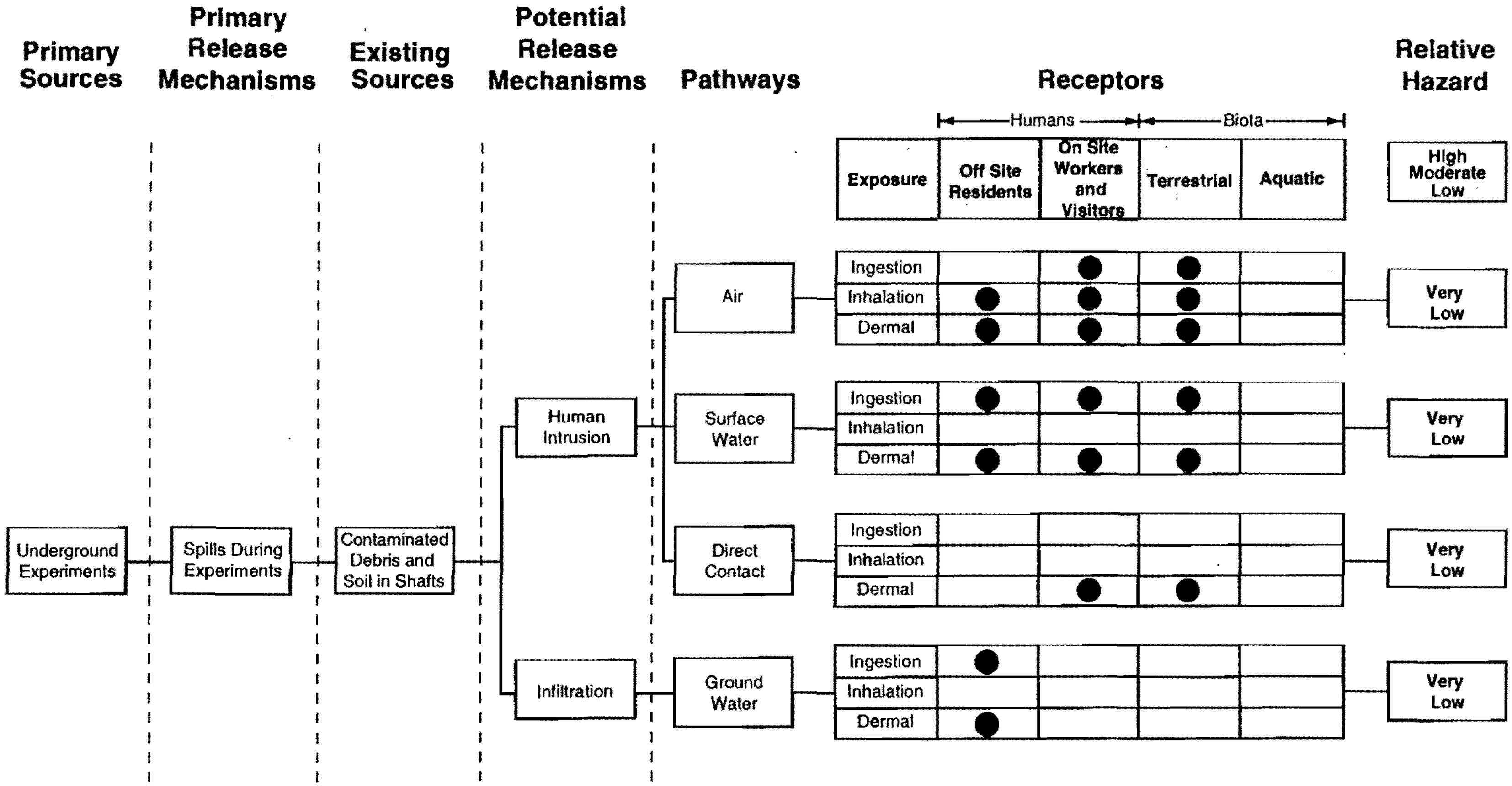


Figure 4.11-2 (d) Underground shafts (other than MDA AB). The relative hazards are judgementally based on available information and assume institutional control.

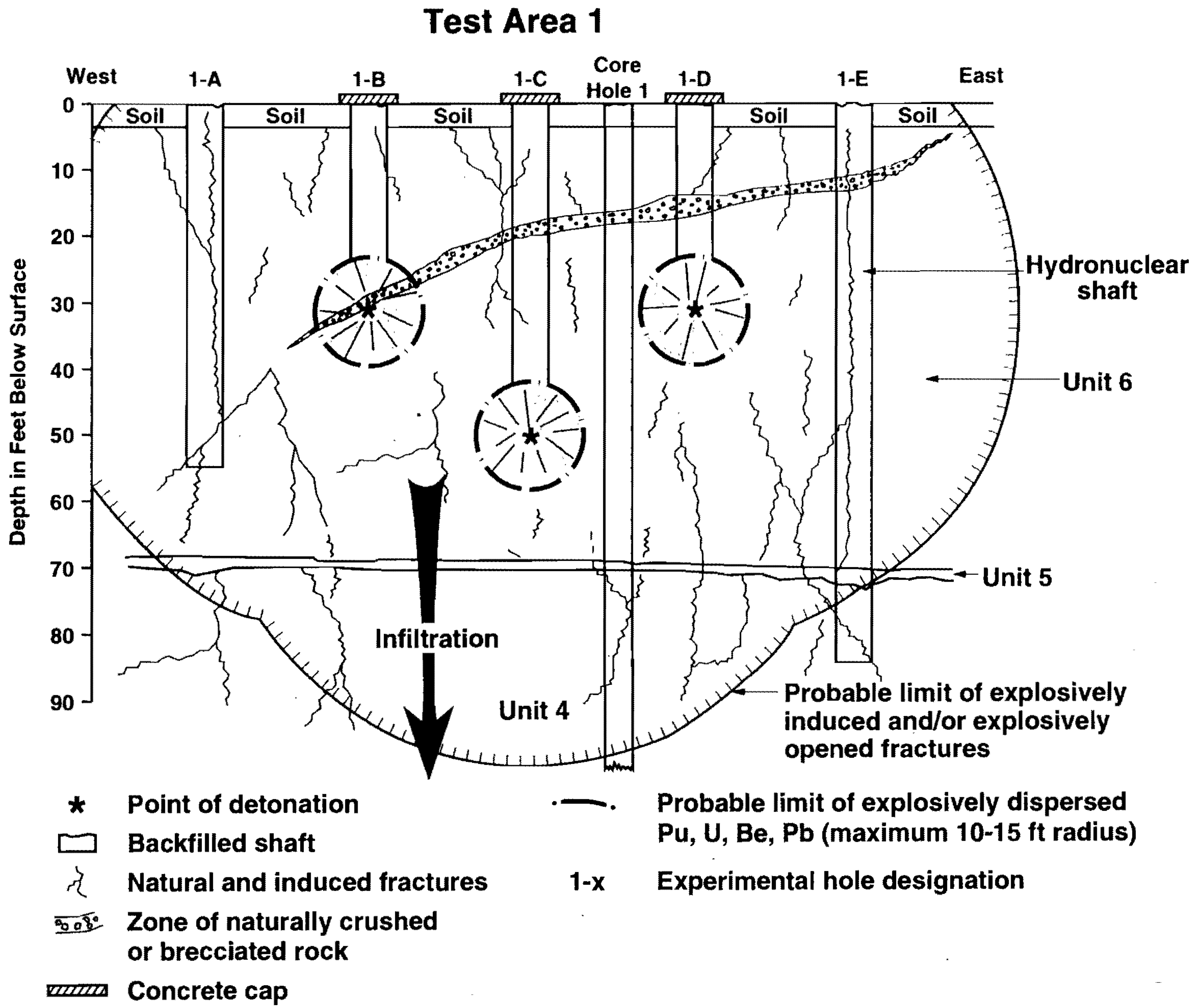
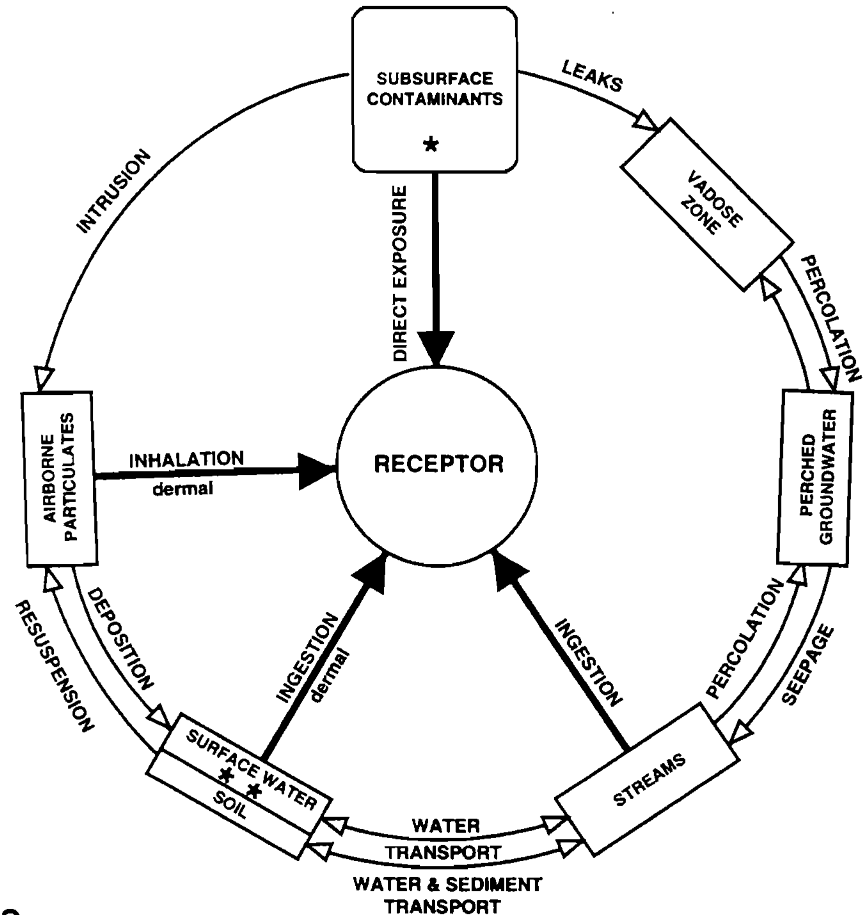


Figure 4.11-3 Conceptual model for the hydronuclear shafts. Stratigraphic units are labelled according to Weir and Purtymun (1962, 0228).



NOTES:

* Contaminants that become exposed to the surface follow the surface contaminant conceptual model.

** Seeps, streams, and temporary water.

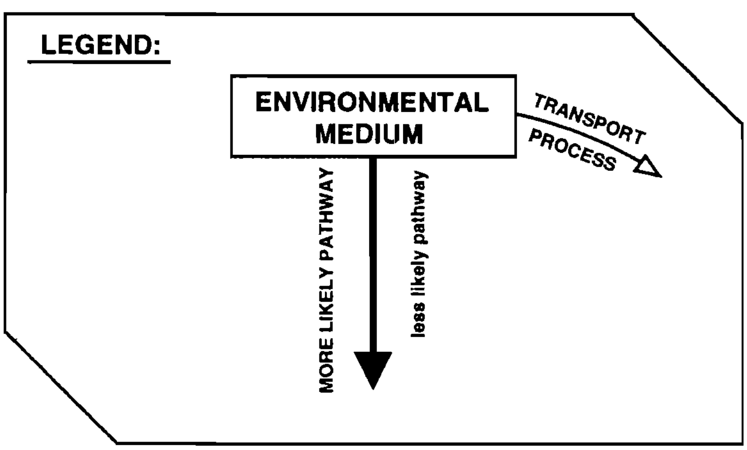
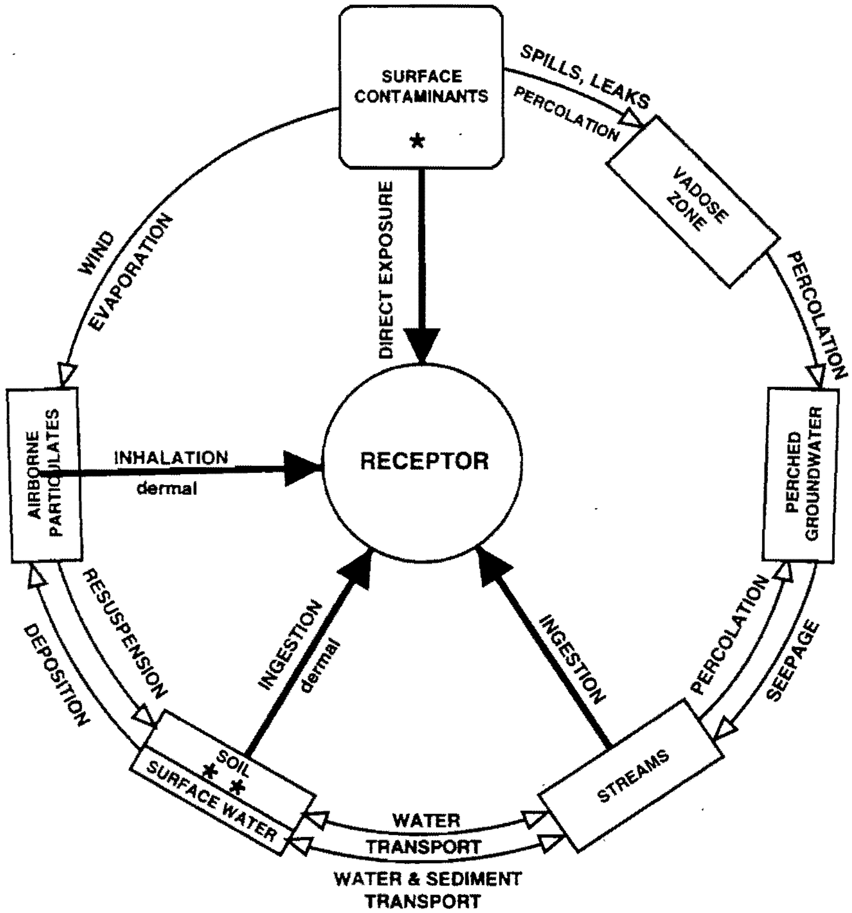


Figure 4.11-4 Conceptual model of subsurface contaminant transport from the TA-49 OU to potential receptors.



NOTES:

* Seeps, streams, and temporary water.
** Pathway of minimal potential risk.

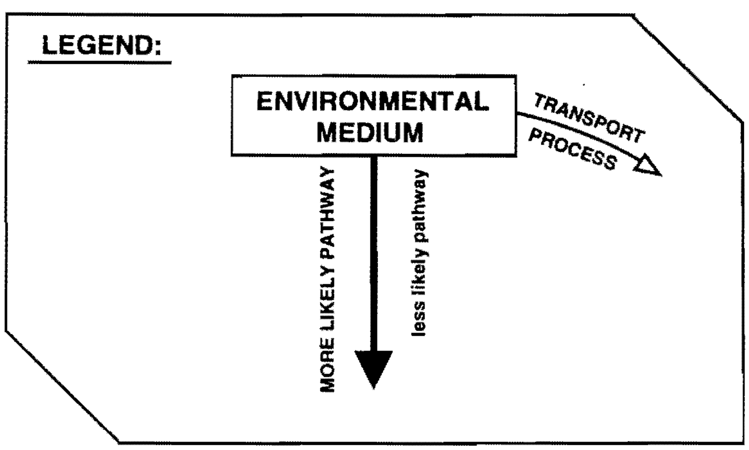


Figure 4.11-5 Conceptual model of surface contaminant transport from the TA-49 OU to potential receptors.

infiltration or intrusion will need to be considered.

Conditional Remedy/Corrective Measures: As discussed earlier in this work plan, it is probable that the conditional remedy of capping/stabilization, accompanied by corrective measures (as appropriate) over time, will be found to be the most appropriate remedial action for MDA AB.

Erosional processes: Erosion of TA-49 near-surface units and consequent transport of precipitation by runoff is a potential low-exposure pathway. Thus, the nature, quantity, and distribution of surface and near-surface contamination needs to be characterized in Phase I of the RFI. In addition, the roles of precipitation run-off and soil erosion and the subsequent movement and fate of water and contaminants in the TA-49 environment needs to be investigated. Aeolian processes represent another low-exposure pathway to be addressed, but they probably are of lesser significance than the surface water pathway. Canyon retreat processes are too slow and visually obvious to be of significance for contaminant transport even over very long time frames.

Infiltration: In general, transport of contaminants through the unsaturated zone to groundwater probably is not a pathway of immediate concern at TA-49, based on the great depth to the main aquifer and extensive past site characterization efforts which indicate the lack of credible groundwater pathways. The magnitude of the source term and the uncertain source of water in Core Hole 2, however, requires that this general hypothesis be tested for MDA AB. Therefore, the significance of infiltration will be addressed during the RFI for MDA AB. Shallow infiltration also needs to be addressed for the leachfield at Area 11, where small liquid radioactive releases may have occurred. Degraded caps, boreholes, and fracture systems represent potential transport pathways of buried contaminants by infiltration of surface water, over long time frames. These issues also will be addressed at MDA AB during the TA-49 RFI.

Biological activity: The exhumation of contaminated soil by burrowing animals currently occurs at Area 2 of TA-49. This creates a pathway for contaminant dispersal by surface runoff and infiltration, as well as through uptake and dispersal by animals and vegetation. The environmental significance of this activity will be addressed during the TA-49 RFI.

Human intrusion: Accidental or deliberate human intrusion into surface and subsurface units represents an exposure scenario of low near-term probability but potentially high consequence at MDA AB because of the large, long-lived source term. Intrusive scenarios have increased significance over very long time frames, when the potential hazard of the buried TRU waste remains high but institutional control cannot necessarily be ensured. Assessment of this scenario for buried radioactive waste is an issue that is being considered by DOE on a national basis (e.g., see Hora 1991, 0642). However, this scenario does not necessarily affect the remedial decision most likely to be selected (i.e., conditional remedy) for MDA AB for the assumed period of institutional control (100 yr).

Food chain: The food chain pathway is not considered a credible pathway for the TA-49 OU because long-term institutional control is assumed for all SWMUs expected to have significant source terms (i.e., MDA AB and Area 11).

Receptors: The maximally exposed human receptors are onsite employees and visitors. Other receptors are unlikely to be important while institutional control is maintained.

4.11.3 Conceptual Model Refinement

Additional site characterization data will enable further refinement of the conceptual model by providing data that tests hypotheses in the current model. Data obtained during the TA-49 RFI as well as new results from other OUs, the ER program's Framework Studies, and the Laboratory's Environmental Surveillance Group will be integrated into updated models.

Properly refining the site conceptual model is an integral part of building an accurate picture of the site processes and pathways important to contaminant migration. As appropriate, mathematical models will be derived from the conceptual model to guide later data collection, hypothesis testing, risk assessments, and design of the CMS.

4.12 Summary of General Data Needs

Table 4.12-1 summarizes the overall data needs for the TA-49 OU as generated from discussions of available information earlier in Chapter 4. While this list may appear to be long, not all of these data are needed for each TA-49 SWMU and the level of detail required is not necessarily great. SWMU - specific data needs are summarized in Table 4.12-2 and the field sampling plans in Chapters 6 and 7 explicitly describe the plan for obtaining the required data.

TABLE 4.12-1

SUMMARY OF GENERAL DATA NEEDS FOR THE TA-49 OU RFI.

Objective	Data Need
Site Hydrology	
1. Characterize stratigraphic properties related to potential contaminant transport pathways at MDA AB	• Locations for subsurface characterization • Borehole cores and lithologic logs to confirm depths and nature of rock unit contacts
2. Determine site physical, mineralogic, and hydrologic properties important to unsaturated transport	• Physical, hydrologic, chemical, and mineralogic analysis of soils, tuff, and fill material in fractures and joints • Downhole borehole logs to identify changes in moisture, density, and mineralogy with depth • Downhole video and direct observation of subsurface fractures, joints, and unit contacts • Retardation factors for indicator contaminants with TA-49 tuff and soil • Isotope dating of water extracted from core holes and tuff • Moisture content and flux in bulk tuff, soils, and fill materials
3. Characterize role of joints and fractures as barriers or pathways for contaminant migration	• Maps of fracture patterns from cores, boreholes, open shafts, and surface exposures • Hydrogeochemical characterization of filling materials • Characterization of impermeable zones and areas with elevated moisture
Site Morphology	
1. Identify surface geology, unit contact expressions, and paleoerosional surfaces	• Geologic map of TA-49 OU from exposed units in Ancho and Water Canyons and borehole data
2. Characterize drainage morphology at MDA AB	• Map of erosional and depositional areas and drainage pathways
3. Characterize fault zones under MDA AB and their potential impact on contaminant transport	• TA-49 fault map from field examination, seismology, and boreholes
4. Determine rate of erosion	• Dates, frequency, and volumes of surface erosion and mass wasting events

Contaminant Sources

1. Identify contaminants at each SWMU	• Verify contaminants at release points
2. Quantify contaminants at each SWMU.	• Field and laboratory analyses for chemical and radiological contaminants
3. Determine OU-wide background levels in soil, tuff, and groundwater	• Media background levels for TA-49 contaminants

Contaminant Migration

1. Identify any migration of contaminants at each SWMU	• Sample analyses along preferential migration paths • Field screening and surveys to guide field work (verified by laboratory measurements) • Mobile contaminant identification

Baseline Risk Assessment

1. Identify potential receptors for each pathway	• Exposure points for each major pathway and human access probabilities • Future land use scenarios
2. Determine contaminant fate and transport	• Physicochemical data on processes associated with site contaminants, as outlined above
3. Assess contaminant levels against action levels and other guides	• Action levels or other applicable guides for site contaminants
4. Assess exposure threat to human health for the no further action remedial alternative	• Summary of reference doses and slope factors for site contaminants

Potential Remedial Alternatives

1. Assess potential remedial measures	• Data and analysis regarding effectiveness of each reasonable remedial alternative • Identification of pathways to be blocked, exposure scenarios, and land use scenarios • Evaluation of ease of implementation, long term effectiveness, and cost

TABLE 4.12-2

SUMMARY OF SWMU–SPECIFIC DATA NEEDS FOR THE TA-49 RFI

	SWMU	Verify location of unit	Identify presence/absence of contaminants in unit	Establish contaminant suite related to unit	Determine lateral extent of contamination	Identify depth of contamination	Estimate source volume/concentration	Estimate contaminant plume volume/concentration	Assess interaction of contaminants with	air pathway	surface water pathway	groundwater pathway	biotic pathway	Determine direction and rate of transport by	air	surface water	groundwater	biota	Estimate potential impact on	human health	environment	
MDA AB Shafts	49-001(a)-(f)				x	x	x	x				x					x			x	x	
Experimental Chamber	49-002		x	x	x	x	x	x		x	x	x	x		x	x				x	x	
Leachfield	49-003	x		x	x	x	x	x		x	x	x	x		x	x	x	x		x	x	
Soil Contamination	49-001(g), 49-008(a)-(d)		x	x	x	x	x	x		x	x	x	x		x	x	x	x		x	x	
Landfills	49-004	x	x	x	x	x	x	x		x	x	x	x		x	x	x	x		x	x	
	49-005(a),(b)	x	x	x	x	x	x	x		x	x	x	x		x	x	x	x		x	x	
Sumps	49-006	x	x	x	x	x	x	x		x	x	x	x		x	x	x	x		x	x	
Septic Systems	49-007 (a), (b)	No data needs; Proposed for no further action (NFA)																				
Underground Tank	49-009	No data needs; Proposed for no further action (NFA)																				

Chapter 4 References

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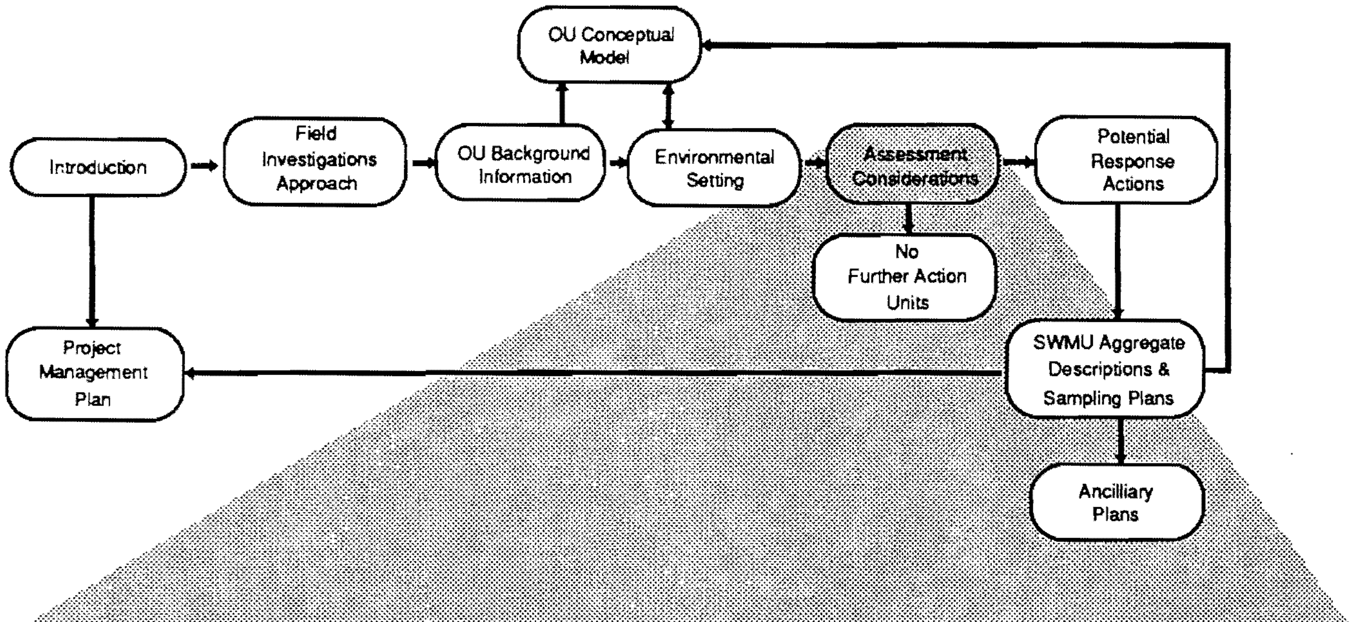
Chapter 5



Assessment and Remedial Considerations and Data Quality Objectives

- Action, Background, and Screening Levels
- Applicable, Relevant, and Appropriate Regulations
- Buried TRU Considerations
- Potential Remedial Actions
- Technical Approach
- Decision Process
- DQO Process
- Field and Analytical DQOs

5.0 ASSESSMENT AND REMEDIATION CONSIDERATIONS

This chapter contains a discussion of assessment and remediation considerations pertinent to the development of the TA-49 OU work plan. Sections of Chapter 5 are listed below.

- 5.1 Action, Background, and Screening Levels
- 5.2 Applicable, Relevant, and Appropriate Regulations
- 5.3 Buried TRU Considerations
- 5.4 Potential Remedial Actions
- 5.5 Technical Approach
- 5.6 Decision Process
- 5.7 Data Quality Objectives Process
- 5.8 Field and Analytical Data Quality Requirements

The information described under these categories, combined with the environmental setting and conceptual model discussed in Chapter 4, lead directly to the SWMU-specific field characterization plans in Chapters 6 and 7 and the recommendations for no further action (NFA) in Chapter 8.

5.1 Action, Background, and Screening Levels

5.1.1 Definitions

Action levels are decision criteria used to determine whether further action is required at known release sites. The philosophy underlying the application of action levels is described in proposed Subpart S and in Section 3.5 of the IWP. For areas where action levels are exceeded, a Corrective Measures Study (CMS) may be required, but remedial action may not always be necessary. For example, this may be true for MDA AB, where long-term institutional control probably will be required for, regardless of other corrective measures which might ultimately be applied.

In this OU work plan, screening levels are preset analytical survey levels, at or below the most conservative action levels which are likely to be set for TA-49 SWMUs, which are used to survey surface areas and to screen discrete samples for radioactivity levels. For the TA-49 OU, a screening level of 10 pCi/g is proposed (see ensuing discussion).

Background levels are the levels of contaminant elements or compounds that are expected to occur naturally (or at fallout levels, in the case of some radionuclides) in site media.

Values for background levels and action levels, which either are listed in Appendix F of the IWP or have been used in cleanup activities at other installations, for TA-49 indicator contaminants are discussed in the following sections and are summarized in Table 5.1-1. Table 5.1-1 also lists detection limits for the survey and analytical methods proposed for use in the TA-49 RFI.

5.1.2 Indicator Contaminants

Past site activities involving hazardous and radioactive materials at TA-49 were limited almost exclusively to well-documented hydronuclear and related experiments during the 1959 to 1961 time frame, and significant contaminants are believed to be limited to a small set. As discussed in Chapters 4, 6, and 7, there is a high probability that minor contaminants that also might be present will be associated with the limited set of primary contaminants. These circumstances make it appropriate to select a set of indicator contaminants that can be used to limit the number of analyses required to characterize the nature and extent of contamination at TA-49 SWMUs. The primary analytical indicators for TA-49 contamination are the following:

- alpha spectrometry (isotopic plutonium analysis, which yields plutonium-238, plutonium-239/240, and americium-241 levels);
- gamma spectrometry (which yields gross gamma radioactivity, americium-241, and cesium-137 levels);
- total uranium;
- gross alpha/beta radioactivity; and
- RCRA regulated metals (which notably includes beryllium and lead). For specific SWMUs discussed in Chapters 6 and 7, it may be appropriate to expand or contract this list (e.g., SVOCs, PCBs, and isotopic uranium might be added).

5.1.3 Action Levels

Table 5.1-1 lists background and action levels for indicator contaminants for TA-49 soils, sediments, and shaft backfill materials (the dominant contaminated medium at TA-49). Action levels for lead, beryllium, and semivolatile organic compounds (SVOCs) are taken from Appendix F of the IWP, which lists Subpart S action levels for soil, water and air as derived from the Safe Drinking Water Act and from health-risk-based criteria. These action levels are applicable to extremely conservative exposure scenarios such as residential use, which are much more conservative than required for scenarios assumed for the TA-49 OU. Thus, there is the likelihood that baseline risk assessment following the TA-49 RFI will show that acceptable contaminant concentrations at the TA-49 OU may be significantly higher than these levels. Radiological levels which can trigger Phase II investigations currently are being developed by the Laboratory ER program's Risk Assessment technical team and will be available in sufficient time for analysis of Phase I data from the TA-49 RFI.

TABLE 5.1-1

ACTION LEVELS, BACKGROUND LEVELS, ANALYTICAL METHODS, AND DETECTION LIMITS FOR TA-49 OU INDICATOR CONTAMINANTS

Indicator Contaminant	Soil Action Level	Background Level[e] Soil	Background Level[e] Sediment	Minimum Detection Limit[f]	Method
Be	400 μg/g[a]	1.9 μg/g	--	0.3 μg/L	SW846 6010
Pb	500 μg/g[b]	24 μg/g	--	42 μg/L	SW846 6010
Total U	35 pCi/g[c]	5.4 pCi/g	4.6 pCi/g	0.7 pCi/g	ICP/MS or delayed neutron counting
Cs-137	80 pCi/g[d]	0.88 pCi/g	0.28 pCi/g	0.1 pCi/g	Gamma spectrometry
Am-241	g	--	--	0.002 pCi/g	Alpha spectrometry
Gross gamma	g	10 pCi/g	2.6 pCi/g	0.1-2 pCi/g	Gamma spectrometry
Pu-238	g	0.003 pCi/g	0.006 pCi/g	0.01 pCi/g	Alpha spectrometry
Pu-239	g	0.019 pCi/g	0.006 pCi/g	0.01 pCi/g	Alpha spectrometry
Gross alpha	g	--	--	4-10 pCi/g	Gas-flow proportional counter
Gross beta	g	--	--	5-12 pCi/g	Gas-flow proportional counter

a) From Appendix F, Table F-3 of the IWP.
b) As per EPA guidance (Draft Technical Support Document on Lead, ECAO-CIN-757, September 1990), an action level of 500 mg/kg for lead in soil may no longer be applicable and a site-specific evaluation may be required.
c) See Subsection 5.1.3 of this OU work plan. A level of 35 pCi/g corresponds to about 50 ppm for natural uranium.
d) From EPA 1977 (0661).
e) Soil and sediment background levels for radionuclides are taken from Table G-32 of the report on the 1989 ESG surveillance program (ESG 1990, 0497). The values given are maximum observed values. Lead and beryllium background values are taken from Ferenbaugh et al. (1990, 0099).
f) Detection limits and methods are as specified in the Generic QA Project Plan, and in Annex II and Appendix C, of this OU work plan.
g) TRU actions levels proposed for unrestricted (residential) site use have ranged from 17 to 100 pCi/g. See Subsection 5.1.3 of this OU work plan.

Except for those cases where action levels are listed in Appendix F of the IWP, this OU work plan makes no attempt to suggest action levels. Instead, action levels for TA-49 indicator contaminants which actually have been used for cleanup efforts at other installations, or which otherwise have been proposed, are noted. These levels are then used to establish reasonable screening levels for the TA-49 RFI which are appropriate for credible exposure scenarios at the OU. The screening levels also may be useful in the process of establishing criteria (including action levels) for deciding whether to terminate the RFI/CMS process, conduct Phase II sampling, or move directly to a CMS.

A surface soil action level for total uranium of 35 pCi/g (approximately 50 ppm for natural uranium) has been adopted as appropriate for unrestricted site use at numerous sites throughout the United States (NRC 1981, 0717). This soil level was developed from the Nuclear Regulatory Commission (NRC) Branch Technical Position on uranium mill tailings sites and similar action levels for uranium have been developed by DOE for its Formerly Utilized Sites Remedial Action Program (DOE 1987, 0723 and DOE 1987, 0728).

A surface soil action level of about 17 pCi/g for the sum of all TRU constituents was proposed (but not finalized) by EPA in 1977 for unrestricted (i.e., residential) site use (EPA 1977, 0661). Recently issued guidance from EPA implies a soil action level for plutonium-239 of about 39 pCi/g for 10^{-5} lifetime risk for residential use (EPA 1991, 0658). Both of these action levels probably are overly conservative for foreseeable exposure scenarios at TA-49. Indeed, higher values have been proposed or actually used in TRU site cleanups (Healy 1977, 0654; Healy et al. 1979, 0727; EPA 1990, 0694). For example, for cleanup of Enewetok Island, a TRU action level of 35 pCi/g was used for a residential use scenario and substantially higher values were used for agricultural and recreational use.

Based on available information, the RFI is very likely to show that contamination at some TA-49 SWMUs is very localized and discontinuous. Therefore, the proposed field investigation will evaluate the spatial heterogeneity and nature of hot spots. The maximum geographical areas ("exposure areas") and contaminant concentrations for which it is appropriate to average hot spots may be specified as part of risk assessment following the RFI. For example, for Area 1 an exposure area might be proposed as 125 ft x 125 ft because this covers the hydronuclear shafts in Areas 1-4. A maximum TRU concentration of ten times the action level set by risk assessment might be proposed as an appropriate maximum concentration for an individual sample that can be used for area averaging. However, because such decisions are not essential to the purposes of the RFI, setting of these parameters is deferred to subsequent risk assessment activities.

5.1.4 Screening Levels

Screening and survey techniques for radioactive constituents in soils and subsurface samples will be used heavily during the TA-49 RFI. Appendix F of this OU work plan describes hand held and tripod-mounted survey instruments and the vehicle-based spectrometry systems which will be used for radiological surveys. These systems detect gamma and low-energy x-ray emissions characteristic of TRU, fission products, and uranium over the energy range

10 KeV to 2.0 MeV. A value of 10 pCi/g over the surveyed area is chosen for the radioactivity screening level for surface soils. This value is below the most conservative action levels that are likely to be set for the TA-49 OU, and are well above background levels and detection limits of the radiological survey instrumentation (see Table 5.1-1 and Appendix F). The radioactivity screening level will be used as a criterion for sampling hot spots and for guiding other aspects of the field investigation.

5.2 Applicable, Relevant, and Appropriate Regulations

Module VIII of the HSWA Permit establishes Corrective Action Requirements (CARs). Task IV, Investigative Analysis, specifies that the permittee must identify all relevant and applicable standards for protection of human health and the environment. Task VI, Identification and Development of the Corrective Action Alternative or Alternatives, further specifies that based on the results of the RFI, the permittee must identify, screen, and develop the alternatives for removal, containment, treatment, and/or remediation of contamination based on objectives established for corrective action. Cleanup requirements can be divided into three categories:

- Contaminant-specific requirements which address specific contaminants;
- Location-specific requirements which are based on a specific site setting; and
- Action-specific requirements associated with specific response actions.

In the absence of more information about contaminant types and concentrations at the SWMUs being investigated in this OU work plan, the identification of CARs at this time would be premature. The full tabulation of location-specific, contaminant-specific, and action-specific requirements will be provided in future technical reports as adequate SWMU information is obtained through the RFI process.

5.3 Buried TRU Considerations

The current definition of transuranic waste (TRU) can be found in 40 CFR 191 (EPA), DOE Order 5820.2A, and 10 CFR 61 (NRC). At present, TRU is defined as wastes with greater than 100 nCi/g of long-lived alpha emitters (half-life greater than 5 yrs). However, isotopes not strictly meeting this definition, such as the beta-emitter plutonium-241, sometimes are considered TRU components.

Potential response actions, exposure routes and receptors for potential contaminant transport pathways are discussed for MDA AB in Sections 4.8-4.11 of this OU work plan, the conditional remedy of long-term institutional control accompanied by site stabilization, monitoring, and maintenance is identified as the likely remedial alternative for MDA AB.

Therefore, the focus of the field investigation of MDA AB is related to an evaluation of site hydrogeochemical factors related to modeling long-term migration potential, and not on source term characterization.

5.3.1 Buried TRU Management

Areas 1, 2, 2A, 2B, 3, and 4 were created during the underground hydronuclear and related experiments from late 1959 to mid 1961 and contain the vast majority of contaminants at TA-49. By 1971, these areas had been designated collectively as a buried TRU disposal area (MDA Y). In 1986, the designation was changed to MDA AB and the site was listed as a RCRA hazardous waste site.

Table 5.3-1 lists the major radionuclides contained in the MDA AB shafts as a function of time. It can be seen that (except for the beta-emitter plutonium-241 and it's daughter americium-241) the radioactive content of MDA AB is almost unchanged in the 30 yrs since the radionuclides were introduced to the site.

Currently, MDA AB is managed pursuant to the requirements of DOE Order 5820.2A on Radioactive Waste Management (DOE 1988, 0074). This order defines "Buried Transuranic Waste" and specifies characterization, monitoring, and closure requirements applicable to MDA AB. Order 5820.2A references the "Comprehensive Implementation Plan for the DOE Defense Buried TRU-Contaminated Waste Program" (DOE 1987, 0723). These two documents cite the following three basic site-closure strategies that could be used singly or in combination, depending upon site-specific and regulatory requirements:

(a) leave waste in place with enhanced monitoring;

(b) leave waste in place, use enhanced confinement or *in situ* immobilization techniques, and provide enhanced monitoring; and

(c) retrieve, process, and dispose of the TRU at the Waste Isolation Pilot Plant.

Strategies (a) and (c) are consistent with the conditional remedy/corrective measures approach described earlier in this OU work plan.

According to the DOE buried waste implementation plan, the costs of strategies (a) and (b) are comparable, but alternative (c) is more expensive by a factor of 7. Because of the high costs and risks involved with option (c), this course of action is likely to be viable only if the potential for waste migration is found to be significant.

In risk scenarios addressed in DOE Order 5820.2A, three premises are assumed explicitly in the analysis of potential remedial actions. These premises also are assumed in the TA-49 RFI work plan. First, it is assumed that DOE will maintain institutional control over the buried TRU waste site for 100 yr beyond 1985. Second, the basic time period for long-term analysis is set at 1000 yr beyond 1985 because EPA and Nuclear Regulatory Commission (NRC) guidelines specify 1000 yr as a reasonable time for projected calculations. Third, it is assumed that the entire current TRU waste source (>99%) must be removed if the waste removal and closure option were exercised.

TABLE 5.3-1

INVENTORY OF MAJOR RADIONUCLIDES AT MDA AB AS A FUNCTION OF TIME
(Areas 1, 2, 2A, 2B, 3, and 4)

				Activity (Ci)				
Radionuclide	Initial Mass(kg)	Half-Life[a] (yr)	Ci/g	t=0 1960	t=30 1990	t=100 2060	t=1000 2960	t=10,000 11960
Pu-239	37.7	24100	0.063	2380	2380	2370	2310	1780
Pu-240	2.22	6563	0.230	511	509	505	460	178
Pu-241	0.20	14.4	104	20800	4910	166	$<10^{-20}$	-0-
Total Pu	40.1			23700	7790	3040	2770	1960
Am-241[b]	-0-	433	3.47	-0-	515	607	145	$<10^{-4}$
U-235	93	7.04×10^8	2.19×10^{-6}	0.204				
U-238	169	4.47×10^9	3.37×10^{-7}	0.057				
Total U	262		3.37	0.26				

[a]Taken from "Chemistry of the Actinide Elements", Katz, J.J., Seaborg, G.T., and Morss, L.R. (Eds.), Chapman and Hall, New York (1986)

[b]Daughter of Pu-241. Maximum Am-241 activity at about the year 2030.

The plutonium isotopic composition used in the calculations was, (wt. %): Pu-239 (93.97), Pu-240 (5.53), Pu-241 (0.500).
[The range of isotopic composition was: Pu-239 (93.5 - 94.2%); Pu-240 (5.30 - 6.05%); Pu-241 (0.458 - 0.563%)].

The choice of time domain crucially impacts the RFI/CMS for waste sites such as MDA AB because of the uncertainties introduced into risk assessment scenarios by the long half-lives of TRU radioisotopes. In the TA-49 work plan, the 100-yr institutional time frame in the context of the conditional remedy/corrective measures approach is used to develop the RFI, but long-term uncertainties with this approach are pointed out. As mentioned earlier in the TA-49 work plan, the Laboratory's Long-Range Site Development Plan assumes that the present institutional use and control of TA-49 will be continued for the indefinite future.

5.3.2 MDA Surveillance Program

In 1979, the DOE issued interim operational criteria for radioactive waste areas owned or operated by DOE and its contractors. In response, the Laboratory prepared an interim environmental surveillance plan for radioactive waste areas (Hansen et al. 1980, 0716). Because of classification difficulties, the plan originally did not include MDA AB, but subsequently this area was added to the list of disposal areas covered by the surveillance program. This program consists of abbreviated surveys of each buried waste area on an annual basis and a more comprehensive study of each area approximately every 5 yr.

General objectives and sampling strategies for the Laboratory's buried waste areas are given in the interim surveillance plan. Although this plan calls for subsurface sampling as appropriate during the more intensive studies, thus far sampling at MDA AB has been limited to surface soils and sediments, vegetation, deep groundwater, and surface runoff on an opportunistic basis. A study in 1987, referred to as the "A411 survey," is the only intensive study of this type that has been carried out at TA-49. MDA AB is scheduled again for intensive study under this program in FY93 or FY94. It is intended that the RFI workplan also will serve the purposes of this surveillance program.

The results of the 1987 A411 survey study are cited extensively in this OU work plan. The analyses were carried out by essentially the same methods and analytical quality levels as proposed in this OU work plan, i.e. analytical data quality of Level III was obtained. Detection limits for the A411 survey therefore are approximately those cited in Table 5.1-1.

5.3.3 TRU and LLW Waste Volumes in MDA AB

Under the Defense Buried Transuranic Waste Management Program and 40 CFR 191, wastes resulting from defense programs with TRU concentrations greater than 100 nCi/g require special consideration. A significant portion of the contaminated backfill material and tuff near the bottoms of the MDA AB experimental holes may be presumed to have concentrations of plutonium exceeding this criterion. A crude estimate of the maximum volume of material meeting or exceeding the TRU criterion can be calculated by assuming that the alpha contamination is distributed uniformly through a spherical volume of about 100 m^3 (diameter 5 to 6 m) at the bottom of each of the 44 experimental holes containing SNM, for a total volume of about 4400 m^3 (Purtymun and Stoker 1987, 0204). With these assumptions, the TRU contamination would be distributed throughout the 4400 m^3 volume.

By using an average density of about 1.5 g/cm^3 for tuff, an average concentration of about 400 nCi/g then can be estimated for the dominant TRU contaminant (plutonium-239).

A similar crude estimate of the total volume of contaminated material that might have to be removed to obtain all the TRU and low-level waste also can be made (Purtymun and Stoker 1987, 0204). Assuming uniform distribution of the plutonium throughout rectangular solids having a thickness of 5 m and the area encompassed by the experimental holes, the estimated volume is about 36,000 m^3, with an average concentration of about 50 nCi/g of plutonium-239.

5.4 Potential Remedial Actions

5.4.1 General

In the observational approach, an attempt is made to identify the most likely remedial actions ultimately to be carried out at the OU, given the current state of understanding of the release sites, so the RFI/CMS can be focussed as tightly as possible. In this section, potential response actions for TA-49 SWMUs are discussed. Tables 5.4-1 and 5.4-2 summarize reasonable remedial measures that can be hypothesized for TA-49 SWMUs, based on current information and hypotheses. Testing the validity of these hypotheses is a key focus of the TA-49 RFI. The final selection of remedies will be based on risk assessment, using data gained from the RFI/CMS process.

For some TA-49 SWMUs, it is quite likely that cumulative releases above action levels, currently set or above the most conservative levels likely to be proposed, will not be found in the RFI, in which case no further action will be proposed. For other SWMUs, only minor remedial action, such as selective removal of surface debris and surface soils, backfill of the open Area 10 shaft, and revegetation is likely to be required. For Area 11 and MDA AB, more extensive actions may be required as described below.

Limited voluntary corrective action (VCA) to selectively remove near-surface contaminated piping and other debris is proposed in Phase 1 to facilitate site characterization and to eliminate easily-removed future source terms. Other highly localized contamination sources such as soil hot spots and lead bricks which might be found also will be removed in Phase I, if feasible. As discussed in Chapter 3, VCAs are highly limited by the Laboratory's present waste disposal capacity.

5.4.2 Potential Remedial Actions for Area 11

For Area 11, only the radiochemical leachfield is likely to be of environmental concern. Phase I sampling of the leachfield area is designed primarily to

TABLE 5.4-1.

MOST PROBABLE REMEDIAL MEASURES FOR TA-49 SWMUS, OTHER THAN AREA 11 AND MDA AB, BASED ON CURRENT INFORMATION AND HYPOTHESES. (No Further Action is Designated by NFA)

SWMU No.*	Location	Description	Probable remedial action
49-005(a)	E. of Area 10	small landfill	NFA
49-005(b)	Area 5	small landfill	NFA
49-006	Area 5	sumps	NFA
49-007(a)	Area 6	septic system	NFA
49-007(b)	HDT Area	septic systems	NFA
49-008(b)	Area 6	soil	NFA
49-009	nonexistent	underground tank	NFA(proposed)
49-002	Area 10	experimental chamber	removal of surface debris; revegetation, and backfill of shaft
49-004	Area 6	open burning/ landfill area	revegetation
49-008(a)	Area 5	soil	removal of surface debris; selective soil removal; revegetation
49-008(d)	Area 12	soil	removal of surface structures and debris; revegetation

TABLE 5.4-2

MOST PROBABLE REMEDIAL ACTIONS FOR AREA 11 AND MDA AB, BASED ON CURRENT INFORMATION (No further action is designated by NFA)

SWMU No.*	Location	Description	Probable Remedial Action
49-001(e)	Area 3	Backfilled shafts and soils	NFA
49-001(misc)	MDA AB	Miscellaneous	NFA - included in other MDA AB SWMUs
49-008(c)	Area 11	Soil	Removal of surface debris; selective soil removal; revegetation
49-003	Area 11	Leachfield	Removal of near-surface pipes; selective soil removal; installation of sediment trap
49-001 (a, d, f)	Areas 1, 2B, 4	Backfilled shafts and soils	Removal of surface and near-surface debris; selective soil removal; capping; long-term monitoring and institutional control
49-001(b,c)	Areas 2, 2A	Backfilled shafts and soils	Selective soil removal; measures to discourage burrowing animals; capping; long-term monitoring and institutional control
49-001(g)	Area 2	Soils	Selective soil removal; revegetation; installation of sediment trap

determine the extent of contamination so that reasonable remedial actions can be evaluated during the CMS (if required). It is highly probable that Area 11 will be managed with MDA AB, for which a conditional remedy is likely.

Excavation and disposal of the leachfield is an option which the TA-49 OU work plan addresses in the field characterization plan. Assuming that the leachfield contamination is restricted to an area of about 50 ft x 30 ft and a depth of about 5 ft, that the waste fits the LLW criteria, and that a cost of about $300/yd^3 will be incurred for disposal at a Laboratory waste disposal site, excavation costs of about $100K would be incurred. These estimates do not, of course, include sampling costs to determine the boundaries of the plume, characterize the waste, and verify the efficiency of waste removal.

Implacement of a down-gradient sediment trap to capture slightly contaminated sediments transported by runoff from Area 11 will be considered as a VCA during Phase II of the RFI or during the CMS.

5.4.3 Potential Remedial Actions for MDA AB

Voluntary corrective actions will be carried out as appropriate, as discussed in Section 2.10 of this OU work plan.

5.4.3.1 Long-Term Institutional Control

For the buried TRU waste at MDA AB, the preferred remedial action most likely to be identified by the RFI/CMS is the conditional remedy of long-term institutional control accompanied by site stabilization, monitoring and maintenance, and additional corrective action as required. This hypothesis assumes that the RFI will confirm that infiltration is not a credible pathway for transporting contaminants from MDA AB.

Potential site stabilization methods include capping with a vegetative cover to control erosion, infiltration. An engineered subsurface (e.g., a rock cobble layer) to reduce vulnerability to burrowing animals would be a logical component of the barrier.

Removal of the asphalt pad and the contaminated fill covering Area 2 prior to capping also is a remedial possibility, as described in the following subsection. Based on the RFI, it is possible that construction of a sediment trap downgradient from Area 2 will be considered to limit transport of contaminated sediments toward Water Canyon and Ancho Canyon.

5.4.3.2 Excavation and Removal

Selective removal of contaminated soil and near-surface debris at MDA AB is likely to be required and may be carried out as VCAs during the RFI/CMS.

In principle, excavation and removal of the deeply buried wastes in MDA AB could be carried out. However, as described in this section, associated with this remedial option are profound technical, risk, and financial implications such that this option is reasonable only if significant potential for waste migration is discovered.

DOE estimated in 1987 that excavation of the buried waste at MDA AB, separation of the TRU and LLW components, on-site burial of the LLW and shipment of the TRU to an off-site facility would cost about 1 billion dollars (DOE 1987, 0723). The estimate assumed a burial volume of 36,000 m^3 within 1.8 acres. This option, therefore, is an extremely costly one, the expense of which would strongly impact the funding available for other remedial actions at the Laboratory. The value of the TRU would be negligible compared to the cost of separation from other subsurface materials.

Excavation also incurs a significant risk of generating substantial hazards for on-site personnel and off-site populations. For example, remedial workers would bear the risk posed by the physical hazards of deep excavation work of the type which would be required. This risk would be aggravated further by significant waste recovery difficulties caused by the large volumes of structural metal and other debris present in the shafts. In addition, by its nature excavation would greatly disturb the stability of the site and tremendously increase the possibility for generating radioactive airborne contamination releases both on and off site. Disruption of the native soil cover also would strongly affect its ability to impede infiltration.

Other practical issues would attend the excavation and removal option for MDA AB. For example, it is unlikely that retrieval of >99% of the TRU contaminants, as specified by DOE Order 5820.2A, could be ensured by using current technology without removing a huge volume of tuff. Removal of such volumes would cause environmental disruption of a significant portion of TA-49 that currently is not affected by existing wastes. Further, because much or all of the retrieved waste would likely fit the criteria for mixed hazardous/radioactive waste (that is, both radioactive and hazardous components are present), the waste could not be disposed of until the Laboratory's mixed waste treatment and disposal facility is completed (1996 at the earliest).

Also of significance is the impracticality of shipping the separated TRU fraction off-site under foreseeable schedules. Currently, the Laboratory plans to ship certified LANL TRU wastes to the Waste Isolation Pilot Plant (WIPP) at a rate of about 120 shipments per year, with a restriction of 5.7 m^3 of waste per shipment (Drypolcher 1992, 03-0032). These Laboratory TRU waste restrictions apply to newly generated operational waste and stored wastes from past operations as well as to wastes recovered during environmental restoration activities. At least 700 to 800 truckloads would be required to handle TRU wastes from MDA AB alone, assuming the waste volumes calculated earlier in this section. Such volume restrictions apply whether these shipments are made to WIPP or to another TRU disposal or storage facility. In addition, the shipments probably would go through Santa Fe and other populated areas, with attendant public concern and risk considerations.

Although the TA-49 RFI/CMS may show that massive excavation of the deeply buried wastes is not feasible for reasons discussed above, selective soil excavation clearly may be practical for localized surface/near-surface contamination at MDA AB, particularly in and around Area 2. For example, the contaminated backfill covering the Area 2 pad could be removed. Assuming that 4300 yd^3 would have to be removed (120 x 120 ft area and an 8-ft depth), that the waste meets the LLW criterion, and that costs for on-site disposal are about $300/$yd^3$, excavation alone would amount to about $1.3 million. These costs, of course, do not reflect associated expenses, including sampling, to define the area to be excavated, to characterize the waste and to confirm the effectiveness of waste removal, and site restoration costs .

5.4.3.3 *In situ* Treatment Options for MDA AB

If the RFI/CMS for the TA-49 OU determines that further stabilization of the buried waste at MDA AB is desirable, a number of *in situ* treatment options could be considered. However, all such methods that might seem feasible at present, generally incur significant risk and expense because they require intrusion into a source that is highly contaminated with radioactivity and that is complicated by large amounts of buried structural debris. *In situ* technologies that are currently available also suffer drawbacks on an individual basis. For example, vitrification has never been demonstrated at the depths required at TA-49 and would be complicated by the large amounts of buried metallic debris. Liquid extraction technologies have never been demonstrated for this type of application and have nuclear criticality implications (see below). In situ extraction also presents the possibility of unintended solubilization and transport of contaminants. Grouting and clay injection schemes suffer from similar drawbacks.

5.4.3.4 Criticality Considerations

As long as water is not introduced into the MDA AB, the fissile inventory in any experimental hole is insufficient to attain criticality under any circumstances (Penneman 1991, 03-0012). However, calculations show that the inventories of plutonium and enriched uranium within some experimental holes at MDA AB theoretically are sufficient to form a critical mass when assembled under certain conditions in an aqueous environment (Penneman 1991, 03-0012). The possibility for criticality conditions to be attained passively are negligibly small, but cannot be ruled out categorically for some remediation schemes that could be contemplated. Recovery (concentration) with liquid extractants represents one such problematical scheme. Although criticality is extremely unlikely under any circumstances because of the dilution of SNM in subsurface materials, this issue would have to be considered seriously if remedial measures involving treatment with fluids were contemplated.

5.5 Technical Approach

The goal of the RFI for the TA-49 OU is to ensure that the environmental impacts associated with past and present activities at TA-49 are investigated in compliance with the Laboratory's RCRA Part B (HSWA module) permit. To accomplish this goal, the nature and extent of contamination must be identified, leading to assessment of risk to human and environmental receptors along any reasonable environmental pathways that may lead to exposure. In addition, for

MDA AB site geotechnical data must be developed which relates to modeling of contaminant transport over substantial periods of time.

The technical approach used in this OU work plan focuses efforts on meeting required site characterization objectives in a cost-effective manner. This approach uses a health-risk-based decision-making process (consistent with the IWP and proposed Subpart S to 40 CFR 264) for recommending SWMUs for no further action (NFA) or for further study of possible remedial actions under any CMS which might be required. As discussed in Section 2.3 of this OU work plan, a decision analysis approach will be employed in this process.

The basic technical approach for the RFI for the TA-49 OU is summarized as follows:

- Archival data are gathered from available sources to help define a basic understanding of the processes and events that produced each SWMU and the contaminants of concern (COCs) that may be present at each SWMU.
- The archival data are evaluated to identify those SWMUs for which no potential hazard exists so that the number of sites which must undergo field investigation can be reduced.
- The SWMUs that require field investigation are assessed on the basis of archival information to determine whether the initial characterization effort will be a limited Phase I or more detailed Phase II investigation.
- Phase I field investigations are carried out as needed to determine the presence or absence of COCs and to supplement existing information on known source terms or site conditions.
- Data gathered during Phase I investigations are used to determine which SWMUs need further characterization and which may be recommended for NFA. For SWMUs that require further study, Phase I data are used and modeled to help design Phase II sampling and analysis plans (SAPs). The RFI work plan will be amended and submitted for EPA review and approval when Phase II SAPs are completed for sites requiring Phase II investigation. Interim Phase Reports (also referred to as technical memoranda) will be submitted at least quarterly as characterization work proceeds.
- Phase II field investigations are conducted where appropriate to fully characterize the nature and extent of contamination and to obtain the data necessary for a quantitative assessment of risk posed by COCs.
- Risk assessment is conducted for each SWMU once the data needs are satisfied by the field investigation.
- An RFI report is compiled that contains the results of field investigations and recommendations for SWMUs evaluated by

the decision process. SWMUs are recommended for CMS when the analytical or risk assessment results exceed certain values established during risk assessment. The remaining SWMUs are recommended for NFA. Recommendations of NFA will be supported by criteria which are discussed in the following text and in Chapter 8 of this OU work plan (No Further Action Units).

5.6 Decision Process

All SWMUs within the TA-49 OU are evaluated using the four-step decision process illustrated in Figure 5.6-1. Italicized terms used in this diagram are defined in Table 5.6-1. Each of the four diamonds in the diagram represents a point at which a decision is or will be made for each SWMU under consideration. To ensure simplicity in the process, each question posed has only two possible answers, "yes" and "no." The process is designed to identify those SWMUs which can be recommended for NFA as early in the process as possible, with the least expenditure of resources. Those SWMUs which cannot be recommended for NFA after Phase I and Phase II investigations and risk assessment are complete will be candidates for a CMS. Pending ER Program Office guidance, candidate SWMUs for voluntary corrective action action (VCA) will be identified as appropriate within the process. Criteria for identifying and handling SWMUs which are candidates for VCA are expected to be developed outside of the work scope of the TA-49 RFI and are not addressed in this OU work plan, except for limited VCAs as noted earlier in this OU work plan and in Chapters 6 and 7.

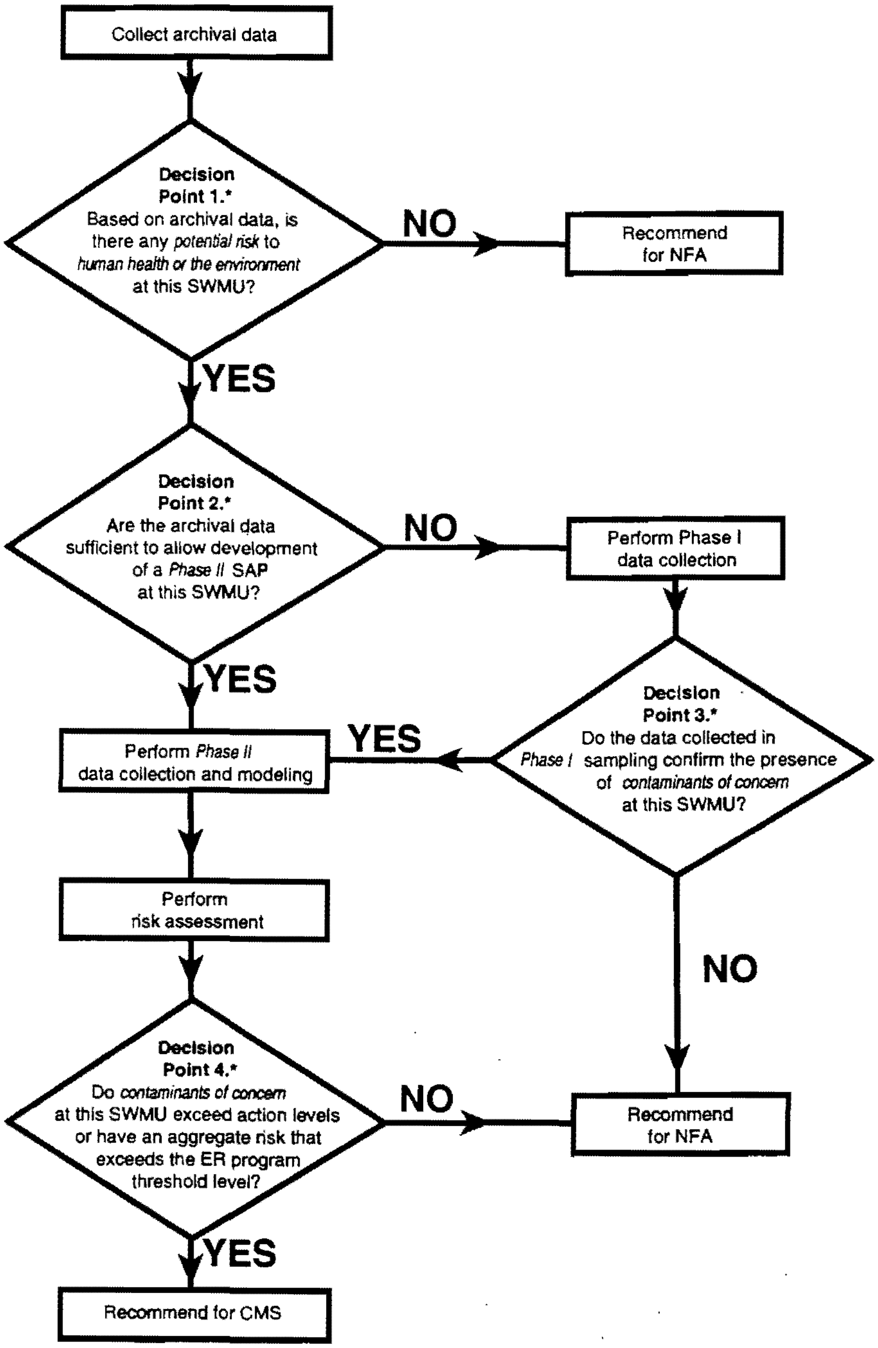
A more detailed discussion of the technical approach for the TA-49 RFI, which amplifies the general process flow illustrated in Figure 5.6-1, appears in the following subsections.

5.6.1 Decision Point 1

On the basis of archival data, is there any significant potential risk to human health or the environment at this SWMU?

The HSWA Permit allows the Laboratory to submit an application for a permit modification when available information demonstrates that releases from SMWUs do not exist which pose a threat to human health or the environment. The function of Decision Point 1 is to differentiate between SWMUs that clearly do not pose a potential risk to receptors, and those that require further investigation. This decision can be made on the basis of qualitative archival information and requires professional judgment on the part of the decision maker.

A "yes" decision indicates that the SWMU under consideration poses some degree of potential risk, or that the available data are insufficient to deny the possible existence of risk. All such SWMUs are recommended for further consideration at Decision Point 2. A "no" decision indicates that, on the basis of professional judgement, the SWMU poses no potential risk and should be



* NOTE: Pending ER program office guidance, voluntary corrective action (VCA) may be carried out at any of these decision points.

Figure 5.6-1 Decision Process for the TA-49 OU (Italicized terms are defined in Table 5.6-1).

TABLE 5.6-1

TERM DEFINITIONS

Archival Data: Archival data comprise information collected to date from published and unpublished records pertaining to the history or processes of a SWMU. Records can include written communication such as reports, memoranda, letters, notes, or calculations. Verbal communication can be considered as archival data. Archival data sometimes has unknown data quality.

Potential Risk: Potential risk is a judgmental determination of risk of the potential release of contaminants of concem to the environment at a SWMU, based on archival data. The determination is based on the likelihood that a release may have occurred at a SWMU and may have entered a potential migration pathway leading to off-site receptors. No potential risk is associated with the SWMU if NFA criteria discussed in Chapter 8 are met.

Contaminants of Concern: Contaminants of Concern (COCs) are organic, inorganic, or radioactive solids, liquids, or gases that, due to quantity, concentration, or physical/chemical characteristics, may cause or contribute to a threat to human health or the environment. COCs may consist of one or more RCRA- or CERCLA-regulated constituents or of radioactive elements/daughter products.

Phase I: Phase I refers to the initial sampling phase of site assessment work, which usually is intended to collect adequate information to confirm the presence or absence of contaminants of concern in the environment. Phase I activities also can include restricted data collection to further define the extent of contamination or site conditions relevant to the potential for waste migration. Information collected during Phase I sampling and analysis will determine if more detailed Phase II sampling is necessary or if NFA is warranted for the SWMU under investigation.

Phase II: Phase II constitutes the second sampling phase of site assessment at SWMUs that have contaminants of concern, and is based on archival or Phase I sampling investigations. Phase II sampling and analysis will help to determine the physical-chemical characteristics of the site and attempt to delineate the nature and extent of contamination. Phase II data will be used for contaminant fate and transport modeling, risk assessment, and design of treatability and corrective measure studies, as required.

Human Health or Environment: Under RCRA, these terms pertain specifically to the health and environment of the general public (exclusive of health concerns for Laboratory employees, which is regulated by OSHA).

recommended for NFA. Because of the judgmental nature of this decision, a recommendation of NFA cannot be made unless the available documentation and/or site inspections clearly show that release of COCs is very unlikely to have occurred, or if a release is documented, that the release is physically prohibited from migrating to off-site receptors, the site has been adequately remediated, or the release is permitted under current regulations.

Evaluation at Decision Point 1 divides the TA-49 SWMUs into two sets. One set consists of SWMUs recommended for NFA and another set consists of SWMUs that must be evaluated at Decision Point 2. Because the first decision is based on existing information, all TA-49 SWMUs were evaluated at Decision Point 1 during the preparation of this OU work plan. TA-49 SWMUs and potential areas of concern recommended for NFA at Decision Point 1 and the criteria used for the basis of such recommendations are addressed in Chapter 8.

5.6.2 Decision Point 2

Are the archival data sufficient to allow development of a Phase II sampling plan for this SWMU?

Decision Point 2 allows the set of SWMUs requiring further characterization to be sorted for development of Phase I or Phase II SAPs. It was decided that existing data for the TA-49 OU would not be used directly at this time for action level comparisons or risk calculations. Existing data are used only for NFA recommendations and for sampling plan design. Archival data was reviewed against several criteria to help determine if Phase I or Phase II sampling is more appropriate. These criteria include the following:

- probability that COCs are present above the most conservative action levels that are likely to be set for the TA-49 OU
- probability that the lateral and horizontal extent of contamination are known with sufficient accuracy for risk assessment
- suitability of existing analytical and site geotechnical data (both location and analytes) for the design of a Phase II SAP
- knowledge of experimental or operational processes that contributed to the SWMU wastes

Most TA-49 SWMUs have an archival data set that provides significant insight into the nature and extent of contamination. For some of these SWMUs, Phase I investigation is and highly focused and is expected to lead to a subsequent recommendation for NFA. However, some archival data is of unsubstantiated quality or is concerned only with radionuclides. In most cases of this type, confirmatory field investigation and analysis is proposed for SWMUs going into Decision Point 2. At the present time, available information is not considered to be adequate to allow efficient design of a Phase II investigation for any TA-49 SWMU.

Decision Point 2 does not provide a mechanism for recommending SWMUs for NFA. Instead, NFAs are addressed by the criteria presented in Chapter 8.

Decisions made at Decision Point 2 produce two sets of SWMUs. One SWMU set requires Phase I sampling and another set can proceed directly to Phase II sampling. Because Decision 2 is made on the basis of existing data, this decision has been made for each SWMU during Work Plan preparation. In no case was a decision made to proceed formally to a detailed and statistically-based Phase II investigation, although some field characterization plans have aspects of Phase II investigations, as discussed in Chapters 6 and 7.

5.6.3 Phase I Sampling Process

The phased approach to site characterization used in this OU work plan is consistent with EPA and Laboratory IWP guidelines. The technical approach generally uses Phase I field investigations to confirm the presence or absence of COCs.

Phase I sampling will be performed at SWMUs for which the potential for significant contamination cannot be ruled out categorically. In these cases, the objective of Phase I sampling is not complete characterization of the SWMU, but simply to determine whether COCs exist. The Phase I sampling design process attempts to model the "worse case" condition of the contaminant scenario so that Phase I sampling points can be chosen with the maximum chance of yielding confirmatory results. As appropriate, fast-turnaround data will be obtained with the use of field survey methods and a field laboratory to rapidly evaluate data needs for Decision Point 3 (discussed below). As analytical results become available, SAPs will be revised as necessary to focus subsequent data collection. In this manner, an iterative process is established which retains flexibility as new data is obtained. Data acquired in Phase I will serve as input for Decision Point 3.

The quantitative data from Phase I will be used to efficiently design Phase II. Accepted statistical concepts for evaluating sufficiency of sampling and additional data needs for modeling waste migration will be identified with the aid of Phase I data.

5.6.4 Decision Point 3

Do the data collected in Phase I sampling confirm the presence of cumulative COCs above levels of concern for this SWMU?

Decision Point 3 is designed so that SWMUs which have been confirmed by Phase I not to have COCs above levels of concern can be recommended for NFA. For those locations where COCs are confirmed, Phase I data will be used in the development of Phase II SAPs. The presence of COCs at a SWMU is considered confirmed if:

1. Any sample contains any COC in a concentration that exceeds the detection limit for that constituent when the appropriate analytical methods are used, and
2. The concentration of that COC exceeds the natural background level for that constituent.

The absence of COCs thus is confirmed if none of the suspected constituents are detected or no suspected COCs exceed their respective background levels.

Regional background concentrations for naturally occurring constituents are available as noted in Chapters 6 and 7 of this OU work plan. Background data from Laboratory locations will be provided by the ER program's Framework Studies technical team in time for analysis of Phase I data. Section 6.1 of this OU work plan also proposes limited studies at TA-49 to address this issue. It is likely that non-parametric tests will be used for comparisons, since sampling is limited and concentrations are generally not distributed normally.

A "yes" answer at Decision Point 3 indicates that the presence of COCs at the SWMU has been confirmed by a technically sound and quality assurance (QA)-validated sampling effort, and that the SWMU must then be evaluated at Decision Point 4. A "no" answer indicates that the absence of COCs at the SWMU has been confirmed and that a recommendation of NFA is justified. Decision Point 3 is the second point in the decision process at which a recommendation of NFA can be made for a SWMU (refer to Figure 5.6-1).

The data required to make a decision at Decision Point 3 include the concentrations of suspected COCs at selected sample locations at each SWMU. The purpose of Phase I sampling is to acquire the analytical and field data needed to make a defensible decision at Decision Point 3. Information on site history, physical site characteristics, chemical and physical behavior of suspected constituents, and other factors must all be considered in determining the appropriate locations and depths at which samples must be collected to support confirmation of the presence or absence of potential COCs. The data quality objectives process to address these data needs are discussed later in Section 5.7.1.

5.6.5 Phase II Sampling and Modeling Process

The purpose of Phase II sampling is to develop a picture of the nature and extent of contamination at SWMUs which is sufficiently detailed for risk assessment and planning of the CMS (if required). The constitution of Phase II SAPs will vary significantly for individual SWMUs as a function of the amount and type of data available from previously obtained information, Phase I and Framework Studies efforts, and other considerations. Sources of potential variation in the environmental measurement process will be included in the design of Phase II SAPs.

Phase II will likely be an interactive process for MDA AB in which rapid turnaround data will be used to track the progress of the investigation against the DQOs for the phase. The Phase II investigation plan will be amended as data needs are refined by Phase I results and future Program Office guidance on risk assessment methods, modeling strategies, long-term institutional control, and other issues important to the TA-49 OU.

As Phase II data becomes available, comprehensive data analysis and modeling of waste migration potential will be conducted. The initial SAPs will be reviewed against transport modeling results and against the initial site conceptual model or sampling rationale for completeness and suitability, and will be revised as appropriate. The data set resulting from Phase II will serve as input to subsequent risk assessment.

5.6.6 Risk Assessment Process

Because health-based risk assessment is integral to the Laboratory RCRA process, risk assessment will be performed for all TA-49 SWMUs that undergo Phase II investigation. This assessment will incorporate the total data set for each SWMU, as obtained through archival review and Phase I and/or Phase II investigations. The risk assessment methodology will reflect the guidance set out in proposed Subpart S to 40 CFR 264 and guidance to be published by the ER Program Office in the 1992 IWP. Data quality objectives for Phase II investigations will incorporate any requirements specific to data gathering for risk assessment not otherwise noted, as they become available from the Laboratory ER Program Office. The risk assessment results will serve as input to Decision Point 4.

5.6.7 Decision Point 4

Do contaminants of concern at this SWMU exceed action levels or have an aggregate risk above the ER Program threshold value?

Decision Point 4 is the final step in the RFI decision process and functions as a point at which SWMUs that have undergone field investigation will be recommended either for CMS or NFA. The purpose of Decision Point 4 is to allow an evaluation of the total set of validated data now available for each SWMU. Concentrations of COCs at each SWMU will be compared against the action levels for each COC present and the calculated aggregate risk from COCs at the SWMU will be compared against the acceptable aggregate risk values determined by the Laboratory ER program office. It is assumed here that risk assessment methodologies to be adopted by the Laboratory will reflect the basic concepts of proposed Subpart S to 40 CFR 264. Calculation of risk as additive for sites with multiple contaminants is assumed. A recommendation of NFA at this point in the decision process will be justified for a SWMU if each of the following criteria are met:

- the mean sample concentration for any listed COC does not exceed the risk-based action level for that COC, and
- the aggregate risk value for the sum of the health-risk-quantified COCs present does not exceed the acceptable risk value set forth by the Laboratory ER Program Office.

The analysis of data during the RFI for the TA-49 OU will follow EPA and IWP guidance for using a 90% (one-tailed) confidence interval. Uncertainty will be handled in accordance with methods shown in Appendix H of the IWP and applicable EPA documents.

A CMS (or an alternative response action) is required for SWMUs at which one or more COCs is present at a level that exceeds the risk-based action level specified in 40 CFR 264 Proposed Subpart S or the Laboratory IWP for that constituent, or at which the cumulative risk posed by two or more COCs exceeds acceptable levels. For radionuclides, numbers for comparison to analytical values are expected to be published in a future IWP or some future EPA guidance.

However, pending further Laboratory ER Program Office guidance, there may not always be a need for carrying a SWMU into the CMS or for corrective action whenever COCs are detected in concentrations that exceed Subpart S action levels. If further site-specific risk assessment indicates that human health and the environment are not at risk (e.g., if there is no plausible pathway from source to potential receptors), then no further action may be appropriate. Criteria for this circumstance is expected to be promulgated by the Laboratory ER program office.

5.7 Data Quality Objectives Process

There are three stages in the decision process at which data must be collected. The first stage involves the initial collection of pertinent archival information. This information serves as data input for Decision Points 1 and 2. The data required to make a decision at Decision Point 3 are collected during Phase I sampling, the second stage of data collection. Phase II sampling is the third stage of data acquisition. The data needs for Decision Point 4 determine the scope of Phase II efforts.

Because these decisions must be technically sound and validated to be defensible, an attempt has been made to collect as much reliable archival information about each site as possible. To ensure that data of appropriate and sufficient type, quantity, and quality are collected during Phase I and Phase II sampling, the Data Quality Objectives (DQO) process has been applied to the development of the Phase I and Phase II SAPs. These SAPs are presented in Chapters 6 and 7 of this OU work plan.

The DQO Process is a seven-step process developed by the EPA for planning effective and efficient data collection programs (EPA 1987, 0086). A well-planned data collection program will ensure that the right type, amount, and quality of data are collected on which defensible environmental decisions can be based. The level of uncertainty which is acceptable also is addressed in the DQO process.

The DQO process is a valuable tool for the following reasons:

- it provides a logical, iterative structure for study planning and ensures that the investigation is focused on the critical questions,
- it provides a focused method to determine data needs,
- it helps data users plan for uncertainty, and

- it facilitates communication among the technical team members and minimizes the amount of time and money spent collecting data.

The seven steps in the DQO Process, and the locations in this OU work plan where pertinent information is located (other than in the remainder of this section), are as follows:

1. **Statement of the problem:** The environmental conditions at TA-49 are addressed generically in Chapters 3 and 4 and by specific SWMU in Chapters 6 and 7. Assessment and remedial considerations are addressed in Chapter 5.
2. **Identify decisions that address the problem:** Potential land use and remedial actions are developed elsewhere in Chapter 5.
3. **Identify inputs affecting the decision:** Decision inputs are addressed in Chapters 3 through 5.
4. **Specify spatial and temporal domains of the decisions:** Domains are addressed in Chapters 3-5.
5. **Develop logic statements:** SWMU-specific logic statements (decision questions) pertaining to specific SWMU characterization are developed in Chapters 6 and 7.
6. **Establish constraints on uncertainty:** Uncertainty issues are addressed generically in Chapter 5 and by specific SWMU in Chapters 6 and 7.
7. **Optimize design for obtaining data:** The characterization plan is addressed in Chapters 6 and 7 for each SWMU.

This seven-step process was followed in developing DQOs for the TA-49 OU work plan. It was decided that, while Decisions 1 and 2 require decision maker confidence in archival data, decisions made from archival data of uncertain quality could be made without a formal set of DQOs. Although not formally documented, Laboratory ER project leaders have agreed that acceptance of archival data at face value sometimes is justified for the purposes of RFI planning. In developing the DQOs to support Decision 3 (post Phase I) and Decision 4 (post Phase II), a more formal process was used (refer to Figure 5.6-1).

Decisions 3 and 4 require data of certain quality, for both determination of the nature and extent of contamination and for risk analysis. The TA-49 RFI work plan follows EPA and IWP guidelines for addressing sampling and analytical uncertainties. For the sampling and analytical effort to determine nature and extent, a confidence interval of 90% (one-tailed) will be used. Phase I data used in making Decision 3 will include data of at least analytical Level III quality. These uncertainty constraints are adopted globally in the RFI process for the TA-49 OU.

As previously stated, risk assessment data needs have not been defined fully for the methods to be used. However, the assumption used in this OU work plan is that methods similar to those in proposed Subpart S to 40 CFR 264 will be applied. Additionally, background concentration values are not yet available. It is assumed that guidance on the methodologies and uncertainties associated with those studies will be supplied by the Laboratory ER Program Office when they are complete. As required, DQOs for the TA-49 OU will be reviewed and amended for consistency as information on risk assessment methodology becomes available.

5.7.1 Phase I Data Quality Objectives

DQOs for Phase I SAPs have been developed using the seven-step process described. The DQOs process for Phase I SAPs is discussed in following sections and is outlined in a diagram in Figure 5.7-1.

5.7.1.1 Problem Statement

For some TA-49 SWMUs, COCs are suspected, but their presence has not been confirmed and no data are available on the concentrations or specific locations of contaminants. Environmental samples will be collected and analyzed to confirm the presence or absence and location of COCs at these SWMUs. For other TA-49 SWMUs, significant levels of COCs are known to be present, but their full extent and potential for migration are insufficiently known. Environmental data associated with these uncertainties must be collected for risk assessment purposes.

5.7.1.2 Questions to be Answered

Do Phase I data confirm the presence or absence of COCs at this SWMU?

If COCs are known to be present at this SWMU, do Phase I data provide sufficient information for design of a Phase II investigation?

Possible answers to these questions are discussed in Section 5.7.6.

5.7.1.3 Decision Inputs/Data Needs

Two sets of decision inputs (data needs) that are necessary to support the decisions made at Decision Point 3 have been identified. These sets include the following:

- the information necessary to design an adequate Phase I SAP, and
- the field and analytical data that will be collected during the sampling program.

The first set includes information that must be gathered before development of the sampling plan. The second set includes the concentrations of COCs at the site as determined by field and laboratory analyses of samples collected at the SWMU.

DATA QUALITY OBJECTIVES FOR PHASE I

Problem Statement:	Contaminants of concern (COCs) are suspected for SWMUs within the TA-49 OU, but their presence has not been confirmed. For other SWMUs, the full extent and potential for migration are insufficiently known.
Question to be Answered:	Do the data collected in Phase I Sampling confirm the presence of COCs at this SWMU? If sufficient levels of COCs are known to be present , are the extent and migration potential adequately defined for Phase II design?
Data Needs:	• Field data (survey and screening results) • Analytical data (concentrations of COCs) • Site Processes • Potential release mechanisms • Site history • Potential COCs
Problem Domain:	Definition of the location and types of COCs within each SWMU.
Decision Rule/ Logic Statement:	If concentrations of all analyzed COCs are below conservative action or screening levels, then recommend for No Further Action. Otherwise, Proceed to Decision Point 4.
Uncertainty Constraints:	Sampling plans will be designed on the basis of professional judgement to minimize the chance of obtaining false negative results.
Sampling and Analysis Plan:	See Chapters 6 and 7

Figure 5.7-1 Data Quality Objectives Process for Phase I of the RFI for the TA-49 OU.

To facilitate the development of the TA-49 work plan, SWMUs have been grouped into the following logical groupings, based on likely remedial actions to be recommended following the RFI/CMS process:

- MDA AB. Large source terms (uranium, plutonium, lead, and beryllium) exist in the hydronuclear shafts. Much smaller, highly localized source terms (soil and debris) exist near the surface at MDA AB. Several remedial options are conceivable for the near-surface contamination. However, because removal or treatment of the deeply buried wastes is likely to be impractical, and the likelihood for contaminant migration is low, this work plan considers the most likely remedial measure for MDA AB to be selected following the RFI/CMS to be capping and stabilization accompanied by long-term institutional control, maintenance, and monitoring.

- Area 11 and Area 5. The Area 11 leachfield is strongly suspected to contain a localized soil zone with TRU contamination but with a small inventory of photochemical wastes, but is unlikely to contain other contaminants above levels of concern. Selective removal of contaminated soil is a possible remedial option for both areas. However, because these two areas are within the geographical area inscribed by individual areas of MDA AB which contain much larger source terms, they are almost certain to be managed with MDA AB, whether or not contaminant levels of concern are present. Therefore, it is assumed that long-term institutional control also will be maintained over Areas 5 and 11 and that remedial decisions for these areas will be considered within the context of actions to be taken for MDA AB.

- All other areas. Based on the available information, SWMUs other than those discussed above are unlikely to contain significant source terms and therefore the no further action (NFA) alternative is the likely recommendation to follow from the RFI. Thus, the RFI is likely to show that these areas are suitable for unrestricted Laboratory use, subject to site-wide restrictions imposed by the use of TA-49 as a buffer zone for adjacent firing sites.

Since highly localized radiological, lead, and beryllium contaminants represent by far the most significant contamination at TA-49, they are the primary focus of SWMU-specific investigations. Other contaminants are known or suspected to exist at TA-49 only in very limited quantities and generally will be associated with the aforementioned contaminants. Thus, sampling plans take these factors into account to maximize the effectiveness of the RFI by focusing on a set of TA-49 indicator analytes, as discussed in Section 5.1.2.

A general table of data needs is presented in Tables 4.12-1 and 4.12-2. Specific data needs on an individual SWMU basis also are called out in Chapters 6 and 7. Table 5.1-1 lists indicator contaminants that are proposed for the TA-49 OU, the appropriate analytical method, and analytical detection limits for each indicator. This table is meant to be a bridge between the development of DQOs and the preparation of the SAPs.

For the purpose of setting DQOs, OU-wide objectives of the TA-49 RFI are defined as follows:

- Identify contaminants (if any) at each SWMU.
- Determine the nature, quantity, and extent of contamination for each SWMU.
- Identify contaminant migration pathways from each SWMU and from the OU as a whole.
- Characterize the TA-49 environment sufficiently to allow quantitative migration pathway modeling and risk analyses, as necessary.
- Provide the data needed for initial assessment of remedial alternatives.
- Provide the basis for planning the CMS.

5.7.1.4 Problem Domain

The problem domain for Phase I sampling includes the definition of the location and types of COCs within each SWMU.

5.7.1.5 Decision Rule/Logic Statement

The decision made at Decision Point 3 will be based on the following rule:

If, for all samples collected for the SWMU in Phase I, the maximum concentration of any COC in any sample does not exceed established action levels or screening levels based on the most conservative action levels which are likely to be set for this SWMU, the SWMU will be recommended for NFA. Otherwise, the SWMU will undergo further study.

This decision will not necessarily be based on a statistical characterization of the contamination levels at a SWMU for several reasons. First, any type of averaging of sample results would dilute maximum values and increase the chances of making a Type II error (i.e., false negative, or incorrect conclusion that COCs are present). Second, in most cases the goal of Phase I is not complete characterization, but rather simply to determine whether COCs are present or absent. In addition, for most TA-49 SWMUs, the location of the SWMUs is not in question. Therefore, it is not necessary to resort to geostatistically based schemes to locate areas with maximum probability of contamination.

However, comparison of sample values to background concentration ranges ultimately could be statistically based, depending upon characterization methods employed by the Framework Studies technical team for background studies. Methodology for these comparisons will be added to the TA-49 OU work plan as it becomes available.

5.7.1.6 Uncertainty Constraints

To fully validate and define a decision to recommend a SWMU for NFA at Decision Point 3, Phase I SAPs have been designed so that the probability of a significant false negative result (Type II error) is very low. This has been done by focusing the sampling toward those areas determined judgmentally to most likely contain the highest concentrations of COCs and by including some low-cost redundancy in the field investigation (e.g., area radiological screening). The most serious consequence of a Type II error is that a recommendation for NFA may be made inappropriately.

No attempt is made in Phase I to limit the chances of false positive (Type I) errors, as these errors will be identified during Phase II sampling. Thus, the consequences of Type I errors is that some additional cost and time will be expended in Phase II.

As stated in Section 5.7.1.5 above, statistical constraints regarding the treatment and comparison of Phase I data to background or action levels depend upon the method the ER Program Office adopts. A comprehensive statistical effort is reserved for Phase II.

5.7.2 Phase II Data Quality Objectives

DQOs for Phase II SAPs have been developed using the seven-step process described above. DQOs for the Phase II SAPs are discussed below and shown in a diagram in Figure 5.7-2.

5.7.2.1 Problem Statement

For SWMUs for which significant levels of COCs has been confirmed, either by archival information or data collected during Phase I sampling, a complete picture of the nature and three-dimensional extent of contamination and potential transport processes will not be known. Environmental data must be collected and analyzed to clarify these issues so that the health-based risk posed by the COCs can be assessed. Transport and exposure modeling for future use scenarios must be employed to assess the risk.

5.7.2.2 Question to be Answered

Do contaminants of concern at this SWMU exceed action levels or have an aggregate risk above the ER Program threshold value, and is there potential for waste migration? This question and its two possible answers form the basis of the decision rule/logic statement following subsection 5.7.2.5.

DATA QUALITY OBJECTIVES FOR PHASE II

Problem Statement:

For those SWMUs where contaminants of concern (COCs) are present, the nature and extent of the contamination and importance of potential transport processes must be clarified.

Question to be Answered:

Do COCs exceed action levels or have an aggregate risk above the ER program threshold value, and is there potential for waste migration?

Data Needs:

Nature and Extent of Contamination

- types of COCs present
- concentrations of COCs
- physical / chemical characteristics of COCs
- vertical and lateral extent of COCs
- plume dimensions

Typical Media Characteristics

- soil and/or rock type
- porosity & permeability
- physical & chemical properties of soil (e.g., ion exchange, adsorption qualities, moisture content, grain size distribution)
- heterogeneity in media
- wind velocity and direction

Problem Domain:

The problem domain encompasses potential receptors, spatial boundaries, and temporal constraints. Potential receptors include site workers and visitors at present and occasional recreational users in the future. Spatial boundaries of the SWMU are defined by the limits of migration of COCs. Temporal constraints are a function of constituent-specific chemical and physical properties

Decision Rule/ Logic Statement:

If no individual COC exceeds its action level, and the aggregate risk value for all COCs present does not exceed the ER Program risk-threshold value, then recommend this SWMU for NFA. Otherwise, recommended for CMS.

Uncertainty Constraints:

Phase II sampling is designed to produce a 90% (one - tailed) confidence rule in COC concentrations. Statistical methods sample mean (and data needs), for background comparison and risk assessment will be consistent with future program guidance.

Sampling and Analysis Plan:

See Chapters 6 and 7

Figure 5.7-2 Data Quality Objectives for Phase II of the RFI for the TA-49 OU.

5.7.2.3 Decision Inputs/Data Needs

The purpose of Phase II sampling is to obtain the data needed to support the decision made at Decision Point 4. In general, enough must be known about the nature and extent of contamination at the site and potential transport processes to facilitate a health-based risk assessment. To meet this end, several sets of decision inputs must be defined during Phase II sampling. These sets include the following:

- the nature and three-dimensional distribution of the contamination;
- the concentrations of COCs at various locations and depths; and
- site geotechnical information related to the potential for waste migration over time

To develop a SAP that will obtain these data, all information obtained to date must be considered, including archival information and data collected during Phase I and other investigations. Consideration of these questions will help to determine the locations and depths at which samples should be collected and the types of analyses that should be run on each sample.

Phase II sampling efforts will be designed on the basis of Phase I or other data. Phase II sampling may use a random, stratified random, or 3-D random sampling approach, as appropriate. Data needs for statistical sufficiency of sampling include number of samples, sample mean, and sample variability, as described in Chapter 9 of SW846 and other EPA guidance documents for statistical analysis. Data needs for transport and exposure modeling and for risk assessment will depend on which codes and methodologies are adopted by the Laboratory ER Program Office for these purposes. The TA-49 OU work plan will be amended as required to reflect guidance as it becomes available. As appropriate in developing Phase II SAPs, SWMUs recommended for Phase II investigation will be grouped into aggregates on the basis of proximity and similarity of sampling techniques and requirements to maximize the cost-effectiveness of Phase II investigations.

5.7.2.4 Problem Domain

The problem domain includes potential receptors, spatial boundaries (the area of a release and spatial limits of contaminant migration), and temporal constraints (the current chemical/physical form of contaminants and future migration potential). Under present use, potential receptors are identified as Laboratory site employees and visitors. Indefinite institutional control is assumed for MDA AB, Area 11, and Area 5. For other areas of TA-49, recreational use by Bandelier National Monument is assumed after 100 yrs of Laboratory institutional control.

5.7.2.5 Decision Rule/Logic Statement

If no individual COC exceeds its action level, and the aggregate risk value for all risk-based COCs does not exceed the ER Program risk-threshold value, the SWMU will be recommended for NFA. Otherwise, the SWMU will be recommended for CMS.

5.7.2.6 Uncertainty Constraints

Sample mean concentration estimates with a 90 percent (one-tailed) confidence interval will be used for comparison to action levels and for risk assessment. These constraints parallel those discussed in EPA SW846 and other EPA publications for statistical analysis of solid waste sites. Refer to Sections 5.7.1.6 and 5.7.2.3 of this OU work plan for additional discussion of uncertainty constraints.

5.8 Field and Analytical Data Quality Requirements

Data quality requirements for field and analytical data collected at the TA-49 OU are governed by the need to make defensible, risk-based decisions for each SWMU. The information collected will be based on sound professional judgment, required EPA protocol, statistical requirements, and overall data objectives for the project. This section contains a discussion of data quality requirements concerning analytical levels, analytical methods, PARCC (precision, accuracy, representativeness, completeness, and comparability) parameters, and field data quality requirements.

5.8.1 Analytical Data Quality Levels

The following five descriptors are used to define analytical data quality levels (EPA 1987):

- **Level I**: data from survey methods used to identify contaminants *in situ*, or field screening methods to be used at the point of sample collection;
- **Level II/III**: field laboratory or field survey methods used to provide rapid quantitative discrete sample analyses or area surveys during field operations;
- **Level III/IV**:field or off-site analytical laboratory methods used to provide accurate, precise, and defensible data; and
- **Level V**: non-conventional methods.

Additional characteristics of the five categories are given in Table 5.8-1. In general, Levels I and II are associated with on-site portable field instrumentation or tests that can yield "real-time" survey or screening data. Levels III and IV are associated with strict field laboratory or off-site laboratory protocol and documentation that will generate high-quality, defensible data. Level V will accommodate all special analytical methods that are not covered under

TABLE 5.8-1
SUMMARY OF ANALYTICAL LEVELS APPROPRIATE TO DATA USES

Data Uses	Analytical Level	Type of Analysis	Limitations	Data Quality
Site characterization; monitoring during implementation; identification of gross contamination	Level I	Radiological field screening and surveys	Response dependent on radiation type and conditions; response limited to upper 1-2m of soil	Method-specific
Identification of gross contamination	Level I	HE spot tests	Matrix dependent	Qualitative
Site characterization; evaluation of alternatives; engineering design; monitoring during implementation	Level II	Variety of organics by GC, inorganics by AA, XRF, ICP	Tentative identification; analyte-specific	Dependent on QA/QC steps employed
		Radiologic field screening and surveys	Response dependent on radiation type	Qualitative or quantitative depending on method
		Field laboratory analyses for some radiological constituents	Tentative identification and quantification	Dependent onQA/QC steps employed
Risk assessment; site characterization; evaluation of alternatives; engineering design; monitoring during implementation	Level III	Organics/inorganics, using EPA procedures other than CLP; analyte-specific	Specific identification; tentative identification in some cases	Detection limits similar to CLP
		RCRA characteristic tests	Can provide data of same quality as Level IV	Less rigorous QA/QC than for Level IV
		Radiological constituent	Specific identification; detection limits below background; with suitable QC, gives quality comparable to SW846 methods	QA/QC comparable to SW846 methods
Risk assessment; evaluation of alternatives; engineering design	Level IV	TCL/TAL organics/ inorganics by GC/MS, AA, ICP, etc.	Tentative identification of non-TCL parameters	Goal is data of known quality
		Low ppb detection limit	May require time to validate packages	Rigorous QA/QC
Risk assessment	Level V	Nonconventional methods	May require method development	Method-specific
			Mechanism to obtain services requires lead time	Method-specific detection limits

[a]EPA (1987)

AA = atomic absorption
GC = gas chromatography
RCRA = Resource Conservation and Recovery Act
CLP = Contract Laboratory Program
ICP = inductively coupled plasma
TAL = target analyte list
EPA = Environmental Protection Agency
MS = mass spectrometry
TCL = target compound list

standard Level III or IV parameters. Quality of Level V work can meet either Level III or IV standards.

5.8.1.1 Phase I Analytical Levels

Investigations for the TA-49 RFI will be performed under a combination of analytical data quality levels to meet SWMU-specific, contaminant-related field investigation requirements described in Chapters 6 and 7. Phase I investigations generally will be performed under analytical Levels I, II, and III. Level I and II data will be collected as part of a field survey and screening program to allow for qualitative, real-time evaluations of site conditions. Level I field screening and survey will include a variety of portable field instrumentation or field test kits that can continually or periodically give information on site conditions. Level I observations also are used as a critical part of the site health and safety plan and for evaluation of samples to determine proper shipping procedures. Table 5.8-2 and 5.8-3 provide additional details concerning the instrumentation and methods for each analytical level.

Level II activities will include the use of field survey methods and portable field laboratories (Table 5.8-2). Field surveys include the use of surface or borehole geophysics to assist in remote sensing activities or assist in the location of sample points. Field analytical laboratories can provide quantitative rapid-turnaround information of Level I, II, and III quality that can be used to support field strategy decisions. The vehicle-based gamma spectrometry system for radiological surveys also yields data of Level II quality.

Level III analytical data will be obtained during Phase I using mobile field laboratories or off-site laboratories that can support RFI/CMS decisions each SWMU. In general, data of at least Level II quality must obtained to support a recommendation of NFA. Strict QA/QC and sample documentation procedures will be followed (see Annex II of this OU work plan and the ER program's Generic QA/QC Plan). Laboratory protocol for sample analysis will be performed using EPA's "Test Methods for Evaluating Solid Waste," SW846, for organic compounds and metals. Radionuclide, high-explosive, or miscellaneous analyses will employ acceptable analytical methods as outlined in the IWP.

Level IV data quality will be used as appropriate for confirmation of Level III or archival analytical data at present, collection of Level IV data is not planned in Phase I. The need for Level IV data in Phase II will be assessed as Phase I results are evaluated.

Level V analyses can include measurements for nonconventional parameters, method modifications, analyte suites from 40 CFR 261 (Appendix VIII) or 40 CFR 264 (Appendix IX), physical testing of soils or rock, or other nonstandard methods that may be employed in the TA-49 RFI. Quality control and documentation for Level V will be equivalent to procedures defined for Level III to maintain the defensibility and quality of data.

If required, selection of analytical methods and data quality levels for COCs that have background or have action levels below standard MDL or PQL levels will be determined by future LANL ER project office guidance.

TABLE 5.8-2

DATA TYPES, USES, AND QUALITY LEVELS FOR TA-49 OU-WIDE CHARACTERIZATION ACTIVITIES

Data Type	Intended Uses	Required Data Quality
OU-Wide Surface Characterization		
Geomorphology (for example, geologic base map, drainage patterns, sediment deposition areas)	Identify surface geologic features that may influence contaminant movement, and distribution	Standard geological field methods will provide sufficient quality for the identified uses
	Determine if overland or channel flow patterns can result in off-site transport	" " "
Map of Faults/fractures	Determine potential impact on site stability and contaminant transport pathways via faults and fractures	Standard documented geological field methods will provide sufficient quality for the identified uses
Background analyte levels	Provide a basis for determining whether individual SWMUs are contaminated	Level III analytical laboratory analyses are required

TABLE 5.8-2 (continued)

DATA TYPES, USES, AND QUALITY LEVELS FOR TA-49 OU-WIDE CHARACTERIZATION ACTIVITIES

Data Type	Intended Uses	Required Data Quality
OU-Wide Subsurface Characterization		
Mineralogy/geochemistry (for example clay mineral content, zeolite mineralogy, cation exchange capacity, content, etc.)	Predict contaminant movement through tuff	Standard operating procedures. The intended use is consistent with normal use of these data, thus standard methods provide appropriate data quality
Hydrogeological parameters (for example moisture content, bulk density, porosity, permeability, moisture characterization curve, hydraulic conductivity)	Estimate flux and veolocity of contaminant movement in vadose zone; input to a flow and transport model	The required data uses can be supported by data provided by standard laboratory methods. Excessive variability in early data may require additional sampling/analysis to identify source of variability
Pore fluid composition (for example isotope characterization of water extracted from bulk tuff)	Delineate depth of migration of water that has infiltrated the subsurface; determine absolute ages of pore water in vertical hydrostratigraphic sections.	Standard field and laboratory methods. These were developed for the intended data uses provided data of sufficient quality.

TABLE 5.8-3

DATA TYPES, USES, AND QUALITY LEVELS FOR SWMU-SPECIFIC CHARACTERIZATION ACTIVITIES

Data Type	Intended Uses	Required Data Quality
Field surveys (e.g., area radiological surveys and geophysical surveys)	Direct reading/recording instruments to scan land surface and measure *in situ* conditions.	Level I and II data are acceptable
Field screening (e.g., gross alpha, area radiological, HEs, and , lithological logging)	Point of collection sample measurements; identification of grossly contaminated samples; documentation of sample lithology; support of Health and Safety operations.	Level I and II data are acceptable
Field laboratory measurement (e.g., gross alpha, gross beta, gamma spectrometry, PCBs, soil moisture)	Guidance for field operations (borehole stopping criteria, health and safety, sample transportation, etc.); aid in selecting judgmental sampling locations (e.g., hot spot samples for contaminant identification); reduction of analytical sample load.	Primarily Level II data will be used since confirmatory analytical laboratory measurements will be obtained. Some techniques may be Level I or Level III, as well.
Analytical laboratory measurements (e.g., SW846, radiochemistry)	High-quality, defensible data; accurate, precise quantification of a broad list of analytes; risk assessment.	Level III data are required. In some circumstances, well supported Level II data may be acceptable.

5.8.1.2 Phase II Analytical Levels

Phase II analytical levels will be similar to those used in Phase I (Levels I, II, and III).

5.8.2 Analytical Methods and PARCC Parameters

Analytical methods selected for the analysis of soil, water, or air samples to be collected during the TA-49 RFI will follow standard laboratory protocol recognized by the EPA (see Tables 5.8-4 and 5.8-5). The analytical methods include a variety of techniques that potentially apply to over 300 individual analytes. Testing for semivolatile organic compounds, PCBs, and inorganic metals will be performed using EPA's "Test Methods for Evaluating Solid Waste," SW846 protocol (EPA 1987, 0292). Analyses for radionuclides, high-explosives, and miscellaneous analytes will be performed under other acceptable analytical methods. Table 5.8-5 summarizes the analytical methods that will be used.

Tables V.3 through V.12, IX.1, and IX.2 in the Laboratory's Generic Quality Assurance Project Plan (QAPjP) contain additional information concerning analytical methods for constituents of interest at the TA-49 OU. The QAPjP lists the individual constituents analyzed under each method, the corresponding chemical abstract service numbers, and the practical quantitation (PQL) or minimum detection limits (MDL) for each constituent using the specific method.

PARCC parameters (precision, accuracy, representativeness, completeness, and comparability) are analytical and sampling quality assurance goals that are established to ensure that quality data are generated A thorough discussion of the PARCC parameters for the Laboratory ER Program is presented in Section 5.0 of the Generic QAPjP.

5.8.3 Sample Collection Quality Requirements

Numerous field activities have an impact on the overall data quality for an environmental restoration program. The activities that have a direct effect on data quality include equipment calibration schedules and procedures, sample method selection and technique, sample containers, preservatives, sample holding times, the number or type of quality control samples, sample documentation, and equipment decontamination. To ensure that data quality is maintained in the field, specific details for each of these activities addressed in Annex II of this OU work plan (QA Project Plan), in the Generic QA/AC plan for the Laboratory's ER program, and in the Laboratory Standard Operating Procedures (SOP) Manual for the ER Program. Table 5.8-6 contains guidelines for sampling frequency for QA/QC control samples of various types.

TABLE 5.8-4

INSTRUMENTATION AND METHODS FOR PROPOSED ANALYTICAL LEVELS

LEVEL I: FIELD SCREENING

- Portable Instruments
  - FIDLER
  - Geiger-Mueller
  - Micro-R Meter
  - Organic Vapor Analyzer (OVA)
  - Photoionization Detector (PID)
  - Explosimeter
  - Oxygen Level Indicator
  - pH, Temperature, Conductivity Meter

- Field Test Methods/Kits
  - OVA Headspace Test
  - HNU Headspace Test
  - Handby Kit
  - Draeger Tubes
  - Hazcat Kits
  - Lab in a Bag®
  - Chloride Test Kits (soil)
  - Hack Kits™
  - High Explosives

LEVEL II: FIELD SURVEYS/INSTRUMENTATION

- Mobile Analytical Lab
- Surface Geophysics
- Borehole Geophysics
- Soil Vapor Surveys (portable instruments)
- Radiological Screening Laboratory
- Vehicle-based Gamma Spectrometry System

LEVEL III: LABORATORY METHODS/INSTRUMENTATION

- SW846 Protocol for soil, air, and water analysis for volatile and semivolatile organic compounds, organochlorine pesticides and PCBs, and metals using Los Alamos, off-site, or field laboratories

- Laboratory, Department of Energy (DOE), US Army, or EPA analytical methods for radionuclides, high explosives, or miscellaneous analyses (see LANL-ER-QAPjP)

- Instrumentation typically includes gas chromatography (GC), gas chromatography/mass spectrometry, inductively coupled plasma atomic emission spectroscopy (ICAP), atomic absorption (AA)

LEVEL V: LABORATORY METHODS

- ASTM protocol for soil/rock testing
- Method specific protocol

TABLE 5.8-5

SUMMARY OF ANALYTICAL METHODS FOR SAMPLE ANALYSIS AT THE TA-49 OU

EPA Methods

• EPA SW-846 Method 8080	Organochlorine Pesticides and PCBs
• EPA SW-846 Method 8270	Semivolatile Organics (SVOCs)
• EPA SW-846 Method 6010	Inorganic Metals by Inductively Coupled Plasma Atomic Emission Spectroscropy (ICAP)
• EPA SW-846 Method 7000	Inorganic Metals by Atomic Absorption (AA)

Radionuclides - LANL or DOE Method[a]

• Gas Flow Proportional Counting	Gross Alpha, Gross Beta
• Alpha Spectrometry	Am-241, Isotopic Pu, Isotopic U
• Gamma Spectrometry	Am-241, Cs-137, Gross Gamma
• ICP/MS	Total Uranium
• Liquid Scintillometry	Tritium

Other Methods

- High Explosives - USATHMA High Performance Liquid Chromatography (HPLC)[a]
- Miscellaneous Analytes[a]
- Physical testing of soil or rock - ASTM[b] Protocol

[a]Refer to Laboratory ER QAPjP for additional information.
[b]American Society for Testing and Materials.

TABLE 5.8-6

GUIDELINES FOR MINIMUM QA/QC SAMPLES FOR FIELD SAMPLING PROGRAM

QC Sample Type	Applicable Sample Matrix	Applicable QA/QC Sample Matrix	Sample Frequency (1 per each analytical batch or)
Bottle Blank	Soil	Water	1 per 20 samples
	Water	Water	1 per 20 samples
Field Duplicate	Soil	Soil	1 per 20 samples
	Water	Water	1 per 10 samples
Rinsate Blank	Soil	Water	1 per 20 samples
	Water	Water	1 per 10 samples
Field Blank)	Soil	Water	1 per shipping cooler
(Trip Blank	Water	Water	1 per shipping cooler
Smear Blank	Paper Smear	Paper Smear	1 per sample event

Chapter 5 References

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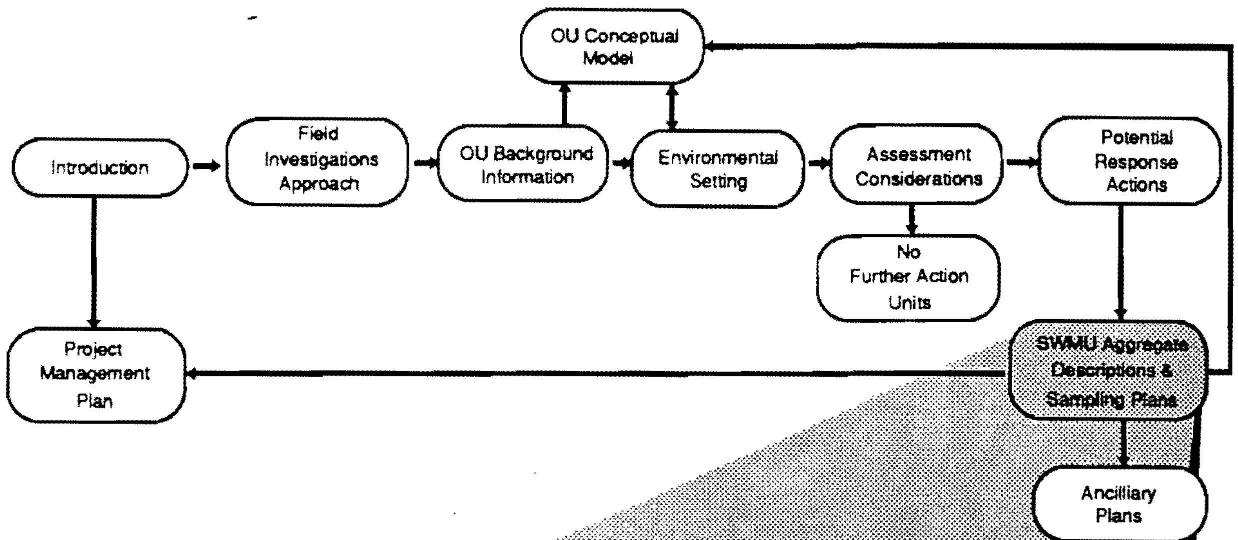
Chapter 6



SMWU Aggregate Descriptions and Sampling Plans

- Baseline
- Area 11
- Area 6
- Area 5
- Area 10
- Area 12

6.0 UNITS OTHER THAN MDA AB
Descriptions, Data Quality Objectives, and Sampling Plans

6.1 BASELINE CHARACTERIZATION

6.1.1 Introduction

To properly assess the potential for contaminant movement within the hydrogeological system at TA-49, a sufficient technical understanding of the site's environmental setting is necessary. Baseline data provide the basis against which SWMU contaminant levels can be compared. Additional baseline data will allow more accurate risk evaluation and will form the basis for selecting remedial alternatives for TA-49 because that selection will be based in part on the influence of natural geological barriers and pathways on contaminant movement. Section 6.1 outlines the plan to obtain this needed data. The field investigation strategy for all RFI activities is summarized in Table 6.1-1(a – d) Tables 6.1-2 of this chapter and E-1 of Appendix E summarize samples and analyses for Phase I baseline characterization.

Required baseline geological, geochemical, and hydrological studies of TA-49 include surface and subsurface characterization. Because TA-49 is located at the south-central extremity of the Laboratory, its location is ideal for providing information of Laboratory-wide relevance. Additional studies at TA-49 are planned by the Laboratory's Framework Studies and Environmental Surveillance Groups.

Baseline geotechnical data is required to provide boundaries for transport model calculations for the vadose zone underlying MDA AB, which contains almost all of the contanimants at TA-49. There is the strong likelihood that MDA AB contaminants will be isolated for extremely long periods of time because of the great thickness of the vadose zone, the low hydraulic conductivity of unsaturated soils and tuff, and the strong retardation of contaminant movement as a result of the inherent properties of subsurface sorptive media. Thus, the removal of buried wastes at TA-49 may not be warranted if institutional control can be ensured and if conditions remain stable over a defined time frame. Alternatively, if active remediation is necessary at MDA AB, geological, geochemical, and hydrological site characteristics will affect the selection of remedial actions and monitoring programs.

Characterization activities within individual SWMU areas are discussed in the remainder of this chapter and in Chapter 7. Section 6.1 addresses only those supporting activities that will be conducted outside the formal SWMU boundaries but within the TA-49 OU boundaries.

6.1.2 Site Hydrogeologic Regulatory Requirements

Section P of the Laboratory's RCRA Part B Permit (EPA 1990, 0306) requires comprehensive characterization of hydrogeological and geochemical properties relevant to contaminant migration in soil and rock units above the water table. Characterization is specified to include, but is not limited to, the following hydrogeological and geochemical information:

TABLE 6.1-1(a)

SUMMARY OF PHASE I INVESTIGATIONS FOR THE TA-49 OU

Chapter/ Section	Description	Benchmark Surveys	Area Surveys: Radiological (ft^2)	Area Surveys: Geophysical (ft^2)	Discrete Samples: **Surface** (0 –6 in.) Number of Samples	Discrete Samples: **Subsurface** Number of Samples	Discrete Samples: **Water** Number of Samples	Discrete Samples: Other
6.1	Baseline	13			12		12	2 (soil characteristics)
6.2	Area 11		65,000	65,000	46	46		
6.3	Area 6		214,100	500	66	26		
6.4	Area 5		94,000	94,000	36	2		
6.5	Area 10		13,000		21			
6.6	Area 12		14,000		23			
7	MDA AB		94,250	101,250	123			
	Total	13	494,350 (14.6 acres)	260,750 (7.7 acres)	327	74	12	

TABLE 6.1-1(b)

SUMMARY OF PHASE I INVESTIGATIONS FOR THE TA-49 OU (Continued)

		Boreholes								
		Vertical (<50 ft)			Vertical (>50 ft)			Angled		
Chapter/ Section	Description	Number of Holes	Total Footage	Number of Samples	Number of Holes	Total Footage	Number of Samples	Number of Holes	Total Footage	Number of Samples
6.1	Baseline									
6.2	Area 11	15	138	46						
6.3	Area 6	9	125	26						
6.4	Area 5	2	20	2						
6.5	Area 10									
6.6	Area 12									
	MDA AB	4	36	15	5	1850	195	2	800	104
7										
	Total	30	319	89	5	1850	195	2	800	104

TABLE 6.1-1(c)

SUMMARY OF PHASE II INVESTIGATIONS FOR THE TA-49 OU

			Area Surveys		Discrete Samples			
					Surface	Subsurface	Water	
Chapter/ Section	Description	Benchmark Surveys	Radiological (ft^2)	Geophysical (ft^2)	Number of Samples	Number of Samples	Number of Samples	Other
6.1	Baseline							6
7	MDA AB		60,000	60,000	115	138		

TABLE 6.1-1(d)

SUMMARY OF PHASE II INVESTIGATIONS FOR CHAPTERS 6 AND 7

		Boreholes								
		Shallow			Vertical (>50 ft)			Lateral		
Chapter/ Section	Description	Number of Hole	Total Footage	Number of Samples	Number of Hole	Total Footage	Number of Samples	Number of Hole	Total Footage	Number of Samples
6.2	Area 11	15			9					
7	MDA AB				4	600	138			

TABLE 6.1-2

SUMMARY OF SAMPLES AND ANALYSES FOR PHASE I FOR TA-49 BASELINE CHARACTERIZATION

Number of Samples[a]

	Soil/Sediment	Groundwater
Analytical Samples	9	9
QA Samples		
Rinsate blank	1	1
Field duplicate	1	1
Field blank	1	1
Total number of samples	12	12

All samples will be field screened for alpha, beta, and gamma radioactivity. Where appropriate, and depending upon convenience and field laboratory availability, analyses will be performed in either the field laboratory or off-site analytical laboratory. Gamma spectrometry yields americium-241, cesium-137, and gross gamma radioactivity levels.

Number of Laboratory Analyses

	Soil/Sediment	Groundwater	Level III Method
Total uranium	12	12	ICPMS
Isotopic plutonium	12	12	Alpha spectrometry
Gross alpha/beta	12	12	Gas flow proportional counter
Gamma spectrometry	12	12	Gamma spectrometry
Isotopic uranium	12	12	Alpha spectrometry
RCRA metals	12	12	SW 6010
Tritium	12	12	
Total number of analyses	84	84	

Other Characterization:

Soil characteristics also will be determined for two samples, and surface field geologic work will be performed as described in Section 6.1.

- regional and facility-specific geological/hydrogeological characteristics affecting groundwater flow beneath the facility;
- topographic features that might influence the groundwater flow system;
- tectonic and cooling fractures within the tuff;
- representative, accurate classification, and descriptions of hydrogeological units that may be part of the migration pathways at the facility (that is, the aquifers and any intervening saturated and unsaturated units).
- structural geology and hydrogeologic cross sections showing the extent (depth, thickness, and lateral extent) of hydrogeologic units that may be part of the migration pathways, identifying:
  - unconsolidated sand and gravel deposits,
  - zones of fracturing or channeling in consolidated or unconsolidated deposits, and
  - ones of high or low permeability that might direct and restrict the flow of contaminants;
- representative description of water level or fluid pressure monitoring;
- manmade influences that may affect the hydrogeology of the site; and
- geophysical information and remote sensing information such as infrared photography and LANDSAT imagery.

Hydrogeologic investigations in Phase I of the TA-49 RFI will focus on Area 11 and MDA AB because they contain the only TA-49 SWMUs known or strongly suspected to have substantial levels of contaminants. Additional hydrogeologic investigations will be proposed in Phase II or under Framework Studies, if they are found to be necessary. RFI characterization activities for Area 11 and MDA AB are outlined in Section 6.2 and Chapter 7, respectively.

6.1.3 Surface Characterization

6.1.3.1 Background/Rationale

Surface studies are an important component of the TA-49 RFI because surface water and airborne processes potentially can expose and transport contaminants to receptors. Selective site-wide TA-49 surface characterization will support SWMU-specific activities by:

- providing indicator analyte background levels against which possible TA-49 SWMU releases can be compared,

- providing additional confidence and documentation that contaminants have not been transported from TA-49 release sites to the boundaries of the OU, and in particular, to the boundary with Bandelier National Monument allowing the significance and potential of surface contaminant transport in the future to be evaluated more accurately,
- determining the lateral and vertical variability in physiochemical properties related to surface transport,
- delineating surface water flow paths, and
- providing surface data to supplement subsurface structural information obtained from boreholes.

6.1.3.2 Existing Baseline Information on TA-49 Soils and Sediments and Data Needs

The extent of knowledge of the characteristics of TA-49 soils and sediments is discussed in Chapter 4 of this OU work plan. Although site soil types have been classified and mapped generally, little of the transport-related data specifically required in the Permit is available for any site soils, notably including those of Area 11 and MDA AB.

Information on site background levels in surface media is primarily inferred from past data. These data are generated from 12 permanent sediment stations and 2 soil stations (indicated on Figure 6.1-1), which have been sampled annually since about 1975 for the Laboratory's routine environmental surveillance program. The TA-49 sediment station network was designed to sample sediments from all the significant drainages leading from MDA AB. These measurements thus provide an upper limit on contaminant levels immediately downgradient from the surface over the largest known source term at TA-49.

Tables 6.1-3 and 6.1-4 show analytical results for these sediment stations from the surveillance sampling in 1989 (ESG 1990, 0497). The results are typical of those reported approximately annually since about 1975 (see Appendix D). General observations on the analyte levels of TA-49 soils and sediments, based on the 1989 and earlier samplings, are presented here.

- Cesium-137 was marginally above regional background at several stations.
- Tritium and plutonium-238 were near regional background or the analytical detection limit at all stations, but plutonium-239/240 significantly exceeded background at station A-3. As discussed in Chapter 7, above-background levels at station A-3 are attributable to known radionuclide release from Area 2.
- Uranium and gross alpha levels in sediments from all 12 stations were near regional background level.
- Total radionuclide concentrations at all 12 alluvial stations were far below the TRU action levels discussed in Section 5.1 of this OU work plan.

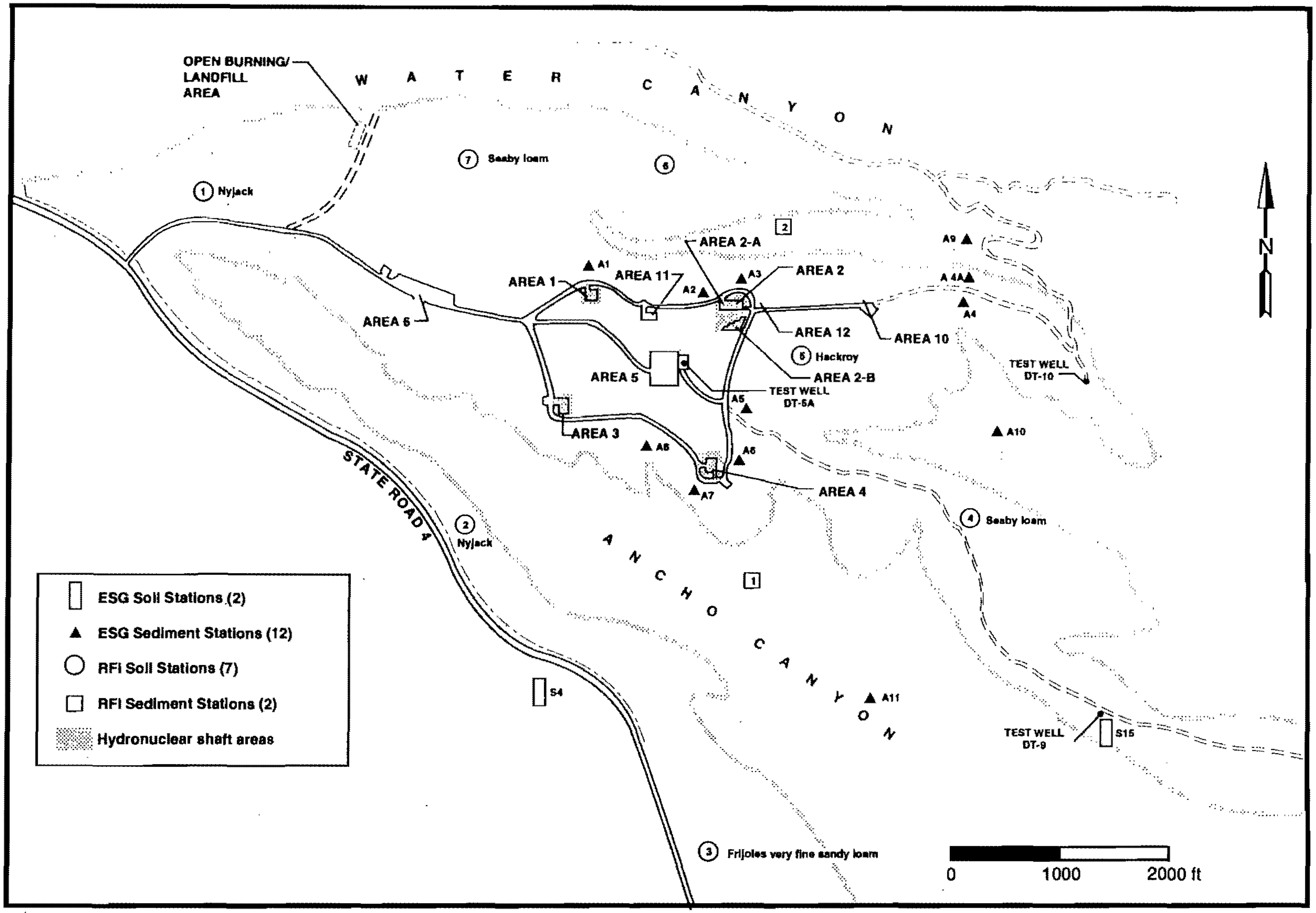


Fig. 6.1-1 Baseline characterization sampling locations at TA-49. Soil types are indicated by the nomenclature of Nyhan et al. (1978, 0161).

TABLE 6.1-3

SUMMARY OF RADIOCHEMICAL ANALYSES OF SEDIMENTS COLLECTED IN 1989 FROM TA-49[a]

Station	^{3}H (10^{-6} mCi/ml)	^{137}Cs (pCi/g)	Total Uranium (µg/g)	^{238}Pu (pCi/g)	$^{239,240}Pu$ (pCi/g)	Gross Gamma (counts/min/g)
A-1	0.4 (0.3)	0.31 (0.08)	4.2 (0.4)	0.002 (0.002)	0.006 (0.002)	3.9 (0.5)
A-2	0.1 (0.3)	0.59 (0.15)	3.2 (0.3)	0.009 (0.002)	0.074 (0.005)	3.4 (0.5)
A-3	0.8 (0.3)	0.27 (0.08)	3.1 (0.3)	0.015 (0.010)	0.902 (0.033)	3.6 (0.5)
A-4	0.7 (0.3)	0.86 (0.17)	2.7 (0.2)	0.002 (0.001)	0.016 (0.002)	3.0 (0.5)
A-4A	0.4 (0.3)	0.44 (0.09)	3.5 (0.3)	0.001 (0.001)	0.020 (0.002)	3.8 (0.5)
A-5	0.6 (0.3)	0.49 (0.15)	3.2 (0.3)	0.001 (0.001)	0.014 (0.002)	4.1 (0.6)
A-6	0.7 (0.3)	1.7 (0.27)	3.8 (0.4)	0.003 (0.001)	0.058 (0.004)	4.5 (0.6)
A-7	0.5 (0.3)	0.16 (0.11)	3.3 (0.3)	0.001 (0.001)	0.002 (0.001)	3.7 (0.5)
A-8	0.3 (0.5)	0.30 (0.09)	2.7 (0.3)	0.003 (0.001)	0.006 (0.001)	4.8 (0.6)
A-9	0.1 (0.3)	0.20 (0.11)	3.3 (0.03)	0.002 (0.001)	0.008 (0.002)	4.3 (0.06)
A-10	0.8 (0.3)	0.47 (0.11)	2.4 (0.2)	0.002 (0.001)	0.011 (0.002)	4.5 (0.6)
A-11	0.0 (0.3)	0.39 (0.13)	0.9 (0.1)	0.001 (0.001)	0.004 (0.002)	1.2 (0.4)
Arithmetic mean	0.5	0.52	3.0	0.003	0.093	3.7
Regional background						
Soils	1.4	0.88(0.18)	3.8(0.4)	0.003(0.003)	0.019(0.002)	10(1)
Sediments	–	0.28(0.13)	3.2(0.3)	0.006(0.001)	0.006(0.001)	2.6(0.5)

[a] Data are from Tables G-32 and G-62 of the Laboratory's 1989 ESG report (ESG 1990, 0497). Statistical upper limits of the analytical error are given in parentheses. Analytical quality level is approximately Level III (see Sections 5.3.2 and 5.7 of this OU work plan). Regional background levels are maximum observed levels for soils and sediments.

TABLE 6.1-4

VOC AND SVOC ANALYSIS IN 1989 FOR TA-49 SOILS AND SEDIMENTS[a]

Station Number	Concentration (µg/kg)	Action Level[b] (mg/kg)	Detection Limit (µg/kg)
Carbon disulfide			
A-2	51	8000 (Table F-3, IWP)	2
A-3	57		2
A-6	35		2
A-7	280		2
A-8	84		2
A-9	120		2
A-10	49		2
A-11	130		2
Trichlorofluoromethane			
A-3	13	20,000 (Table F-3, IWP)	2
A-7	16		2
A-9	13		2
A-11	21		2
2-butanone			
A-3	95	4000 (Table F-3, IWP)	10
A-4	32		10
A-8	77		10
A-10	71		10
1.1.1-trichloroethene			
A-3	12	64 (Table F-2, IWP)	10
A-6	20		10
A-7	50		10
A-8	25		10
4-methyl-2 pentanone			
A-5	14	4000 (Table F-3, IWP)	10
p-isopropyltoluene			
A-5	11		2
A-8	6		2
Bis (2-ethylhexyl)phthalate			
A-2	470	2000 (Table F-3, IWP)	330
A-3	2400	83 (Table F-2, IWP)	330
A-4A	600		330
A-7	410		330
A-10	500		330
A-11	510		330

a Data are from Table 38 of the 1989 ESG report (ESG 1990, 0306). Analysis was conducted for 65 VOCs, 68 SVOCs, 22 pesticides, 5 herbicides, and mixed PCBs. Only compounds that exceeded detection limits are listed above. Analytical quality level is approximately Level III (see Sections 5.3.2 and 5.7 of this OU work plan).

b Soil ingestion action levels are taken from Table F-3 (systemic toxicants) and Table F-2 (carcinogens) from Appendix F of the IWP.

- In the 1989 sampling, levels of toxicity characteristic leaching procedure (TCLP) metals from the 12 TA-49 sediment stations were found to be below TCLP threshold values in all cases and below analytical detection limits in almost all cases. The concentrations of 22 pesticides, 5 herbicides, and mixed PCBs were below detection limits.
- Measured levels of priority volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) were found to be far below TCLP threshold criteria in all cases and below detection limits in the great majority of cases (Table 6.1-4). Levels slightly above detection limits were reported from some of the 12 stations for carbon disulfide, 2-butanone, and 1,1,1-trichloroethene, p-isopropyltoluene, and 4-methyl-2-pentanone. The consistently low levels of these common laboratory chemicals over varied drainage areas, coupled with the improbability that any of these chemicals has ever been used at TA-49, suggests that inadvertent contamination probably occurred during the 1989 sample collection and analysis. In support of the hypothesis that these positive indications for some organics are artifacts, analysis of sediments collected at the 12 ESG sampling locations in 1990 did not show detectable quantities of those VOCs and SVOCs detected in the 1989 sampling.
- The SVOC compound bis(2-ethyl-hexyl)phthalate was reported slightly above detection limits for sediments from six stations during the 1989 sampling. Phthalates are well-known ubiquitous contaminants (plasticizers) commonly found in the environment and are picked up frequently during analysis in the laboratory. The low (and remarkably similar) concentrations at five of the six stations suggest laboratory contamination. Phthalates were not observed in the 1990 sampling.
- In the 1990 sampling, the only target compound detected above detection limits was 1,2,4-trimethylbenzene (6 to 10 μg/g in 10 of the 12 samples). Again, this suggests contamination during collection or analysis because of the consistent levels in all samples.

Data from other TA-49 studies related to baseline contaminant levels are summarized below.

- Monitoring of the two permanent soil sampling stations (stations S4 and S15 in Figure 6.1-1) in the vicinity of TA-49 over many years has shown radionuclide concentrations at or below regional background levels during every sampling round (ESG 1990, 0497). Sediment and water samples from Water and Ancho Canyons, where State Road 4 intersects the two canyons approximately 2 miles downgradient from TA-49, have shown radionuclide levels near background levels or below detection limits (see Chapter 2 of the IWP).

- In September 1982, an aerial radiological survey of TA-15 was performed that overlapped the northern portion of TA-49, including Areas 1, 2, 2A, 2B, 6, 10, and 12. This survey, which is especially sensitive for depleted uranium and cesium-137, failed to detect any surface contamination by man-made radioisotopes at TA-49 above 10 to 12 μR/hr (within the range of regional background) (EG&G 1989, 03-0030).
- A beehive is located within the meteorology complex in the southeastern portion of TA-49. Analysis of honey and bees from this hive for a wide range of metals and radionuclides in 1988 showed that analytes for all levels except chromium were at or below levels for hives maintained in the region (ESG 1989, 0308). Chromium levels in honey and bees were a factor of 2 to 3 times regional background, but near the range for Laboratory-wide levels.

6.1.4 Surface Baseline Characterization Plan

6.1.4.1 Soils and Sediments

During the initial TA-49 baseline characterization, seven surface soil and two sediment samples will be collected at an interval of 0–6 in. from spatially distributed locations well separated from TA-49 SWMUs (Figure 6.1-1). These locations will supplement the Environmental Surveillance Group's annual sampling at 14 established surface stations (also indicated in Figure 6.1-1) and will augment surface sampling at individual SWMUs, as described later in this chapter and in Chapter 7.

The new soil sampling locations have been sited at sizable distances from MDA AB to provide reasonable radial coverage from the main experimental area to the site's boundaries, especially to the south along the boundary with Bandelier National Monument (BNM). Data from these locations will provide confirmatory evidence that transport of detectable levels of TA-49 contaminants to the site periphery has not occurred. A second consideration in the selection of the new sampling locations was coverage of the principal soil types at TA-49.

The two new sediment sampling points are sited further downgradient from existing stations near Areas 2 and 4, for which radionuclide concentrations above background have been reported in the past. These new stations will permit more accurate delineation and documentation of the extent of detectable contaminant transport from MDA AB.

The RFI soil sample location 5 (see Figure 6.1-1) will provide an undisturbed Hackroy-series location for comparison with the disturbed Hackroy soils at Area 11 and MDA AB. For similar reasons, the Seaby Loam will be sampled at location 7.

General soil characteristics also will be determined for the undisturbed Hackroy and Seaby Loam samples, as listed below:

- surface soil distribution;
- ASTM soil classification;
- transects of soil stratigraphy;
- hydraulic characteristics including porosity, permeability, and conductivity;
- particle size distribution and surface area;
- moisture content;
- mineralogical properties including chemical composition, ion exchange capacity, pH, indicator contaminant retardation factors, and clay and organic content; and
- vegetative cover characteristics.

In Phase I, soil and sediment background levels for the key TA-49 indicator analytes gross alpha/beta and gamma radioactivity, gamma spectrometry (including americium-241 and cesium-137), total uranium, isotopic plutonium, isotopic uranium, tritium, and RCRA metals will be determined at Level III, as summarized in Table 6.1-2. It is probable that the Phase I investigation will yield sufficient baseline data on site soil and sediment characteristics for the purposes of the TA-49 RFI. However, if Phase I results are found to be inadequate, based on decision criteria discussed in Chapter 5, additional characterization will be carried out in Phase II. Phase II could involve vertical soil profiling by means of shallow pits and an east-west trench that extends a few feet into bedrock at TA-49.

6.1.4.2 Geologic Base Map

Although Weir and Purtymun prepared a geologic map of TA-49 in 1962 (see Appendix G of this OU work plan), as was discussed in Subsection 4.5.1 of this OU work plan, this work is not completely consistent with more recent studies and does not address important structural characteristics (for example, faults and fractures) in sufficient detail for the purpose of the TA-49 RFI. Additional data is necessary to form the basis for correlation of hydrogeologic units and the extrapolation of hydraulic properties relevant to modeling the movement of water in the vadose zone beneath MDA AB. By incorporating new data from the TA-49 RFI, as well as other information that was not available in 1962, the hydrogeologic map of TA-49 will be updated.

Surface geologic field work will be carried out at the TA-49 OU and at outcroppings in adjacent canyons to supplement data that will be obtained from boreholes. The geologic map will be updated as additional information is obtained during the RFI and will summarize existing baseline geologic information to support subsequent site characterization that may be required. The map will show the distribution of TA-49 rock units and surficial materials as well as the orientation and dip of contacts, bedding planes, foliations, faults, and other discontinuities. The map also will show the lateral extent and thicknesses of rock units and major subunits, including their relative offsets, orientations, and fracture density. The TA-49 soil maps shown in Figures 4.3-1 and 4.3-2 will be updated as additional information is obtained during the RFI.

6.1.4.3 Geomorphic Characterization

Geomorphic characterization of Frijoles Mesa will identify significant erosional processes that may compromise TA-49 SWMUs over varied time scales. This characterization will generate a 1:3600 scale map emphasizing erosion and deposition areas relevant to MDA AB and Area 11. This map will include landforms and drainage patterns, sites of active and potential erosion, and potential infiltration areas. It also will indicate soil series, colluvium and artificial fill, and the degree of soil profile development.

6.1.4.4 Lateral Groundwater Discharge Points

Although no springs and seeps are currently known at TA-49, a search will be conducted by field geologic teams during the spring and summer months when flow on the Pajarito Plateau is greatest. The search will include areas of unusual vegetation that may indicate above-normal amounts of subsurface water. The bedrock and geomorphic characteristics will be determined at any site of groundwater emergence. In addition, geomorphic features such as amphitheater-shaped alcoves will be examined to identify potential sites of significant groundwater emergence during periods of wet climactic conditions. Water from any springs or seeps encountered will be analyzed for the water quality parameters indicated in Table 6.1-5.

6.1.4.5 Benchmark Resurveying

Errors up to several hundred feet are known to exist in the Laboratory's engineering survey data base for TA-49 benchmarks. Therefore, these benchmarks will be resurveyed by global position satellite or standard land surveying techniques to an accuracy of at least 1 ft (vertical and horizontal).

6.1.5 Subsurface Characterization

6.1.5.1 Background/Rationale

The available data discussed in Chapter 2 of the IWP suggests that, in general, infiltration through the vadose zone is not a pathway of immediate concern for Pajarito Plateau mesa tops. However, additional vadose zone characterization is a crucial investigative focus of the TA-49 RFI because of the large inventory of TRU wastes buried at MDA AB, the extremely long period of time over which they will remain hazardous, the anomalous occurrence of water in Core Hole 2, and the relative lack of subsurface characterization to detect potential contaminant movement. Vadose zone characterization also is important

TABLE 6.1-5

ANALYTICAL SUITE FOR TA-49 WATER SAMPLES COLLECTED FROM DEEP WELLS, SEEPS, PERCHED ZONES, AND ROCK PORES

[a]Major Anions
Bicarbonate
Chloride
Sulfate
Fluoride
Nitrate
Nitrite
Nitrate and nitrite
Phosphate

[a]Major Cations
Ammonium
Calcium
Magnesium
Sodium
Silica

[a]Radionuclides
Gross alpha/beta
Gamma spectrometry
Isotopic uranium
Isotopic plutonium
Isotopic americium

Other Parameters
Total organic carbon
Total dissolved organic carbon
Total suspended solids (<10 µm)

[a]Field-Measured Parameters
Temperature
pH
Eh
Specific conductance
Carbonate
Alkalinity
Dissolved oxygen

Minor and Trace Constituents
Aluminum
Antimony
Arsenic
Barium
[a]Beryllium
Boron
Bromide
Cadmium
Chromium
Cobalt
Copper
Iron
[a]Lead
Manganese
Mercury
Molybdenum
Nickel
Selenium
Silver
Strontium
Thallium
[a]Uranium
Vanadium
Zinc

Environmental Isotopes
Hydrogen/deuterium ratio
Oxygen-16/oxygen-18 ratio
Low-level tritium
Chlorine-36
Low-level plutonium

[a]*Included in the reduced suite of analytes.

because capping-in-place with *in-situ* stabilization and long-term maintenance and monitoring is a likely conditional remedy for MDA AB.

Thus, an important data gap for TA-49 involves hydrogeochemical data to improve the understanding of vadose zone processes immediately beneath MDA AB, as described in Chapter 4. The proposed baseline subsurface characterization will support the characterization activities within MDA AB, as addressed in Chapter 7.

6.1.5.2 Existing Information

As discussed in detail in Chapter 4 of this OU work plan, earlier studies (1959 – 1961) of experimental holes and cores at TA-49 provided a considerable amount of geotechnical information on the vadose zone at TA-49. However, as described in Subsection 4.5.1, some subsurface structure interpretations in the earlier studies are not completely consistent with current understanding of the Pajarito Plateau geohydrology.

Additionally, sufficient coring has not been conducted to fully establish the variability of subsurface structure over the site, particularly at depths below the shaft bottoms at MDA AB. For example, there are substantial uncertainties regarding the existence and/or significance of a fault zone under MDA AB. Also, core samples from the earlier investigations are no longer available for the detailed geotechnical characterization of the vadose zone beneath MDA AB now required. Surface investigations alone are inadequate for this purpose because fault zones of the Pajarito Plateau typically occur in "swarms" with small individual displacements and therefore often are not obvious in the field.

6.1.6 Subsurface Characterization Plan

6.1.6.1 Approach

Subsurface characterization at TA-49 will be carried out in two phases. During Phase I, 700-ft vertical boreholes and lateral coreholes beneath Areas 1 and 2 of MDA AB will be drilled. The rationale for the location and number of these boreholes and the characterization to be performed, as well as other Phase I studies to be conducted within the boundaries of MDA AB, are described in Chapter 7. The result will be a network of boreholes and core samples providing direct information on water and contaminant movement, hydraulic properties, and the significance of fracture systems beneath TA-49. The Framework Studies and Environmental Surveillance Groups are involved in planning these activities to ensure that the resulting data is cost effective and of the maximum utility for the entire Laboratory ER program.

Subsurface baseline studies at TA-49 will address the transport-related geologic, geochemical, and hydrologic properties of geologic units that presently contain waste or that lie between waste disposal sites and the main aquifer. The borehole network will address the following issues for the vicinity of MDA AB (where the principal source term exists):

- confirmation that significant perched water zones are not present beneath MDA AB;
- confirmation that deeply buried contaminants in the experimental shafts have not moved significantly beyond the originally contaminated zones;
- determination of vertical and lateral changes in stratigraphy and lithology to a depth of 700 ft;
- determination of subsurface hydraulic, geochemical, and mineralogical properties needed to model transport of water and contaminants in the upper vadose zone;
- characterization of faults, fractures, partings, stratigraphic contacts, welding zones, and similar structural features;
- identification of potential natural barriers to, and conduits for, contaminant transport; and
- determination of the origin, age, and recharge flux of vadose zone fluids.

As described in Chapter 7, standard field protocols described in ER SOPs will provide appropriate data quality levels for geologic field work. Level III techniques will be required for analysis of soils, sediments, cores, and groundwaters.

Core samples collected during the TA-49 RFI will be archived for subsequent chemical, physical, and mineralogical analyses, as appropriate.

6.1.6.2 Stratigraphic Sections

During the Phase I TA-49 baseline geologic investigation, hydrostratigraphic data will be compiled on the following:

Within cooling units

- Welded tuff/nonwelded tuff
- Zeolitic zones
- Lithic-rich zones
- Dense, competent tuff
- Fractured, jointed tuff
- Open fractures, joints
- Mineral coatings on open surfaces
- Clay-filled fractures, joints

Stratigraphic contacts between contrasting lithologies

- Weathered tuff
- Cooling units

- Surge deposits
- Pumice and ash-fall deposits

Sediments

- Fluvial sands, gravels, and cobbles
- Lacustrine fine sand, silt, and clay
- Inter-layered alluvial, ash flow, and ash - fall deposits

At least two detailed stratigraphic sections will be prepared for TA-49 and will be correlated with hydrologic properties to model movement in the vadose zone. These sections will incorporate data from past studies of upper Bandelier Tuff outcrops and boreholes at and around Frijoles Mesa, as well as from new studies proposed in the TA-49 RFI. The stratigraphic sections will detail:

- lithologies, stratigraphic contacts, welding and devitrification features;
- zones of vapor-phase crystallization;
- major hydrogeological subunits, where matrix and fracture properties could control the movement of moisture and contaminants;
- cooling joints and tectonic fractures and their orientations; and
- Secondary minerals and filling materials in fracture zones and joints from selected core segments, to characterize their potential role as mineralogic barriers to upper vadose zone contaminant migration.

The permeable surge deposit that composes stratigraphic Unit 5 will receive particular attention because it lies at the level of the major source term at MDA AB.

6.1.6.3 Additional Deep Test Well Near TA-49

Contingent upon the results of Phase I investigations and according to the decision process outlined in Chapter 5, a deep bore hole into the main aquifer in the vicinity of TA-49 may be proposed in Phase II of the TA-49 RFI. The purposes of an additional deep well at or near TA-49 would be consistent with recommendations of the recent ER-sponsored external review of the hydrogeology of the Laboratory site (Kearl et al. 1991, 0652) and would allow several issues pertinent to the TA-49 OU to be addressed.

- Deep core sections would be available to refine stratigraphic sections for deep-lying epiclastic rocks in the Cerro Toledo rhyolite and fluvial sedimentary rocks that occur in the Puye Formation and the Santa Fe Group.
- Better definition of groundwater flow direction beneath TA-49 would be possible.

- An additional deep aquifer station would be available for monitoring groundwater quality in the main aquifer.

Better flow definition is desirable because at present, flow directions are extrapolated using data from the cluster of three wells at TA-49 (the only wells along the southern periphery of the Laboratory), springs in White Rock Canyon, and deep wells along the northern boundary of the Laboratory. Although the potential for contamination of the main aquifer is very small, even a small realignment of the currently assumed flowpaths could project groundwater flow from TA-49 toward BNM.

Figure 4.4-2 shows the locations of existing core holes at TA-49. The precise siting of a new deep well near TA-49, if required, would be determined in part by the results of the TA-49 Phase I RFI. The Laboratory-wide Framework Studies Environmental Surveillance groups, and RFI activities at adjacent OUs, will play important roles in determining both the location and specific measurements to be carried out at such deep wells.

6.1.6.4 Characterization of Groundwater and Vadose Zone Water

Throughout Phase I, groundwater samples will be collected from deep test wells DT-5A, DT-9, and DT-10 on an annual basis and will be analyzed for the parameters listed in Table 6.1-5. In addition, any perched or spring waters or seeps that may be encountered in the RFI will be sampled on a quarterly basis for the duration of the TA-49 RFI. If no contaminants are found in the two initial samplings, the quarterly samples will be analyzed for a reduced analytical suite judged to provide adequate indication for significant change in groundwater quality. (The reduced suite is indicated in Table 6.1-5.). Level III analysis is required to ensure that the data collected are of sufficient quality for subsequent risk assessment.

Pore water from core sections obtained beneath Areas 1, 2, 3, and 4 also will be collected and analyzed as described in Chapter 7.

6.2 AREA 11 - RADIOCHEMISTRY AND SMALL-SCALE SHOT AREA

Description, Data Needs and Objectives, and Sampling Plan for:
- SWMU 49-003 (radiochemical leachfield)
- SWMU 49-008(c) (surface contamination)

6.2.1 Introduction

Section 6.2 describes Area 11 of TA-49, which includes SWMU 49-003 (a radiochemistry leachfield), SWMU 49-008(c) (soil contamination), and the small-scale shot area. The objectives of the field investigation and the detailed sampling plan also are described in this section. Summaries of samples and analyses for Area 11 field investigations are given in Tables 6.2-1 of this chapter and Tables E-2(a) and E-2(b) of Appendix E.

For Area 11, data are needed primarily to define the distribution and extent of contaminants in surface and near-surface soils. A conceptual model for Area 11, including potential transport pathways and receptors, is identified in Section 4.11 of this OU work plan. The principal potential contaminant-migration pathway is erosion (aerial resuspension and surface water runoff). However, the significance of infiltration from small radioactive liquid releases in the past also will be investigated. Although highly localized contamination above action levels may well be present in the leachfield, the likelihood of transport of significant levels of contaminants from Area 11 in the near term is considered unlikely for the following reasons:

- Area 11 is located on a relatively flat portion of Frijoles Mesa, minimizing runoff;
- the depth to the main aquifer is about 1200 ft and there are no aquifers known or expected in the area;
- the distance to potential off-site receptors is large for the assumed exposure scenarios and no credible pathways are known;
- access and use of the site is strictly controlled; and
- a relatively low inventory of contaminants is anticipated at Area 11.

For these reasons, the likelihood for significant impact to public health or environment from Area 11 contaminants is minimal over the assumed institutional time frame of 100 yr. The near-term concern caused by contamination in Area 11 is the potential for runoff dispersal of very low (but above background) radionuclide levels downgradient, thus complicating the interpretation of environmental data from other areas of TA-49.

The criteria for preliminary identification of potential response actions at Area 11 are presented in Chapter 5. Site capping and stabilization (accompanied by long-term institutional control, monitoring, and maintenance) and selective removal/disposal of soil hot spots and contaminated near-surface debris, are identified as the most likely remedial alternatives. Installation of a sediment trap

TABLE 6.2-1

SUMMARY OF SAMPLES AND ANALYSES FOR PHASE I INVESTIGATIONS FOR AREA 11 [SWMUS 49-003 AND 49-008 (c)]

Number of Samples[a]

	Soil Sample	Borehole Sample
Analytical samples	40	40
QA/QC samples		
Rinsate blank	2	2
Field duplicate	2	2
Field blank	2	2
Total number of field samples	46	46

[a]Routine field survey instruments will be used to screen for gross alpha and beta contamination. HE spot tests will be used to screen cores from the small-scale shot area. Where appropriate, and depending upon convenience and field laboratory availability, analysis of Area 11 samples will be performed in either the field laboratory or off-site analytical laboratory. Gamma spectrometry will yield gross gamma; americium-241, and cesium-137 levels.

Number of Laboratory Analyses

	Soil Sample	Borehole Sample	Level III Method
Total uranium	23	23	ICPMS
Isotopic plutonium	23	23	Alpha spectrometry
Gross alpha/beta	46	46	Gas flow proportional counter
Gamma spectrometry	46	46	Gamma spectrometry
SVOCs	0	39	SW 8270
HEs	0	2	Baytos 1991, 0741
RCRA metals	23	23	SW 6010
Total number of analyses	161	202	

Other Characterization:

Number of boreholes = 15
Linear feet of core = 138
Radiological and geophysical surveys will be conducted over an area of 65,000 ft^2.

to intercept runoff immediately downgradient from the leachfield also is a possibility. Because Area 11 is encompassed by components of MDA AB, it is likely that Area 11 and MDA AB will continue to be managed together for the indefinite future. Thus, the degree of characterization and the selection of remedial actions for Area 11 are logically considered jointly with those of MDA AB.

6.2.2 Description and Site History of Area 11

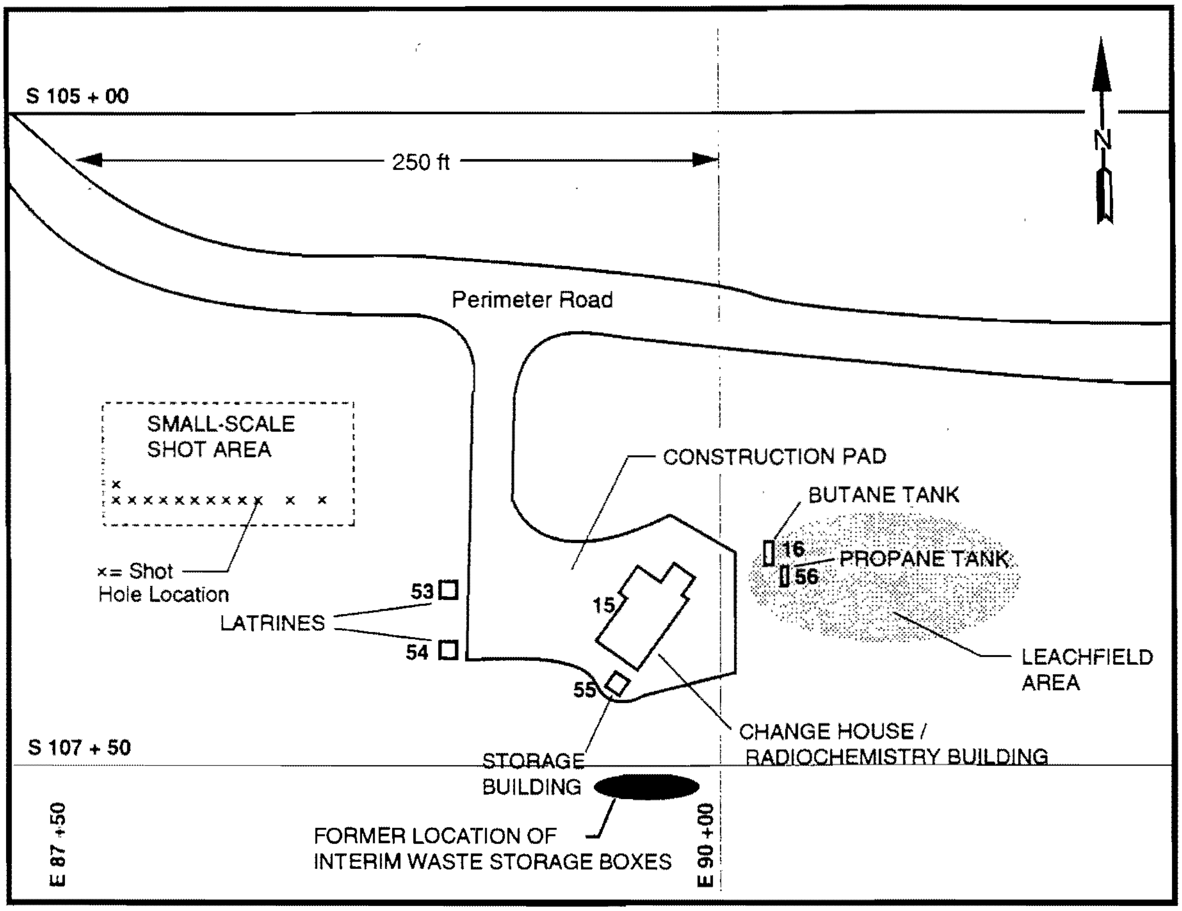
The general location of Area 11 within TA-49 is given in Figure EXEC-3. A 1961 site diagram of Area 11 is given in Figure 6.2-1 and a recent low-altitude photograph across Area 11 is given in Figure 3.1-2(c). As Appendix A shows, the land surface gently dips to the east from Area 11 so that runoff is primarily directed from Area 11 toward Area 2.

Significant Laboratory use of Area 11 was limited to activities related to the hydronuclear program at TA-49 from 1959 to 1961 (Purtymun and Stoker 1987, 0204). Area 11 activities during that period consisted exclusively of limited radiochemistry operations and small-scale containment experiments involving HE detonations in shallow shafts (where indicated in Figure 6.2-1).

Area 11 was used first for small-scale containment experiments involving approximately thirteen 10-in.-diameter by 12-ft-deep vertical holes that were cased in steel (Figure 6.2-2). Explosive charges were set off at the bottoms of the holes, usually after backfilling the holes with sand to contain the explosive force. In some of the shots, irradiated uranium-238 tracer was employed. According to Laboratory records, a maximum of 10.5 g of uranium was used for this purpose and the irradiated samples are estimated to have contained initially only microcurie levels of neptunium-239. Neptunium-239 has a half-life of only 2.3 days and thus has decayed completely to negligible levels of plutonium-239 (Minor 1991, 03-0034). Some of the shot holes also may have contained small quantities of lead. Some holes probably were backfilled partially with concrete at the conclusion of the experiments. Two capped holes with 10-in. casing that extends above ground are visible in this area at the present time.

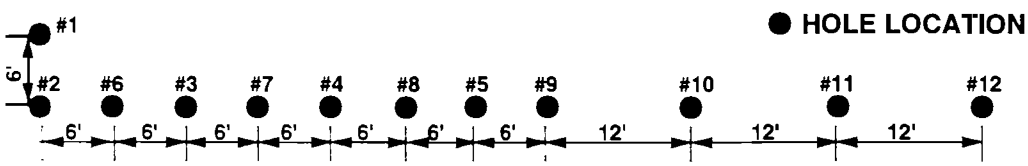
Radiochemistry operations were performed in Area 11 in structure TA-49-15, located where indicated in Figure 6.2-1. This building contained hoods and sinks for performing radiochemical operations. Eventually, a drain line was installed to connect the radiochemistry building to a leachfield located a few feet to the east. One site employee recalled that the drainline extended from the southwest portion of the building. Small quantities of liquids may have been discharged to the soil beneath the building before the drainline was connected to the leachfield. The subsurface leachfield and associated pipes remain in place and now constitute SWMU 49-003. The approximate location of the leachfield now is marked by signs labeled "TA-49-15 Drain Field." Other structures in this area were support facilities that did not involve hazardous or radioactive materials.

The structures shown in Figure 6.2-1 were located on a level, elevated construction pad created by backfilling the natural area with clean, crushed tuff (Eller 1992, 03-0035). Inspection of laboratory notebooks and interviews of radiochemists and health physicists who worked at Area 11 indicate that



AREA NO. 11

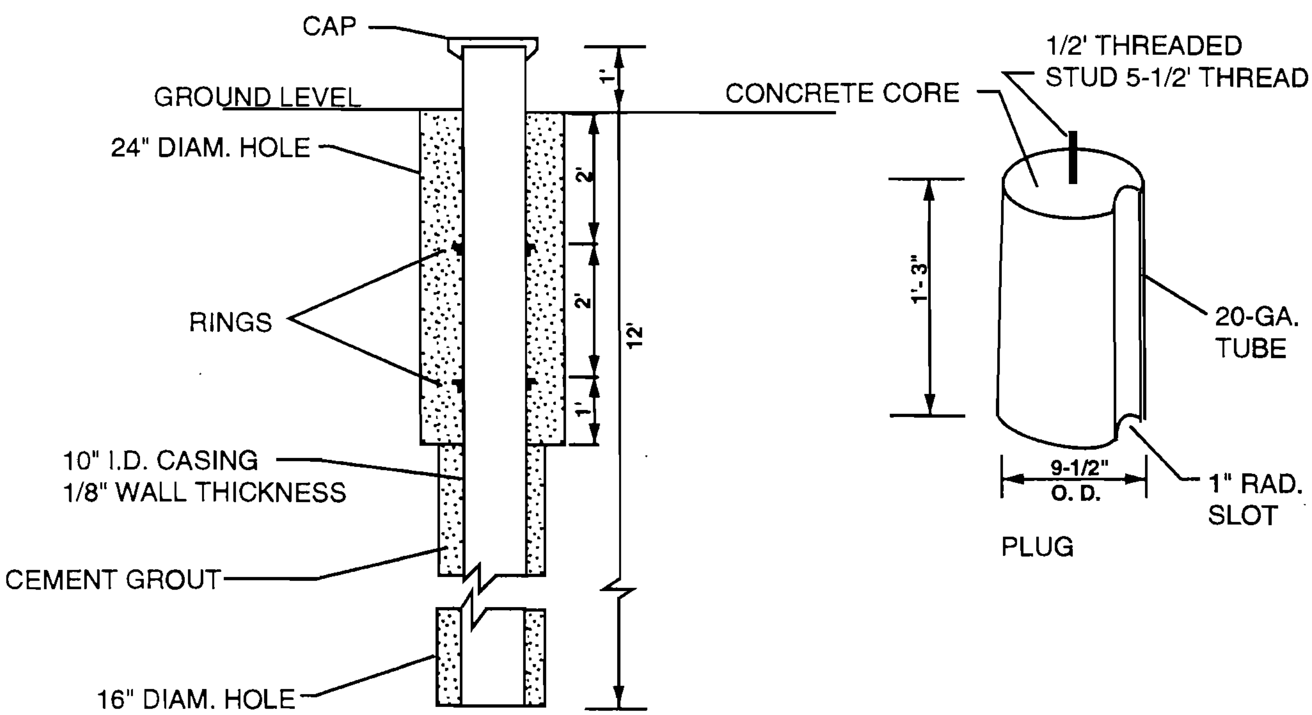
FIGURE 6.2-1 Engineering diagram of Area 11 around the period of peak site activities. Former structure numbers are indicated with their number designations (adapted from engineering drawing ENG-R2486, 8/15/61)



LAYOUT OF TEST HOLES

DATA:

HOLE: #6 10" I.D 8' 8" DEEP
#7 10" I.D 12' 0" DEEP
#8
#9
#10 - SEE SKETCH - 12' 0" DEEP - 10" CASING GROUTED IN PLACE
#11
#12



TYPICAL SECTION THROUGH A 10" CASED HOLE

Figure 6.2-2 Layout and hole construction information for the small-scale shot area (adapted from Laboratory Engineering drawings).

radiochemical wastes were limited in quantity and were mostly collected in containers for disposal at a Laboratory radioactive waste disposal facility. Total radioactivity involved in Area 11 radiochemistry operations is estimated to have been less than 10 mCi of TRU, and levels of fission products were much lower (Barr 1991, 03-0001).

The radiochemistry operations consisted of initial acid dissolution (by nitric, hydrochloric, hydrofluoric, sulfuric, and perchloric acids) of solid residues recovered from experiments conducted in Areas 2, 2A, 2B, and 4. Quantities of acids were limited to a few tens of liters or less per dissolution. Solvent extraction involved only several liters or less of methylisobutyl ketone, ammonium hydroxide, and sodium hydroxide. Small quantities of 8-hydroxyquinoline also were used for chemical separation. Area 11 radiochemical wastes also consisted of low levels of plutonium, americium, uranium, cesium-137, and possibly minor amounts of other alpha, beta, and gamma emitters. Beryllium and lead were present in very limited amounts.

Most Area 11 waste solutions were drained into containers that were taken to a Laboratory radioactive waste disposal facility. However, it is likely that small quantities of very low level radionuclide solutions were discharged to the soil outside the radiochemistry laboratory. Waste radiochemical solutions sometimes were placed in bottles for interim storage in a steel box at the location indicated in Figure 6.2-1. The box was removed from TA-49 during or before cleanup of Area 11 in 1971.

The precise location and details of the underground distribution system of the leachfield are unknown but the location is estimated in Figure 6.2-1. The estimate is based partially on interviews of the construction engineer who installed the field. The engineer stated that the underground distribution system most likely was constructed of terra cotta pipe laid in a gravel matrix (Eller 1992, 03-0035). Additional information was obtained from Laboratory documents, including a 1971 report that describes the field as a "settling area 20 to 25 ft east of TA-49-15" (Eller 1992, 03-0002). Former site radiochemists have estimated that less than 50 gal of organics and less than several hundred gal of water could have been discharged into the leachfield during the entire period of operation (Penneman 1991, 03-0048).

In 1970 and 1971, Area 11 radiochemistry structures were decontaminated, demolished, and removed (Eller 1992, 03-0002). Contaminated equipment, debris, and chemicals were packaged and sent to TA-54 for disposal. All equipment and building debris found to be free of contamination by field instruments used at the time were taken to the open burning/landfill area in Area 6. Approximately 2160 ft^3 of material went to this disposal area, which was then covered with about 3 ft of topsoil.

Butane tanks TA-49-16 and TA-49-56 (both above-ground tanks) were shown to be free of radiological contamination and were taken to the Laboratory salvage yard (Eller 1992, 03-0002; Eller 1992, 03-0035).

During removal of the Area 11 radiochemistry building in 1971, typical maximum alpha contamination levels ranged from 10,000 cpm (sinks) to more than

100,000 cpm (hood ducts and blowers), but roofs and other exterior surfaces were found to be essentially free of detectable contamination (Eller 1992, 03-0002).

During the operations from 1959 to 1961, and during the 1971 cleanup, extensive and frequent field monitoring for gross alpha, beta, and gamma radioactivity was conducted. Available information indicates that levels of contamination of concern at that time were not detected except for the Area 11 structures as described above). Additional information on the Area 11 cleanup in 1971, including structure-contamination levels and demolition photographs are available in a detailed report (Eller 1992, 03-0002).

During a reconnaissance investigation in 1987, alpha contamination was detected in pipes leading to the leachfield (DOE 1987, 0264). Soil samples were taken from the leachfield during a DOE environmental survey in 1988, in which the leachfield was identified as a prototypical Laboratory environmental problem (DOE 1989, 0450). The soils were found to contain above background levels of uranium, plutonium, americium, and alpha radioactivity but little detail was contained in the survey report.

Contamination of Area 11 soils potentially has occurred from airborne transport of low levels of radionuclides from Areas 1 through 4. However, because of the isolated and very limited nature of such potential releases, contamination levels at Area 11 resulting from this mechanism are expected to be undetectable.

Currently Area 11 is within the locked exclusion fence that surrounds Areas 1, 2, 2A, 2B, and 4 of MDA AB. Access also is controlled by the locked gate at State Road 4, which limits ingress and egress at TA-49.

The extent of surface and subsurface contamination in the radiochemical leachfield has not been determined precisely, but based on the historical information summarized above, contaminant inventories are expected to be localized and limited in quantity. Only limited surface soil sampling has been conducted at Area 11, and no subsurface sampling has been carried out.

6.2.3 Additional Information on Potential Source Terms at Area 11

The most intensive study of Area 11 contamination was carried out in 1987 as part of the A411 survey discussed in Section 5.3.2 of this OU work plan. During this survey, soil and vegetation samples were collected in the general area formerly occupied by the radiochemistry building (Soholt 1990, 0698). Analytical results for radionuclides are summarized in Table 6.2-2. Figure 6.2-3 shows sampling locations and measured levels of plutonium-239/240 in Area 11 surface soils.

Apparently because of errors in the Laboratory's survey database, an adjustment of several hundred feet was necessary to make the plots in the A411 survey agree with field notebooks and A411 survey stakes remaining in Area 11. It appears that the A411 survey sampled only the construction pad and the westemmost edge of the presumed leachfield area.

TABLE 6.2-2

SUMMARY OF 1987 A411 SURVEY RESULTS FOR AREA 11

Radionuclide	Area 11[a] Soil	Area 11[a] Vegetation	Regional Soil Background
	(22 samples)	(20 samples)	
Cs-137 (pCi/g)			
Mean	0.38	1.17	0.88
Std dev	0.30	0.73	0.18
Number of samples	20	19	---
Total Uranium (µg/g)			
Mean	4.1	0.44	3.8
Std dev	1.73	0.26	---
Number of samples	20	20	0.4
Pu-238 (pCi/g)			
Mean	0.140	0.001	0.003
Std dev	0.542	0.001	0.003
Number of samples	20	20	---
Pu-239/240 (pCi/g)			
Mean	7.52	0.046	0.019
Std dev	26.9	0.065	0.002
Number of samples	20	20	---
Am-241 (pCi/g)			
Mean	1.39	0.164	---
Std dev	4.96	0.192	---
Number of samples	20	20	---

[a]Area 11 data are from the 1987 A411 report (Soholt 1990, 0698). Background levels are maximum values from Table G-32 of the 1989 ESG report (ESG 1990, 0497). Analytical quality level is approximately Level III (see Sections 5.3.2 and 5.7 of this OU work plan).

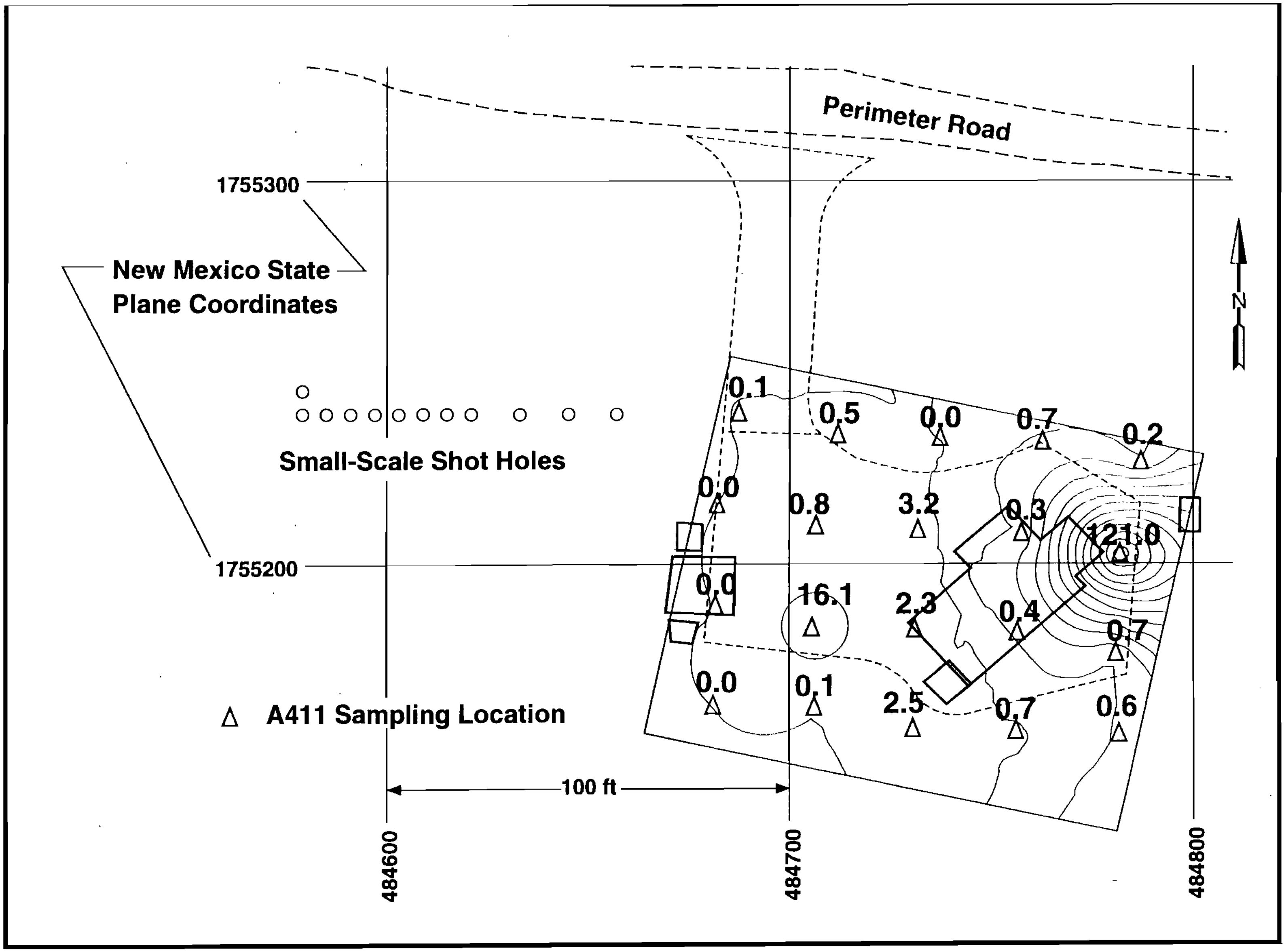


Figure 6.2-3. Soil sample locations and plutonium-239/240 levels (pCi/g) for Area 11 adapted from the 1987 A411 survey report (Soholt 1990, 0698). The sampling locations around the sampled area are from Figure 14(a) in the A411 report. The A411 data have been overlaid on Laboratory engineering drawings; the position is based on field observations of existing A411 survey stakes.

Radionuclide levels were near background for most sampling locations, but activities of total uranium, plutonium-238, plutonium-239/240, and americium-241 were above background for a few samples.

The most elevated radioactivity by far was associated with a sample location near the east edge of the former radiochemistry building, possibly where the sink drain was located (see Figure 6.2-3). Contamination levels at this sampling point were 121 pCi/g (plutonium-239/240), 22 pCi/g (americium), and 2.4 pCi/g (plutonium-238). Figure 6.2-3 clearly shows the highly discontinuous distribution of radioactive contaminants in Area 11, as has typically been observed at other TA-49 SWMUs, and as discussed later in this chapter and in Chapter 7. The total radionuclide level averaged over the sampling stations is about 0.6 pCi/g (when the elevated station is excluded), well below the TRU action levels in Section 5.1 of this OU work plan.

During the A411 survey, levels of radionuclides were determined for 20 vegetation samples collected from Area 11 (Table 6.2-2) and were found to be unexceptional. Statistical comparisons of mean activities in soils and vegetation suggested poor correlations between the two media (Soholt 1990, 0698).

In May 1991, a geophysical survey of Area 11 was performed using magnetometry, as well as electromagnetic and ground-penetrating radar techniques (Geophex 1991, 03-0031). Figure 6.2-4 displays an interpretive sketch of Area 11 based on these measurements. Additional technical information on the geophysical survey are given in Appendix D of this OU work plan. In the likely location of the leachfield, the survey results suggested near-surface piping and electrically conductive areas possibly related to subsurface chemical contamination or elevated moisture levels. The survey also confirmed the location of some buried metal in the small-scale shot area. Other portions of the area surveyed appeared to be entirely free of artifacts.

6.2.4 Data Needs and Objectives and Investigation Rationale

The overall objective of the field investigation at Area 11 is to determine the feasibility of unrestricted Laboratory use, subject to general site restrictions from continued use of TA-49 as a firing site buffer zone and its management with MDA AB.

The key field objective is the determination of the distribution and level of contamination in the surface and subsurface, particularly in the leachfield area.

Based on existing information described above and in preceding chapters of this OU work plan, the observational approach implies that Area 11 characterization needs are limited to those that directly address the following decision questions:

Do contaminants of concern exist above action levels, other than in the leachfield subsurface?

What is the vertical and lateral extent of contamination above action levels in the leachfield?

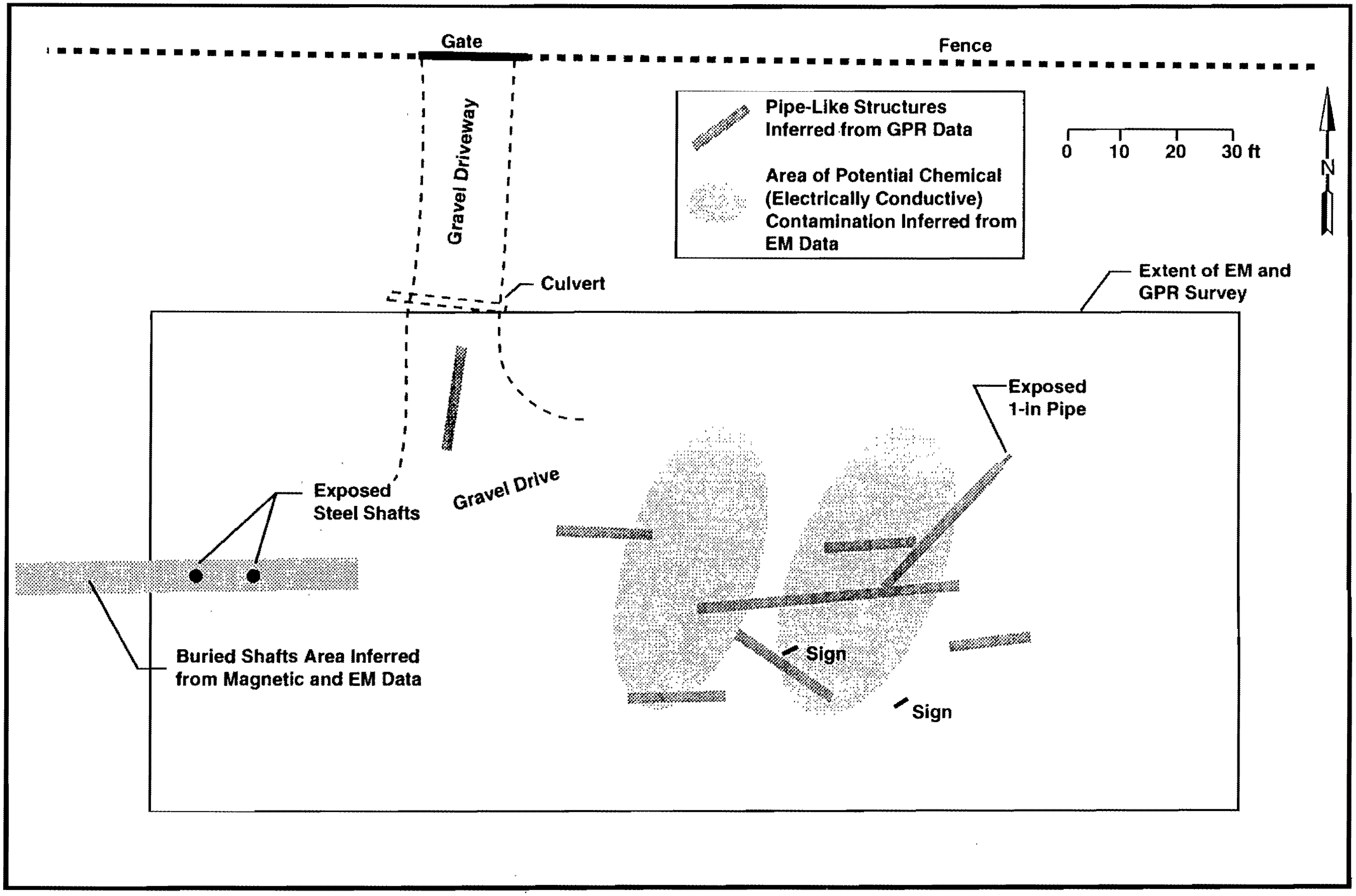


Figure 6.2-4 Interpretive sketch of Area 11 based on geophysical data (adapted from Geophex 1991, 03-0031).

Given the contamination levels and site properties, are runoff and infiltration significant transport mechanisms for the leachfield?

A single phase of investigation probably will be adequate to answer the first decision question. If the answer is negative, no further action will be proposed and the RFI/CMS will cease for portions of Area 11 addressed by this question.

The second decision question also might be answered in Phase I, but uncertainties are greater than those for the first question. Therefore, a second investigation phase is assumed to be necessary, for planning purposes, to adequately define the subsurface plume.

The answer to the third decision question is likely to be negative in Phase I, but it is closely related to the second question.

A combination of geophysical surveys, surface area radiological surveys, and Level III analysis of discrete surface and subsurface samples is proposed to answer the first and second questions. Limited characterization of soil and corehole characteristics is used to answer the third question. Specific data objectives for Area 11 include the efforts below.

- Surveys of surface soils to detect radiological hot spots will cover at least 90% of the area indicated in Figure 6.2-5. This survey will be supplemented by Level III analysis for radionuclides and RCRA metals for planned grid samples and any hot spots discovered by the surveys.
- Soil samples from a network of shallow coreholes at the expected leachfield area will be collected and analyzed as described for surface soils, in addition to SVOCs.
- Hydrogeochemical properties pertinent to potential contaminant transport will be determined for selected soil and near-surface tuff samples from the leachfield area.
- Borehole samples from representative small-scale shot holes will be collected for Level III analysis of radionuclides and metals. If spot tests indicate the presence of HEs, Laboratory analysis for HEs also will be performed.
- A shallow core sample and a surface sample will be collected at the former location of the steel box used for interim storage of containers filled with radiochemistry waste solutions. Level III analysis will be carried out for radionuclides, metals, and SVOCs.

Based on the relatively detailed historical information on past uses of Area 11, the sampling rationale assumes that a limited set of analytes is sufficient to define areas of contamination through direct surface and subsurface sampling. It is further anticipated that surface contamination will be highly discontinuous (see Figure 6.2-3) but that subsurface leachfield contamination will be relatively continuous (although restricted to a small area) because it originated from small liquid discharges.

6.2.5 Sampling Plan

The QA/QC field samples for the Area 11 investigation are listed in Table 6.2-1 of this section and Table E-2 of Appendix E. Surface sample and borehole locations will be surveyed by standard land surveying methods to an accuracy of at least 1 ft. (vertical and horizontal).

6.2.5.1 Area 11 Surface Soils Survey [SWMU 49-008(c)]

Characterization of Area 11 surface contamination will begin with radiological surveys of at least 90% of the area over the leachfield area, the construction pad that formerly supported Area 11 structures, and the small-scale shot area, as is indicated in Figure 6.2-5. The radiological survey will use either hand-held or tripod-mounted detectors or a mobile gamma spectrometry system of the type employed by the DOE Remote Sensing Laboratory (operated by EG&G-Las Vegas) for site-wide radiological surveys. If hot spots are detected, a FIDLER, PHOSWICH, or equivalent system will be used to precisely locate the hot spots and soil samples will be collected. A description of these survey instruments, including detection limits for target radionuclides, is given in Section 4 of Appendix C and in Appendix F of this OU work plan. To determine spatial variability, additional samples will be collected 1 m laterally from and at a depth of 6 to 12 in. below the hot spots.

In addition to samples of hot spots, surface soil samples will be collected on a 20- by 20-ft mesh square grid over the leachfield area, as indicated in Figure 6.2-5. This mesh was chosen because it provides reasonable spatial sampling resolution of the potentially contaminated leachfield area that ultimately might be excavated. This grid spacing also is compatible with the assumed separation of the subsurface distribution lines (approximately 10 ft). Separate surface soil samples will be collected at the leachfield borehole sampling points.

For surface soil samples, gross alpha, beta, and gamma spectrometry measurements (using either the field laboratory or an off-site analytical laboratory) will be conducted for all samples collected. One-half of these samples, plus all samples for which above-background levels of these analytes are indicated in the field laboratory, also will be analyzed in an analytical laboratory for isotopic plutonium, total uranium, and RCRA metals at Level III.

6.2.5.2 Leachfield Drainlines

As appropriate, drainlines located by the 1991 geophysical survey will be removed as VCAs (see Section 2.10 of this OU work plan). At least one soil sample associated with each 10-ft section of pipe will be collected and analyzed at Level III by the process described for Area 11 surface soils. Based on available information, 10 ft is judged as a typical length of piping (that is,

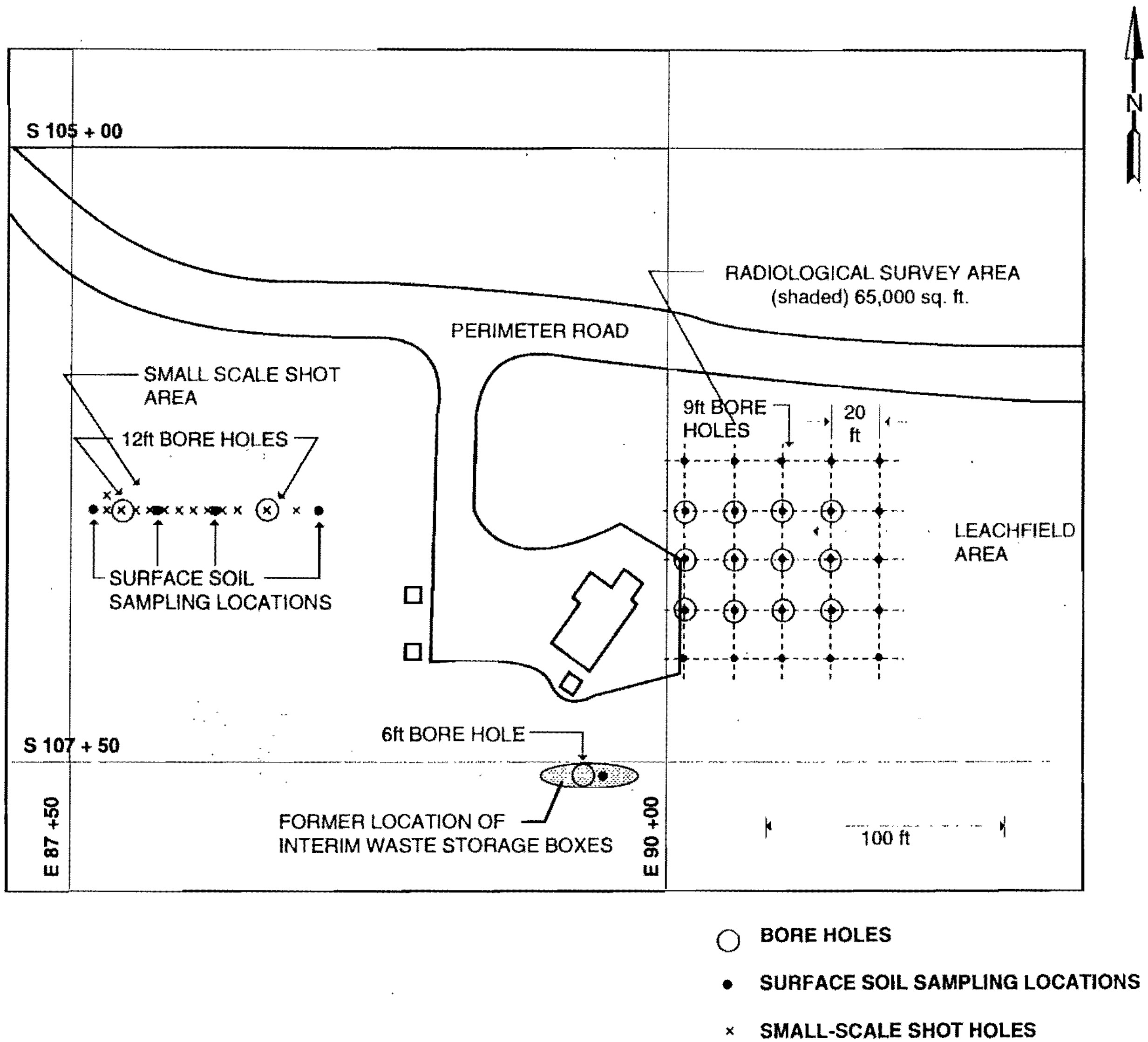


Figure 6.2-5 Proposed RFI soil and core sampling loactions at Area 11. Former structure locations are shown (adapted from engineering drawing ENG-R2487, 8-15-61).

distance between joints) and sampling at 10-ft intervals is judged to be adequate for the purposes of the investigation. Based on the 1991 geophysical survey, about 10 samples of this type will be required. After it is believed that all the piping has been removed, a geophysical survey will be repeated over the leachfield area to locate any remaining near-surface debris.

6.2.5.3 Leachfield Boreholes (SWMU 49-003)

Shallow boreholes will be installed in the suspected leachfield area as shown in Figure 6.2-5. The proposed area for coring and the corehole depths are based on available information and are expected to bound the subsurface plume. The sampling grid interval was chosen to provide a reasonable judgementally sampling density for subsequent statistical treatment of soil contaminant levels and to serve as a convenient basis from which Phase II sampling can be designed (if necessary).

Core samples will be collected in 3-ft increments by auguring to a depth of about 9 ft, which should extend into intact tuff. Based on available information, this should encompass the entire vertical zone of contamination. If sample analysis does not show that the plume limit has been defined by this scheme, sampling over a wider and deeper area may be required in Phase II sampling. Core sections will be analyzed as described for Area 11 surface soils, with the addition of SVOCs.

Neutron moisture profiles will be run for all leachfield boreholes. Soil characterization as described in Section 6.1 will be performed on two sets of leachfield borehole samples (a total of six samples).

6.2.5.4 Interim Storage Container Area

One surface soil sample will be collected and one 6-ft vertical bore hole will be augured at the former location of the radiochemical waste storage box. Analysis of the soil sample and two 3-ft sections from the bore hole will be carried out as described for Area 11 borehole samples.

6.2.5.5 Small-Scale Shot Holes

Coreholes will be drilled into two randomly selected (uncapped) small-scale shot holes, as indicated in Figure 6.2-5. The operating assumption is that sampling of two of the shot holes will provide sufficient data, when coupled with historical information, to determine with adequate confidence whether significant subsurface contamination exists in the holes. The coreholes are designed to intersect the shot cavities and a single 5-ft sample section, centered on the expected location of the cavity where contaminants are most likely to occur, will be collected from each borehole. The samples will be field-screened using a HE spot test and analyzed as described for Area 11 soils, including HEs (if any are detected in spot tests).

6.2.6 Phase II Investigations at Area 11

Although adequate definition of the extent of surface and subsurface contamination is intended to be completed in Phase I, for planning purposes it is assumed that Phase II characterization may be required to define with adequate precision the extent of contamination in the leachfield. In this case, sampling of additional surface soil and shallow borehole locations beyond the sampling area indicated in Figure 6.2-5 may be needed. For planning purposes, it is assumed that 15 additional soil samples and 9 additional boreholes (27 core samples) will be required in Phase II.

6.3 LANDFILLS, TRENCHES, AND AREA 6 SOIL CONTAMINATION

Description, Data Needs and Objectives, and Sampling Plan for:

- **SWMU 49-004 (open burning/landfill area in Area 6)**
- **SWMU 49-005(a) (small landfill east of Area 10)**
- **SWMU 49-005(b) (small landfill in Area 5)**
- **SWMU 49-008(b) (potential soil contamination in Area 6)**

6.3.1 Introduction

Section 6.3 describes the objectives and details of the field investigation for the following four SWMUs:

- open burning/landfill area in Area 6 (SWMU 49-004),
- small landfill near Area 10 [SWMU 49-005(a)],
- small landfill east of Area 5 [SWMU 49-005(b)], and
- potential soil contamination in Area 6 [SWMU 49-008(b)].

Four open trenches west of the open burning/landfill also are addressed in Section 6.3.

The locations of SWMUs and open trenches addressed in Section 6.3 are shown in Figure EXEC-3 and in the aerial photographs in Figure 3.1-1. Recent views across these areas are shown in Figure 3.1-2(e). Figure 6.3-1 shows recent ground-level photographs of the open burning/landfill area, the possible location of the small landfill, and the open trenches. Figure 6.3-2 shows the appearance of the open burning/landfill area in 1971. Figure 6.3-3 shows the location of structures in Area 6 during the hydronuclear and related experiments at TA-49 from 1959 to 1961.

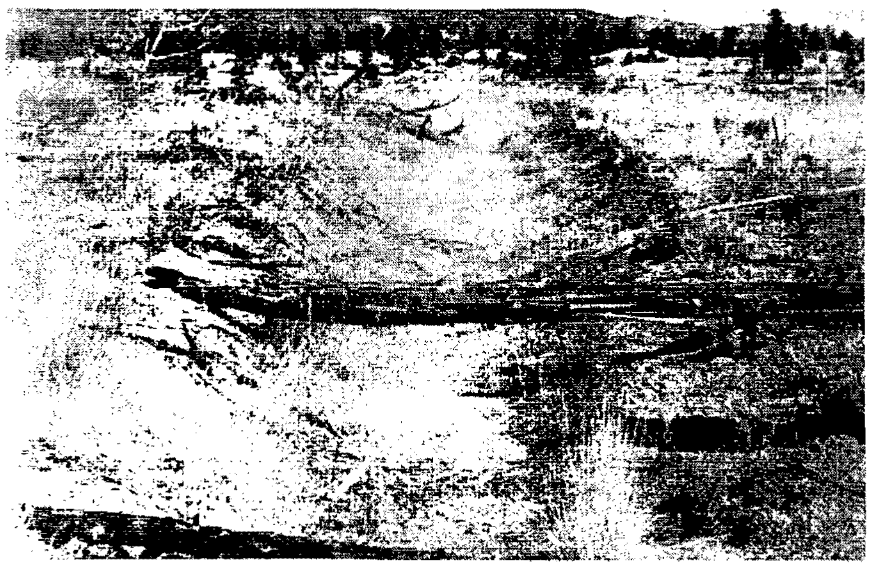
Field measurements and laboratory analyses for the field investigations proposed in this section are summarized in Tables 6.3-1 and E-3 (Appendix E).

The overall goal of the field investigation is to demonstrate and document the suitability of these SWMU areas for unrestricted Laboratory use, subject to site-wide restrictions resulting from the ongoing use of TA-49 as a firing site buffer zone. Indefinite continuation of present use of these areas by the Laboratory is assumed.

For SWMUs addressed in Section 6.3, RFI data are needed primarily to determine the presence or absence of contaminants in the soils and subsurface relative to levels that could threaten human health and the environment. Conceptual models for these SWMUs, including potential exposure routes, pathways, and receptors, are identified in Chapter 4 of this OU work plan. The principal potential contamination-migration pathways for these SWMUs are erosion (surface runoff and aerial resuspension) and (less likely) infiltration

Figure 6.3-1 Photographs of the open burning/landfill area, possible location of the small landfill, and the open trenches.

(a) View across open burning/landfill area (SWMU 49-004). Nov 1990.



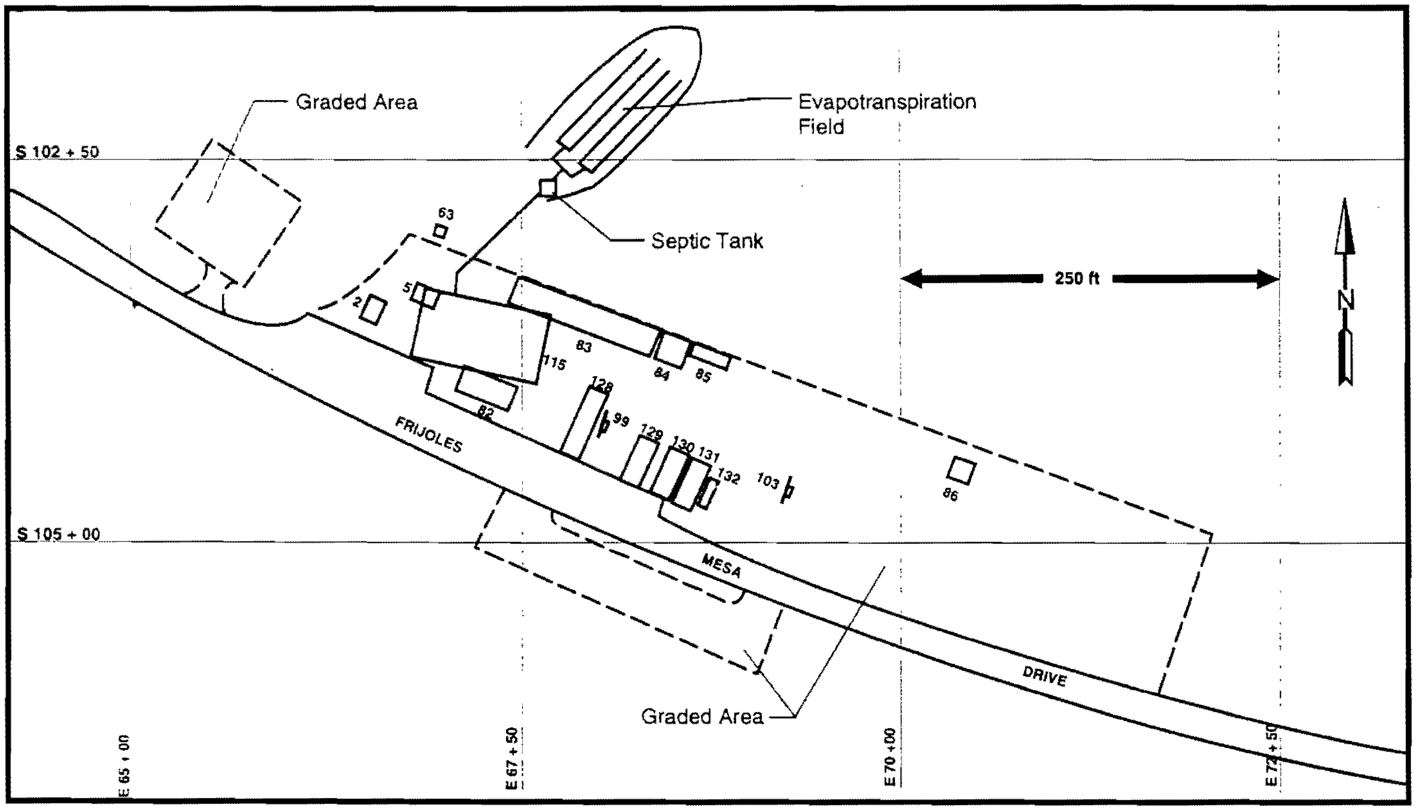
(b) Open trench near open burning/ landfill area of TA-49 April 1991.

(c) Possible site of small landfill used in 1984 cleanup [SWMU 49-005(a)]. Nov. 1990.

Figure 6.3-2 Photographs of the open burning/landfill area

(a) 1971 photograph of the burial trench that was used for the disposal of noncontaminated items during operational periods.

(b) Photograph of the Area 6 trench during burial of noncontaminated material removed from Area11 in 1971. After being crushed by a bulldozer before it was covered, the material volume was greatly reduced.



Structure List (ENG-R 2484, ENG R-5126)

Present Structures		Former Structures	
TA-49-115	Dayroom	TA-49-2	Office Building
TA-49-128	Trailer, Storage	TA-49-5	Craft Shack
TA-49-129	Trailer, Storage	TA-49-63	Latrine
TA-49-130	Trailer, Storage	TA-49-82	Craft Shack
TA-49-131	Trailer, Storage	TA-49-83	Carpentry and Electrician Shed
TA-49-132	Trailer, Storage	TA-49-84	Tool Building
		TA-49-85	Storage Building
		TA-49-86	Storage Building
		TA-49-99	Power Panel
		TA-49-103	Power Panel

Figure 6.3-3 Engineering drawing of Area 6 showing present (shaded) and former structure locations [adapted from engineering drawings ENG-R 2487, 8/15/61 (03-0025) and ENG-R 5126, 7/12/89 (03-0026)].

TABLE 6.3-1

SUMMARY OF SAMPLES AND ANALYSES FOR PHASE I INVESTIGATIONS FOR TA-49 LANDFILLS, OPEN TRENCHES, AND AREA 6 SOIL CONTAMINATION[a]

Number of Samples

	Surface Soil Samples	Borehole Samples
Analytical samples	57	23
QA samples		
Rinsate blank	3	1
Field duplicate	3	1
Field blank	3	1
Total number of samples	66	26

[a]All soil and core samples will be screened for alpha/beta and gamma contamination by using field survey instruments. Where appropriate, and depending upon convenience and field laboratory availability, analyses will be performed in either the field laboratory or an off-site analytical laboratory. Gamma spectrometry yields americium-241, cesium-137, and gross gamma radioactivity levels.

Number of Analyses - Level III Laboratory Analyses

	Surface Soil	Borehole Core	Level III Method
Total uranium	33	13	ICPMS
Isotopic plutonium	33	13	Alpha spectrometry
Gross alpha/beta	66	26	Gas-flow proportional counter
Gamma spectrometry	66	26	Gamma spectrometry
RCRA metals	33	13	SW 6010
SVOC	0	13	SW 8270
Total number of analyses	231	104	

Other Characterization:

Number of boreholes 9
Total linear feet of borehole: 125
Area surveyed radiologically: 214,100 ft^2
Geophysical survey area: 500 ft^2

beyond the time period assumed for institutional control. However, the likelihood of significant contaminant transport from these SWMUs is considered low for the following reasons:

- these SWMUs are located on relatively flat portions of Frijoles Mesa, minimizing runoff;
- the distance to the main aquifer water is about 1200 ft, and there are no perched aquifers known or expected in the area;
- the distance to potential off-site receptors is large for the assumed exposure scenarios and no credible pathways are known; and
- no significant inventory of contaminants is likely to exist at these SWMUs.

The criteria for preliminary identification of potential response actions for the SWMUs addressed in Section 6.3 are presented in Chapter 5. Available information discussed below suggests that the field investigation is likely to demonstrate that contamination levels above reasonable action levels are not present. Therefore, the no further action (NFA) alternative (other than restoration of the soil and vegetative cover over the main open burning/landfill area) is likely to be a sufficient and appropriate remedial alternative to achieve the unrestricted use objective. If significant contamination is found, additional field work may be required in Phase II. If risk assessment then indicates that NFA is inappropriate, the most likely appropriate remedial measures are selective soil removal/disposal or capping/stabilization accompanied by long-term monitoring, maintenance, and institutional control.

Currently Area 6 contains the Day Room (structure TA-49-115, also known as the Antenna Test Facility, constructed in 1987) and equipment trailers (structures TA-49-128 through 132). The septic system [SWMU 49-007(a)] associated with the Day Room is described in Section 8.3 (No Further Action Units). These facilities currently are used by the Laboratory's High-Power Microwave Group (AT-9).

6.3.2 Site Description, History, and Potential Source Terms

6.3.2.1 Open Burning/Landfill Area

Extensive site-employee interviews and archival searches indicate that none of the landfills addressed in Section 6.3 were used for operations other than the burial of uncontaminated debris. Wastes buried in the landfills are reported to have been screened with field instruments to ensure the absence of radionuclides (Purtymun and Stoker 1987, 0204; DOE 1987, 0264; Eller 1992, 03-0035; Purtymun 03-0028). Although checks were made only for radioactive contamination, based on historical information, the disposal of significant amounts of hazardous materials also is unlikely. However, documentation is limited on this point and subsurface sampling at TA-49 landfills and trenches apparently has not been performed.

The landfill in Area 6 (SWMU 49-004) was used from late 1959 to mid-1961 for open pit burning of combustible construction wastes and for burial of uncontaminated residues generated during hydronuclear and related activities in other areas of TA-49 (Purtymun and Stoker 1987, 0204; DOE 1987, 0264). During the 1971 cleanup of TA-49, the Area 6 landfill was reopened for disposal of uncontaminated materials, principally from Area 11. Figure 6.3-2 shows the Area 6 landfill during this period.

The Area 6 landfill was reopened during the general TA-49 surface cleanup in 1984. A trench reported to be approximately 30 ft wide by 100 ft long and 15 ft deep was created for burial of uncontaminated debris collected during the cleanup (LANL 1990, 0145).

During the A411 survey of TA-49 in 1987, part of the open burning/landfill area surface was sampled. However, results for this area are not discussed in the A-411 report (Soholt 1990, 0698). In the survey, about 60 soil and 10 vegetation samples were collected on an approximately 25- by 25-ft mesh grid covering an 80- by 275-ft area of the open burning/landfill area. Analytical results and soil sampling locations are summarized in Table 6.3-2 and Figure 6.3-4.

A few of the A411 samples from the open burning/landfill area were found to be above regional background and indicated highly localized, discontinuous distribution of contaminants. The individual analyte maximum concentrations and total radionuclide concentrations at each sampling point are well below the TRU action levels for unrestricted site use discussed in Chapter 5. Radionuclide concentrations in vegetation at the open burning/landfill area also were found to be well below levels of concern.

As Figure 6.3-4 shows, there is no apparent geographical correlation between elevated soil concentrations of different radionuclides. However, locations of slightly elevated concentrations appear to be concentrated toward the central portion of the sampled area.

Lead and beryllium levels for some samples also appear to be slightly above regional background, but are well below action levels.

In June 1991, a geophysical survey was carried out at the open burning/landfill area to define the limits of the landfill (Geophex 1991, 03-0031). Figure 6.3-5 provides an interpretive summary of this work, and more detailed geophysical data are contained in Appendix D. Four metal posts present at the time of the survey (and still in place in May 1992) outline a rectangular area of approximately 35 by 200 ft. These stakes may have defined the landfill area used in the 1984 burial operations. Strong magnetic and electromagnetic anomalies were observed for this area, no doubt as a result of the considerable quantities of cable and other metallic debris known to be buried in the landfill.

TABLE 6.3-2

SUMMARY OF 1987 A411 SURVEY RESULTS FOR OPEN BURNING/LANDFILL AREA SURFACE SOILS[a]

SOILS

Analyte	Number of Samples	Range	Mean	Regional Soil Background	Comment
Am-241	60	BDL-3.2 pCi/g	0.2 pCi/g	------	3 samples >0.7 pCi/g
Cs-137	60	BDL-3.5 pCi/g	0.7 pCi/g	0.88 pCi/g	3 samples >3.0 pCi/g
Pu-239/240	64	0.001-0.81 pCi/g	0.032	0.019 pCi/g	6 samples >0.10 pCi/g
Pu-238	60	BDL-0.031 pCi/g	0.0034	0.003 pCi/g	1 sample >0.015 pCi/g
Gross gamma	60	6-17 pCi/g	8 pCi/g	10 pCi/g	3 samples >15 pCi/g
Total U	60	2-27 μg/g	6 ppm	3.8 ppm	1 sample >16 μg/g
U-235/238 ratio	60	0.0055-.0083	0.0067	0.0073	
Be	60	BDL-3.5 μg/g	2.4 ppm	1.9 ppm	
Pb	60	1-55 μg/g	37 ppm	24 ppm	5 samples 50 to 57 μg/g

VEGETATION

Analyte	Number of Samples	Range	Mean
Am-241	10	0.002-0.006 pCi/g	0.003 pCi/g
Cs-137	10	BDL-2.9 pCi/g	0.9 pCi/g
Pu 239/240	19	BDL-0.003 pCi/g	0.002 pCi/g
Pu-238	9	BDL-0.001 pCi/g	0.00 pCi/g
Total U	11	0.3-1.2 μg/g	0.6 μg/g

aRadionuclide soil background maximum values are reported in Table G-32 of the 1989 ESG report (ESG 1990, 0497). Lead and beryllium background values are from (Ferenbaugh et al 1990, 0099).

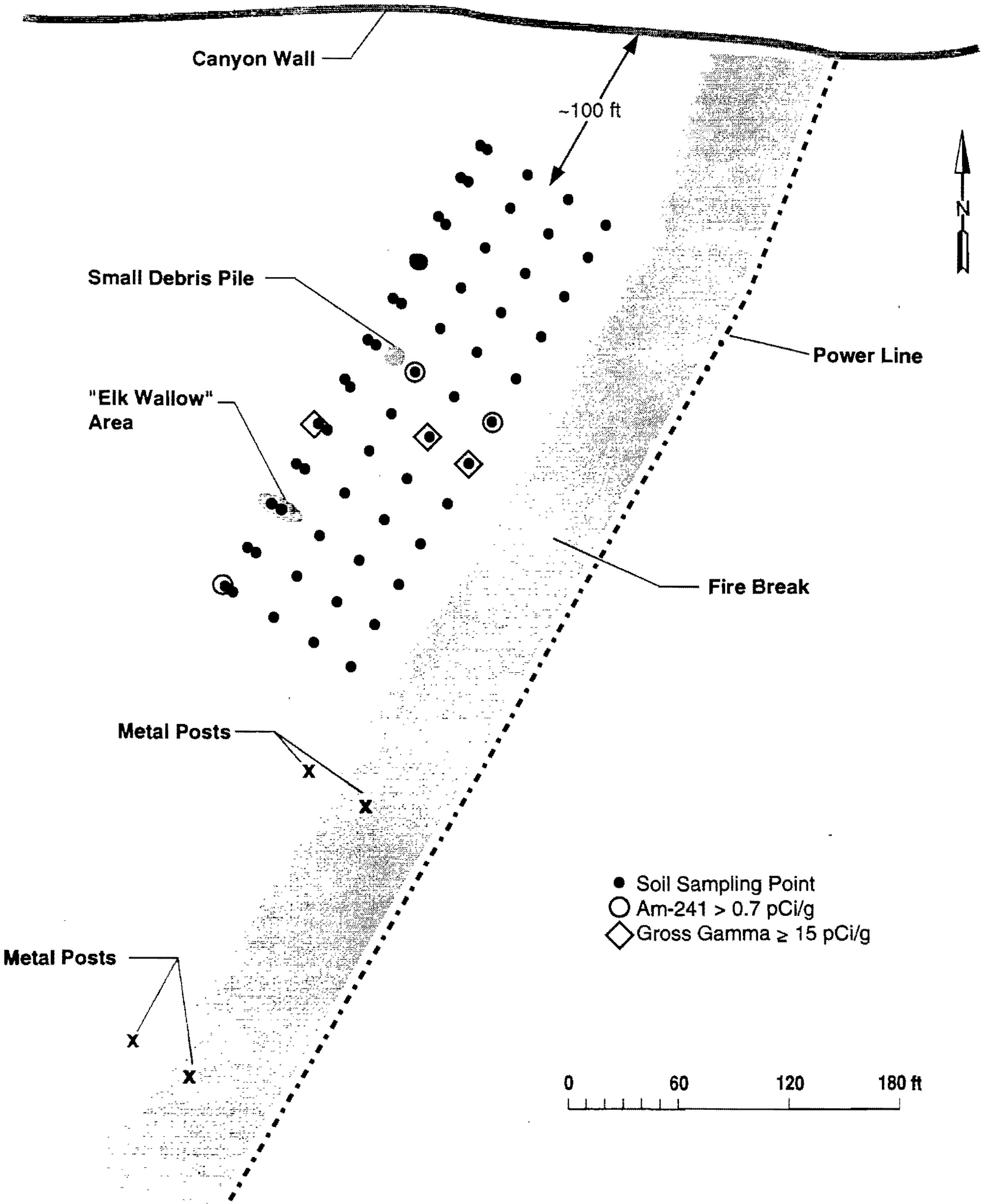


Figure 6.3-4 Soil sampling locations for the 1987 A411 study of the open burning/landfill area of TA-49, based on existing survey stakes and field notes.

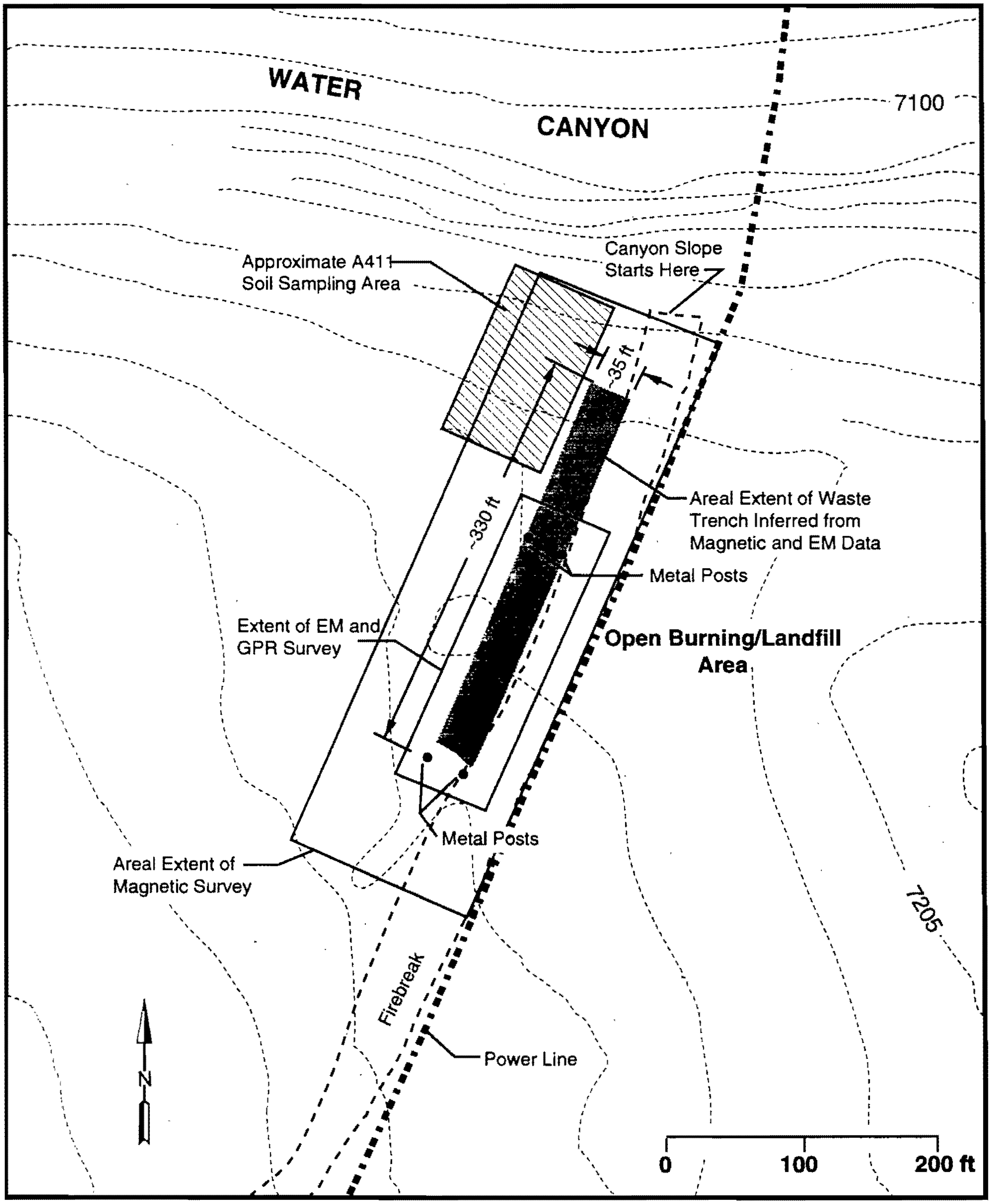


Figure 6.3-5 Interpretive sketch of the open burning/landfill area, based on geophysical data collected in 1991 (adapted from Geophex, 1991, 03-0031).

The observed geophysical anomalies allow the landfill boundaries to be defined with a high degree of confidence. It is apparent that the trench extends northeast about 130 ft beyond the staked area and nearly to the edge of the Water Canyon, indicating that the total landfill lateral dimensions are approximately 35 by 330 ft. The extension appears to be in line with, and a continuation of, the area defined by the metal stakes. The northernmost detectable geophysical anomaly was about 50 ft from the canyon edge. The geophysical survey, and survey stakes still remaining from the A411 study, also indicate that the A411 sampling stations were not over the main body of the landfill (see Figure 6.3-5).

Attempts to use ground-penetrating radar to precisely define the depth to the detected metal were unsuccessful, but a minimum of 4 ft of overfill was estimated.

6.3.2.2 Small Landfills

During the 1984 cleanup a small pit, now designated as landfill SWMU 49-005(a), was created north of the road that runs eastward from Area 10. Another small landfill in Area 5, SWMU 49-005(b), consists of a small pit that also was created during the 1984 cleanup campaign. Available information, primarily from employee interviews, indicates that these small landfills were used solely to dispose of uncontaminated debris from the 1984 cleanup operations (Purtymun 1991, 03-0028; Weston 1991, 03-0015). Inspection of aerial photographs and field inspection of the most likely locations for these small landfills has failed to indicate the exact position of these units.

6.3.2.3 Open Trenches

Aerial photographs of TA-49 reveal four previously undocumented open trenches that are located west of the Area 6 open burning/landfill area [see Figures 3.1-1 and 6.3-1(b)]. Field inspection in 1991 showed that these trenches are about 10 ft wide by 4 to 6 ft deep and 50 to 100 ft long and probably were dug with mechanized equipment. One trench appears to have been backfilled partially and at least one other trench passes directly through a prehistoric ruin. Surface material indicative of burial of artificial debris was not evident at any of the trenches. The amount of excavated soil appears to be commensurate with the open space in the trenches.

The open trenches are especially evident in 1977 photographs, which were taken after the La Mesa fire removed substantial vegetation, but they also are apparent in the 1965 photographs (see Figure 3.1-1). Because the trenches appear in 1954 aerial photographs, they obviously predate the hydronuclear and related experiments from 1959 to 1961. Because high-altitude photographs from 1935 do not show the trenches, it is evident that the trenches were created between 1935 and 1954. Aerial photographs of TA-49 for the period 1935 to 1954 are not available, and it has not been possible to determine more precisely from other information when the open trenches were created.

Extensive archival searches and interviews with key site employees has revealed no specific knowledge of the open trenches before 1959. Some anecdotal information suggests that the trenches may have been present as early as 1943, and other anecdotal information suggests that the trenches were constructed in the late 1940s. However, this information is not completely consistent with other information discussed in this subsection. It is noteworthy that until 1959, this site was relatively remote from known Laboratory operations and disposal of debris at this site would have involved an unusually high degree of effort.

The ruin intersected by one of the trenches apparently has been described briefly by a Laboratory archeological survey and is designated as archeological Site Number LA 15866 (Steen 1982, 0659). This document states that the ruin was excavated in 1977 and shows a photograph of a trench cut through the ruin.

The 1982 archeological report contains the statement, "When TA-49 was abandoned, it was planned to bury scrap metal and other "garbage" in the three large trenches. Bulldozers bladed out the trenches and one of them was partly filled with trash when it was determined not to bury the scrap." Thus, this report implies that the trenches were created around 1961 when the hydronuclear and related experiments ended. The source of this information cannot be verified, but is questionable because aerial photographs show the trenches existed at least 13 yr before 1977. It is likely that the open trenches referred to in this archeological report have been confused with the known open burning/landfill area immediately to the east, which was created just before 1961, as described in the archeological report.

The possibility that the trench was dug by individuals seeking cultural artifacts was considered, but this seems unlikely because other trenches are not associated with obvious cultural resources at TA-49 and the trench depths are unusually deep for such purposes. The trenches conceivably are related to mine-claim speculation activities before the Atomic Energy Commission (AEC) acquired the property in the 1940s. However, investigation of available regional mining records shows no reference to the TA-49 area before acquisition by AEC (Eller 1992, 03-0035).

In summary, the purpose of these open trenches is unknown. However, the possibility that they were created by the Laboratory for waste disposal or other purposes is highly unlikely but cannot be excluded categorically.

6.3.2.4 Potential Soil Contamination in Area 6

Where indicated in Figure 6.3-3, a portion of Area 6 just north of the access road to the main experimental area was developed as a general support area very early in the TA-49 hydronuclear program (Eller 1992, 03-0035). Area 6 included storage and office buildings and structures used by carpenters and electricians. All of these structures had been removed by 1977. Anecdotal information suggests a slight possibility that a small lead-casting shop also was operated briefly at Area 6. A "boneyard" approximately 400 ft^2 in area was used to store lumber, fencing, and steel. Cables, pipes, and sand for backfilling shafts also were stored at Area 6.

Area 6 operations would have been greatly complicated by radioactive contamination, and therefore, the presence of radioactive materials was very closely controlled (Eller 1992, 03-0035). For example, after the initial TA-49 experiments, a directive was issued that "salvage material from shot holes will be marked as to the hole from which it came, and will be sorted in a separate area within Area 6 for future use or disposal." It is therefore conceivable that materials with trace contamination were stored in the area temporarily, but effective contamination controls no doubt were in place. It is known that low levels of contamination were tracked into some Area 6 structures during the unintended release of radioactivity in Area 2 in 1960 (see Chapter 7 of this OU work plan). However, it is highly likely that this contamination was low level, very localized, and quickly cleaned up.

Other than those mentioned above, no other operations involving materials of environmental concern are known or suspected to have been carried out in Area 6.

Documentation of soil sampling in the Area 6 crafts area has not been located.

6.3.3 Data Needs and Objectives and Investigation Rationale

The overall objective of the field investigation of the TA-49 landfills, trenches, and Area 6 surface soil areas addressed in this section is to demonstrate and document their suitability for unrestricted Laboratory use, subject to general TA-49 site restrictions as a result of its ongoing use as a buffer zone for adjacent firing sites. Based on existing information described above and in earlier sections of this OU work plan, the observational approach implies that characterization needs for SWMUs addressed in this section are limited to those that directly address the decision question:

Do contaminants of concern exist above action levels at these SWMUs?

To answer this question, a combination of radiological and geophysical surveys and Level III analyses of discrete surface and subsurface samples is needed.

The rationale for data at Level III quality and the consequences of Type I and Type II errors are discussed in Chapter 5 of this Ou work plan.

The proposed field investigation includes the specific aspects outlined here.

- Geophysical surveys will be used to locate (if possible) the small landfills.
- Area radiological surveys will be used at Area 6 and the three landfills to detect radiological hot spots. At least 90% of the area indicated in Figure 6.3-6 and 6.3-7 will be covered. If the small landfills can be located, the area over and immediately adjacent to the landfills will be surveyed radiologically.
- Discrete soil sampling will be carried out on grids at Area 6, including the former crafts area and the previously unsampled

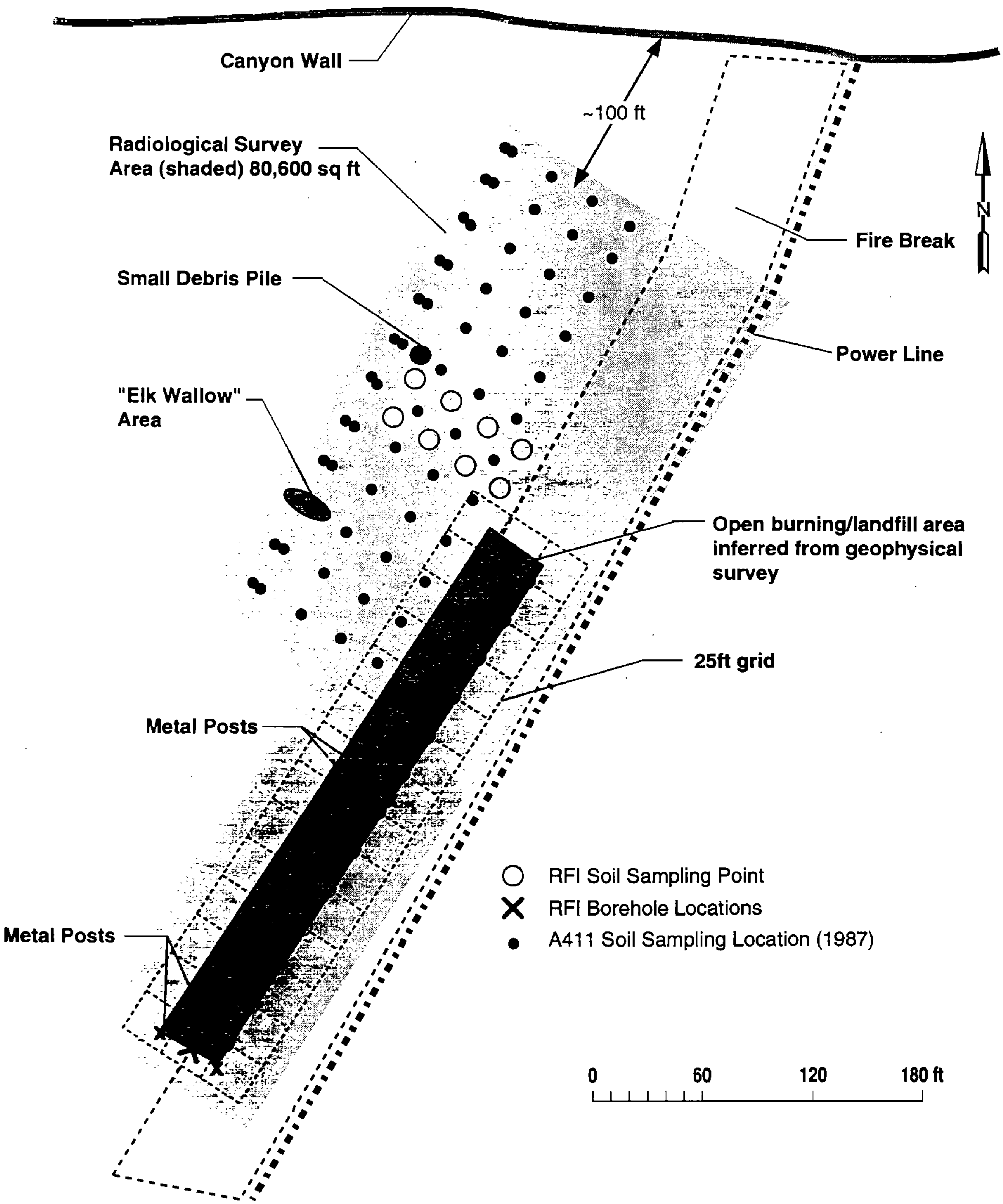


Figure 6.3-6 Proposed RFI soil and borehole locations for the open/burning landfill area.

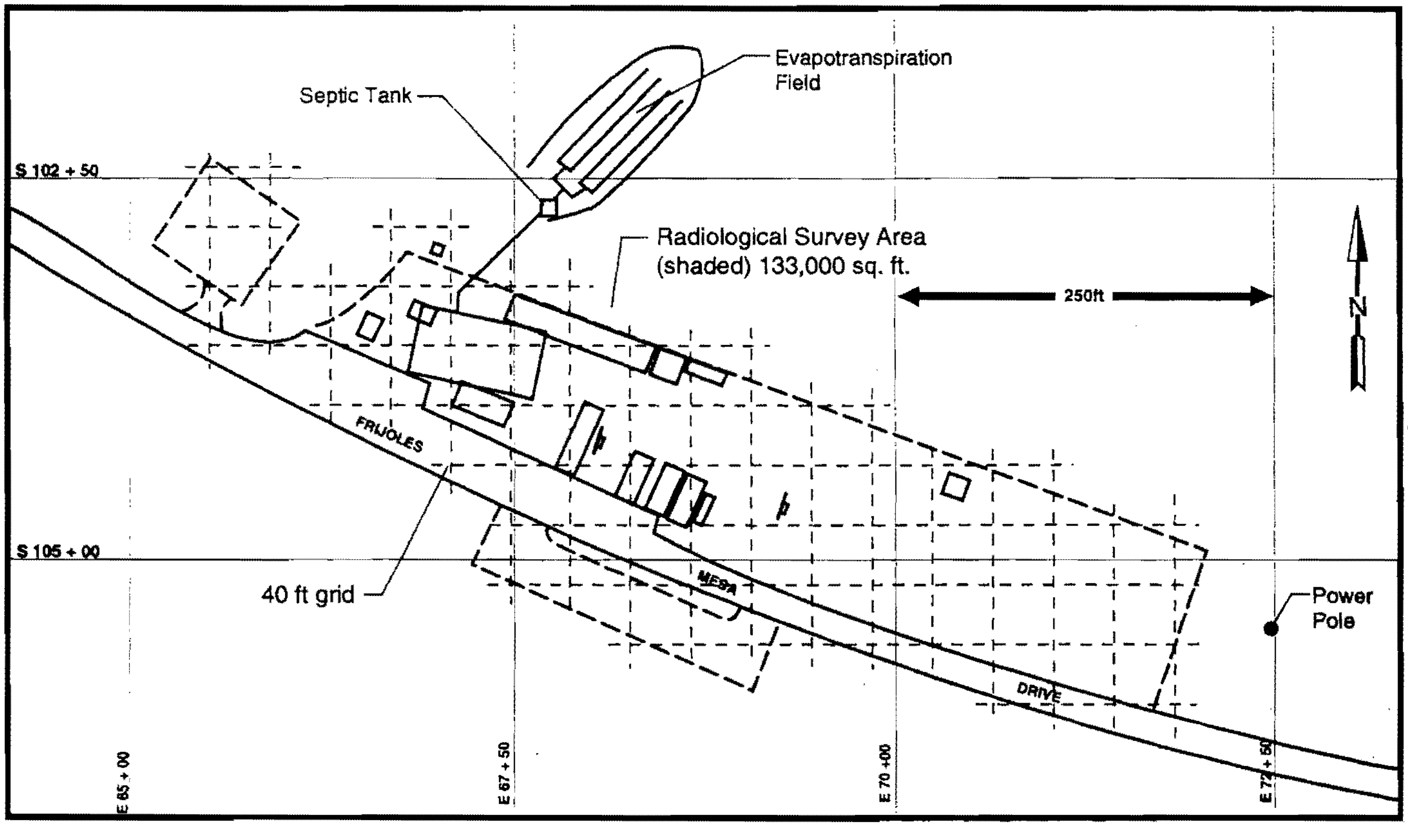


Figure 6.3-7 Proposed RFI soil sampling locations for Area 6; 25% of the grid intersections (randomly choosen) will be sampled, excluding those under existing structures. Existing (white boxes) and former structure locations are indicated (refer to Figure 6.3-5 for description).

surface of the open burning/landfill area. Surface soils at the small landfills also will be sampled. Level III analyses will be carried out for the indicator analytes total uranium, isotopic plutonium, gamma spectrometry, gross alpha/beta radioactivity, and RCRA metals.

- Discrete soil samples will be collected at hot spots identified by radiological surveys and where clusters of slightly elevated radionuclides were found in the A411 survey. Analyses will be performed as proposed for grid samples.
- Core samples will be collected to the bottoms of the landfills and analyzed as proposed for hot spot samples. In addition, these samples will be analyzed for SVOCs.
- At the open trenches, radiological surveys will be carried out to determine the presence or absence of near-surface radioactive contamination. A geophysical survey of the trenches will be carried out to determine the presence or absence of buried metallic debris.

It is expected that only a single phase of investigation will be necessary for the areas discussed in this section because the likelihood of detecting levels of contamination above action levels in Phase I is considered low (that is, a negative answer to the decision question is likely). In this case the RFI/CMS will cease after Phase I and NFA will be proposed. If this expectation is not fulfilled (that is, a positive answer to the decision question), Phase II investigation may be required and this could involve statistically based surface and subsurface sampling over a greater spatial extent and for a wider analyte suite.

The field investigation logic assumes that potential contaminants of concern will be detected by radiological surveys and by discrete sampling and analysis for a limited set of indicator analytes. A sampling interval of 0 to 6 in. is judged appropriate for surface soil samples, based on historical information and intended uses of the data. The logic also assumes that historical information, coupled with the failure to detect above-background radioactivity or man-made debris, will constitute sufficient information to conclude that contamination levels of concern are absent at the open trenches.

Gross alpha, gross beta, and gamma spectrometry measurements (using either the field laboratory or an off-site analytical laboratory) will be conducted for all grid soil samples collected. One-half of these samples, plus all samples for which above-background levels of these analytes are indicated, will be examined in an analytical laboratory for isotopic plutonium, total uranium, and RCRA metals.

6.3.4 Sampling Plan

The general investigation strategy for each unit addressed in this section is a sequential approach in which the investigation area is surveyed by nonintrusive radiological and geophysical methods, followed by discrete soil sampling. The radiological surveys will be extended beyond the denoted areas until background levels are recorded. The QA/QC sample requirements are summarized in Table 6.3-1 of this chapter and Table E-3 of Appendix E.

6.3.4.1 Open Burning/Landfill Area

The area first will be surveyed for radiological hot spots using hand-held or tripod mounted detectors or mobile gamma spectrometry systems. At least 90% of the outlined area in Figure 6.3-6 will be covered. Any detected hot spots will be located precisely and sampled to a depth of 6 in. The spatial variability around any detected hot spots will be determined from samples collected at a depth of 6 to 12 in. below the hot spots and a depth of 0 to 6 in. at a lateral distance of 1 m from the hot spot.

The areas directly over the open burning/landfill area, as defined by the 1990 geophysical survey but not covered by the A411 survey, will be sampled on a 25- by 25-ft grid, as indicated in Figure 6.3-6. Sampling will be conducted at all of the indicated grid points. This grid size, location, and sampling frequency were chosen judgementally to ensure that adequate data are collected for subsequent statistical analysis, which will include the previously collected A411 data (also on a 25- by 25-ft grid). In addition, supplemental samples will be taken as indicated in Figure 6.3-6 to more fully characterize the apparent cluster of slightly elevated radionuclides indicated in the 1987 survey.

Figure 6.3-6 also shows locations of boreholes for subsurface sampling by split spoon auguring at the open burning/landfill site. Seven boreholes spaced about 50 ft apart will be drilled down to the level of undisturbed tuff, which is expected to be about 15 ft. below the land surface. The borehole interval is based on historical information, the apparent dimensions of the trench, and the intended use of the data. The total depth is judged to encompass the depth over which contamination (if it exists) is most likely to occur. Five-foot sections from each borehole will be analyzed as described above for soil samples, as well as for SVOCs.

6.3.4.2 Small Landfills

The small landfills will be located (if possible) by standard geophysical techniques and their locations will be surveyed to a site benchmark. If the small landfills can be located, their surface areas then will be surveyed for radiological contamination as described above for the open burning/landfill area.

Two boreholes, well separated over the defined landfill area, will be drilled through each small landfill to the level of the undisturbed tuff, which is expected to be within 10 ft of the surface. Level III analysis of the lowest 5 ft of the recovered core will be carried out as described for the cores from the open burning/landfill area. Only the lowest 5 ft of the small landfills will be sampled because it is the most likely to be contaminated.

Two surface soil samples, well-spaced over each of the small landfill areas, will be collected and analyzed for the same analyte suite used for the open burning/landfill surface samples.

Two borehole samples and two soil samples for each small landfill are judged to provide a minimum level of redundancy and measure of spatial variability.

6.3.4.3 Open Trenches

Radiological surveys will be conducted over at least 90% of the open trench surfaces and a border immediately adjacent to the trenches, as described for the open burning/landfill area. The trenches also will be surveyed by standard geophysical methods to determine whether buried artificial materials are present. If the field radiological and geophysical surveys show no anomalies, it will be assumed that the trenches are free of contamination and NFA will be proposed. If artificial materials are indicated, Phase II sampling may be required that includes analysis of soil samples and cores. If radiological hot spots are detected, discrete soil sampling will be conducted as described for the open burning/landfill area and the radiological survey will be extended until background levels are recorded.

6.3.4.4 Area 6 Surface Soils

The Area 6 investigation will begin with a surface radiological survey over at least 90% of the area indicated in Figure 6.3-7. Any hot spots that are detected will be characterized as described for the open burning/landfill area.

A 40-ft grid interval for discrete surface soil sampling will be used over the area shown in Figure 6.3-7, and samples will be collected at 25% of the indicated grid points. The grid location was selected to cover the area used for craft activities during the hydronuclear program. The proposed grid size and sampling frequency were selected to ensure that sufficient data points are obtained for subsequent statistical analysis of Area 6 soil contaminant levels. This grid size is based on the available information, which suggests low likelihood for significant contamination in Area 6, and the fact that supplemental radiological surveys will be conducted. The surface soil sampling protocol and analyte suite proposed above for the open burning/landfill area will be used. Supplemental surface soil samples will be collected and analyzed similarly if areas of discolored soil or stressed vegetation are found.

6.4 AREA 5 CONTROL AREA

Description, Data Needs and Objectives, and Sampling Plan for:
- SWMU 49-006 (sump)
- SWMU 49-008(a) (surface contamination)

6.4.1 Introduction

Section 6.4 provides a description of Area 5 and of SWMUs 49-006 and 49-008(a), which are located in this area.

The Laboratory SWMU report also lists an underground fuel tank (SWMU 49-009) and a small landfill [SWMU 49-005(b)] within Area 5. The fuel tank is believed to never have existed and is discussed in Chapter 8 with other units recommended for no further action (NFA). The small landfill [SWMU 49-005(b)] is discussed with other landfill SWMUs in Section 6.3.

The objectives and details of the Area 5 field investigation are described in this section. The ultimate goal is to demonstrate and document the suitability of Area 5 for unrestricted Laboratory use, subject to site-wide restrictions resulting from the continuing use of TA-49 as a firing site buffer zone and the present enclosure of Area 5 within the MDA AB exclusion fence. Future land use is assumed to be the same as that at present; that is, Area 5 will remain a controlled area within the fence enclosing MDA AB and will be managed with MDA AB for the indefinite future.

For Area 5, data are needed primarily to document the presence or absence of contaminants relative to action levels in the soils and subsurface. The principal potential contamination-migration pathway over the assumed institutional control time frame is erosion (surface water runoff and aerial resuspension). A conceptual model for Area 5 SWMUs, including exposure routes and potential environmental transport pathways, is identified in Section 4.11 of this OU work plan.

The likelihood for significant contaminant transport from Area 5 is very low for the following reasons:

- Area 5 is located on a relatively flat portion of Frijoles Mesa, which minimizes runoff;
- the depth to the main aquifer is about 1200 ft and no other aquifers are known or expected in the area;
- the distance to potential off-site receptors is large for the assumed exposure scenarios, and no credible pathways are known;
- access and use of Area 5 are strictly controlled; and
- a significant inventory of contaminants is not likely to exist at Area 5.

The criteria for preliminary identification of potential response actions at TA-49 SWMUs are presented in Chapter 5. The NFA alternative is likely to be sufficient and appropriate for the unrestricted use objective because the field investigation is likely to demonstrate that contaminants above action levels are not present in Area 5. If significant contamination is found, Phase II investigation may be necessary to further characterize the contamination. If subsequent risk assessment indicates that NFA is inappropriate, an appropriate remedial action may be selective soil removal and disposal.

Field measurements and laboratory analyses for field investigations at Area 5 are summarized in Table 6.4-1 of this section and in Table E-4 of Appendix E.

6.4.2 Description and Site History

Area 5 served as the main control area for the hydronuclear and related experiments conducted at TA-49 from 1959 to 1961. Many experimental support activities also were located in this area. An engineering drawing showing the layout of Area 5 structures around the period of maximum use in 1961 is shown in Figure 6.4-1. Recent low-altitude photographs across this area are given in Figures 3.1-2(c) and (d). Other engineering drawings of Area 5 are contained in Appendix B.

Several permanent structures and at least 18 easily relocated trailers were used for a variety of functions in Area 5 from late 1959 and mid 1961. Figures 6.4-2(a) and (b) show the layout of these structures at two times during that period, and Figure 6.4-3 shows photographs of Area 5 taken during this time. Almost all of the surface structures were removed or destroyed between 1961 and 1984.

Extensive interviews have been conducted with personnel directly involved in Area 5 activities during the 1959 to 1961 period of maximum usage. These personnel included the TA-49 site engineering supervisor, experimental test director, radiochemists, and photography staff. Examination of the Zia Engineering Diary, which recorded the engineering work at TA-49 from 1959 to 1961, as well as other archival records has provided additional detail on potential contaminants associated with Area 5 activities. Current descriptions of selected structures, including those known or suspected to have contained hazardous or radioactive materials, are based largely on this information.

Late in 1959, an elevated photo tower [structure TA-49-96, visible in Figure 6.4-3(a)] was assembled in Area 5 to photograph hydronuclear and related experiments in Areas 1 through 4. Photographic activities probably occurred for the most part in trailer J-13-3 [see Figure 6.4-2(b)], which contained a darkroom with a drain line. In 1965 the photographic tower was used in a study of atmospheric phenomena. During both sets of activities, on-site film development and disposal of limited quantities of spent photochemicals into sumps at Area 5 may have occurred (see ensuing discussion). The tower was removed during the 1984 cleanup campaign.

During 1960 or 1961, an 8-ft-deep by 6-ft diameter hole in the floor of structure TA-49-8 was used in calibration activities (see Figure 6.4-1). Encapsulated cobalt-60 and polonium-beryllium radioactive sources probably were used for

TABLE 6.4-1

SUMMARY OF SAMPLES AND ANALYSES FOR PHASE I INVESTIGATIONS AT AREA 5[a]

Number of Samples	Surface Soils	Boreholes Samples
Analytical samples	30	2
QA/QC samples		
Rinsate blank	2	0
Field duplicate	2	0
Field blank	2	0
Total number of samples	36	2

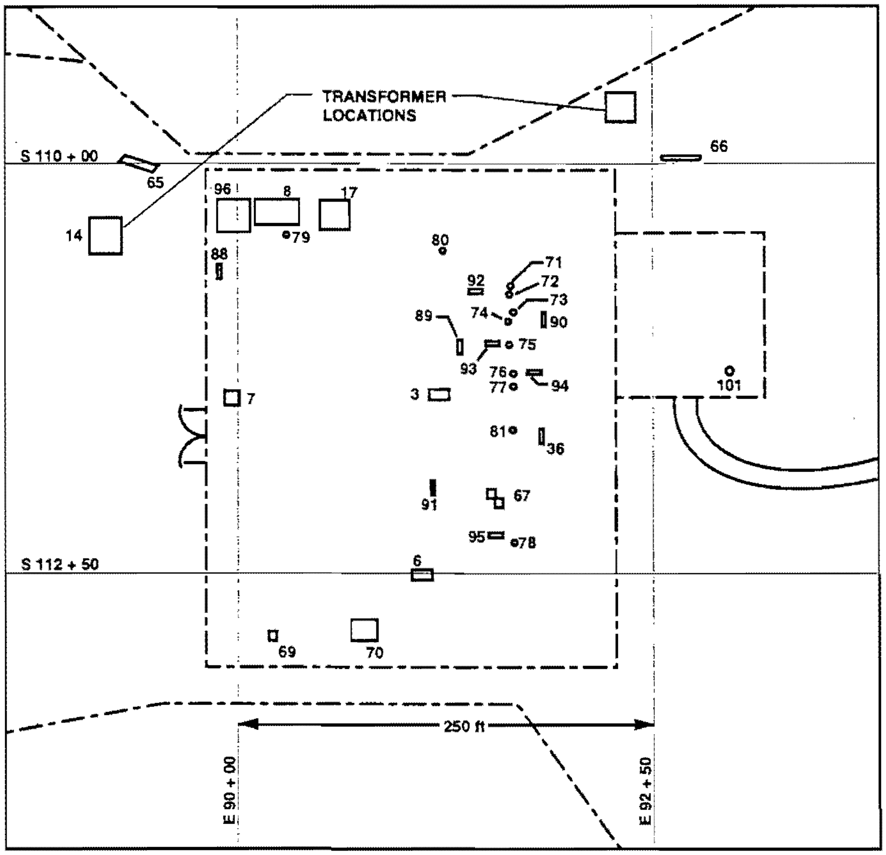
[a]All samples will be field screened for gross alpha/beta and gamma contamination. Gamma spectrometry yields gross gamma, americium-241, and cesium-137 levels. Where appropriate, and depending upon convenience and field laboratory availability, analysis of Area 5 samples will be performed in either the field laboratory or an off-site analytical laboratory.

Laboratory Analysis

	Surface Soils	Borehole Sample	Level III Method
Total uranium	16	2	ICP/MS
Isotopic plutonium	16	2	Alpha Spectrometry
Gross alpha/beta	32	2	Gas Flow Proportional Counter
Gamma spectrometry	32	2	Gamma spectrometry
SVOCs	10	2	SW 8270
PCBs	4	0	SW 8080
RCRA metals	16	2	SW 8010
Total number of analyses	116	12	

Other characterization:

Radiological and geophysical surveys will be conducted over an area of 94,000 ft^2.
The two core samples will be collected from two 10-ft boreholes.



STRUCTURE LIST (ENG-R 2487 8-15-61)

TA-49-3 CRAFT SHACK
TA-49-6 CRAFT SHACK
TA-49-7 GUARD HOUSE
TA-49-8 THE SHED
TA-49-14 TRANSFORMER STATION
TA-49-17 THE BARN
TA-49-36 SIGNAL PANEL
TA-49-65 BUTANE TANK
TA-49-66 WATER TANK
TA-49-67 U.G. COUNTING ROOM
TA-49-69 LATRINE
TA-49-70 LATRINE
TA-49-71 MANHOLE (PORTABLE)
TA-49-72 MANHOLE (PORTABLE)
TA-49-73 MANHOLE (PORTABLE)
TA-49-74 MANHOLE (PORTABLE)
TA-49-75 MANHOLE (PORTABLE)
TA-49-76 MANHOLE (PORTABLE)
TA-49-77 MANHOLE (PORTABLE)
TA-49-78 MANHOLE (PORTABLE)
TA-49-79 MANHOLE (PORTABLE)
TA-49-80 MANHOLE (PORTABLE)
TA-49-81 MANHOLE (PORTABLE)
TA-49-88 POWER PANEL A
TA-49-89 POWER PANEL B
TA-49-90 POWER PANEL C
TA-49-91 POWER PANEL D
TA-49-92 POWER PANEL W
TA-49-93 POWER PANEL X
TA-49-94 POWER PANEL Y
TA-49-95 POWER PANEL Z
TA-49-96 PHOTO TOWER
TA-49-101 TEST WELL NO. 5 (DT-5)

NOTE: The location of the photo tower has been updated to the status of the 1969 revision of this engineering drawing. Photos indicate this was the correct location for the photo tower (TA-49-96).

Figure 6.4-1 Engineering site diagram for Area 5 [adapted from ENG-R 2487, 8/15/61 (03-0025)]. Structure numbers are indicated in the diagram.

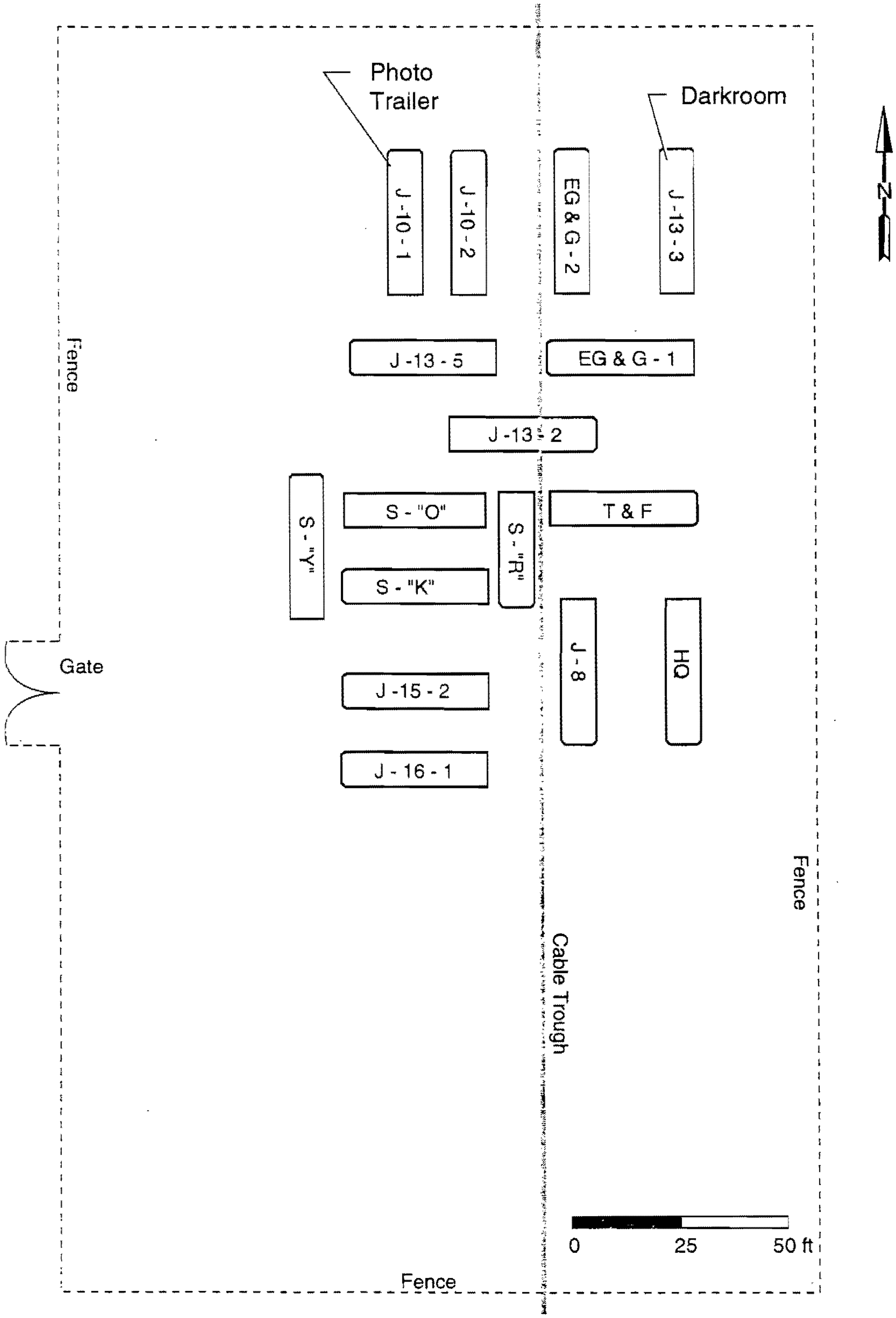


Figure 6.4-2(a) Early layout of structures of Area 5, October 24, 1959 [adapted from ENG C28505 (03-002)].

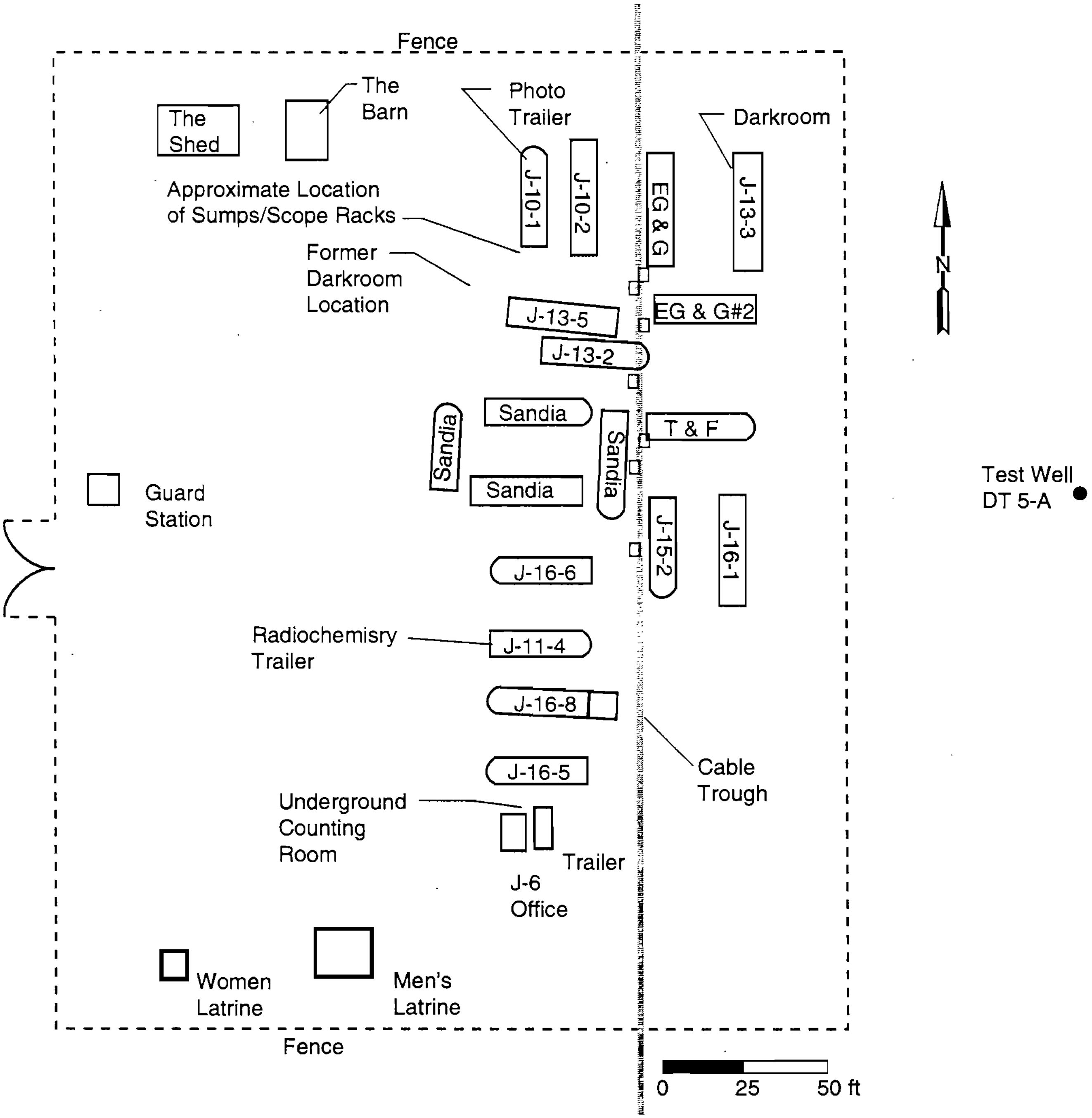


Figure 6.4-2 (b) Early layout of structures at Area 5, August 29, 1960 [adapted from ENG C28286 (03-0002)].

Figure 6.4-3 Area 5 photographs around the time of peak site activities

(a)
Photograph of TA-49 photo tower (TA-49-96) and butane fuel tank (TA-49-65).

(b)
Typical Area 5 structures.

calibration work in this structure and in adjacent structure TA-49-17. These radioactive sources later were removed from the site. There is no historical or anecdotal reason to suspect that contaminant release resulted from these sources.

Trailer J-11-4 was used as a radiochemistry laboratory from 1959 to 1961 [see Figure 6.4-2(b)]. According to interviews with numerous personnel involved with these operations and examination of laboratory notebooks, the radiochemical operations involved sample dissolution with a few liters or less of perchloric, hydrofluoric, and hydrochloric acids. In addition, low levels of radioactivity from solid samples as well as a few liters or less of organic solvents and extractants were involved. Waste chemicals from these operations were collected in bottles for off-site disposal. The radiochemistry laboratory was equipped with a sink and it is conceivable that small quantities of contaminants were discharged through drain lines to soils outside this facility. However, significant discharge of radioactive wastes in Area 5 is very unlikely to have occurred because this would have complicated general Area 5 operations, especially the very low level radiochemical counting operations conducted in support of the hydronuclear experiments.

Lead shields were used in trailers J-11-4 and J-16-8 and perhaps in other Area 5 facilities. Lead bricks also were stored on the north edge of Area 5. A few lead bricks scattered around the surface of Area 5 were noted during a site visit during the summer of 1991 (Eller 1992, 03-0003). Lead bricks and lead sheet were used at TA-49 for shielding during the counting of low-level radioactive samples. Isolated low level soil contamination from weathering of metallic lead is therefore a possibility.

The Zia Engineering diary indicates that in November 1959, two 24-in.-diameter by 40-ft-deep sump holes were drilled in Area 5. Engineering drawings indicate that drainlines were to be run from the J-10-1 phototrailer to a sump located under the scope rack. However, the exact number of sumps drilled and their ultimate use is unknown. The sumps possibly were used to dispose of small volumes of waste chemicals, notably, spent photographic solutions.

Engineering drawings indicated that the underground counting room (structure TA-49-67) was equipped with a concrete sump for drainage collection. It is unknown whether the sump ever collected contaminated liquids. However, the small size of the sump indicates that the volume of collected liquids (if any) was very small.

Electrical transformers were located just west and north of the Area 5 fence but have been removed since 1961 (see Figure 6.4-1). Transformer oil of unknown composition probably was used, but the volume is likely to have been very small, according to available information. The likelihood that PCBs were present in these transformers is unknown and sampling apparently has not been performed. Staining is evident on the existing concrete pad that formerly supported the westernmost transformer station, structure TA-49-14 (Eller 1992, 03-0003). A small above-ground fuel tank (TA-49-65) was located outside the northwest portion of the fenced area of Area 5, as shown in Figures 6.4-1 and 6.4-3.

This tank was used only for above-ground storage of butane and/or propane and was removed from TA-49 in 1971. This unit does not constitute a potential contaminant release site.

Activities in Area 5 after 1961 were very limited and probably did not involve significant quantities of hazardous or radioactive materials. The photographic tower was used in the early 1970s as an optical platform from which upper atmosphere phenomena were studied with cameras and television equipment. In June 1977, a seismic study was conducted during which 37 shot holes were drilled to a depth of 2 m in an area extending from Area 5 to test well DT-9. Small quantities of explosives were placed in the holes and detonated. All holes had complete detonation, after which the detonation wires were either cut off or pulled from the holes (Purtymun and Ahlquist 1986, 03-0013). All unused explosives were removed from the site after the studies.

Almost all Area 5 structures were removed or destroyed between 1961 and 1984, primarily during routine equipment removal in 1964 and major cleanup campaigns in 1971 and 1984. Other combustible structures were destroyed by the La Mesa forest fire in June 1977. At present, the only surface structures remaining in Area 5 are the DT-5A observation well enclosure (structure TA-49-101) and the concrete pads of the former transformer station (TA-49-14) and the photographic tower. Small amounts of metallic debris (including some lead bricks) remain on the surface in Area 5.

At least some of the debris collected during the 1984 cleanup of Area 5 is believed to have been disposed of in a small existing pit or sump in Area 5 (dimensions less than 10 ft by 10 ft by 10 ft) (Purtymun 1991, 03-0028). This landfill, listed as SWMU 49-005(b) in the Laboratory SWMU report, is discussed in Section 6.3 with other TA-49 landfills.

6.4.3 Additional Information on Potential Source Terms at Area 5

As discussed above, available information indicates that operations carried out at Area 5 never involved large amounts of hazardous or radioactive materials. Therefore, only very small amounts of contaminants could have been released to soil under and around structures associated with these activities.

Release of photographic solutions after film development in trailer J-13-3 may have occurred, although such a release has not been corroborated during extensive interviews and archival searches. Any release that might have occurred likely would have been through drains either to the previously mentioned sumps or to nearby soil areas within Area 5. The total quantity of waste photographic solutions generated during all Area 5 activities probably would have been less than a few hundred gallons (Penneman 1991, 03-0012).

Available information discussed earlier in Section 6.4 indicates that several sump holes were drilled in Area 5 and may have been used for disposal of small quantities of spent photo solutions and possibly other wastes. Drainlines leading to these sumps may also exist. No definitive information is available on the presence or absence of contaminants in the sumps, and the precise location of the sumps is unknown.

However, even if limited amounts of contaminants were discharged to the sump holes, they are not likely to be of environmental significance because no credible migration pathways are known to exist.

Airborne and other inadvertent transport of extremely low levels of radionuclides from Area 2 (and possibly from Areas 1, 2A, 2B, 4, and 11) to Area 5 soils is a remote possibility. Because of the small, isolated nature of any such releases, contamination levels from this mechanism at Area 5 are expected to be undetectable.

During the 1959 to 1961 operations and the 1971 and 1984 cleanups associated with Area 5, extensive and frequent field monitoring for gross alpha, beta, and gamma radioactivity was conducted. Interviews with health physics personnel who were on-site during these operations indicate that contamination levels of concern were not detected in Area 5. However, only partial documentation is available and there is no analytical information available for Area 5 surface or subsurface samples.

6.4.4 Data Needs and Objectives and Investigation Rationale

The technical objective of Phase I of the Area 5 field investigation is to determine the presence or absence of indicator contaminants above action levels, as required to assess the suitability of Area 5 for unrestricted Laboratory use, subject to the restrictions discussed in Section 6.4.1. The observational approach, based on existing information described above and in preceding chapters of this OU work plan, implies that Area 5 characterization needs are limited to those that directly address the following decision question:

Do contaminants of concern exist above action levels at Area 5?

A combination of geophysical surveys, area radiological surveys, and Level III analysis of discrete surface and subsurface samples is proposed to answer this question. Specific Area 5 data objectives include:

- geophysical surveys to locate sumps, landfills, and undocumented subsurface features of interest;
- radiological surveys of at least 90% of the surface contained within the Area 5 exclusion fence;
- Level III analysis of discrete grid soil samples for radionuclides and RCRA metals and analysis of soils from the two former transformer locations for PCBs; and
- Level III analysis of borehole samples from the sumps (if located) for radionuclides, RCRA metals, and SVOCs.

The rational for collecting data of Level III quality is discussed in Chapter 5. The consequences of Type I or II errors also are addressed in Chapter 5.

Only a single phase of investigation is expected to be necessary for Area 5 because Phase I is likely to show with adequate confidence that contaminant levels above action levels are not present (that is, negative answer to decision question). In this case, the RFI/CMS will cease and NFA will be proposed. If this expectation is not met (that is, positive answer to decision question), Phase II investigation may be required and could involve more extensive surface and subsurface sampling over a larger spatial volume of the site and over a wider analyte suite.

The sampling logic assumes that contaminant levels above action levels will be detected by radiological surveys and by discrete sampling of soils (0- to 6-in. depth) and sumps. The indicator analytes isotopic plutonium, total uranium, gamma spectrometry (which yields gross gamma radioactivity, americium-241 and cesium-137 levels), gross alpha/beta radioactivity, radioactivity, and RCRA metals will be used.

6.4.5 Sampling Plan

Field QA/QC samples for the Area 5 investigations described in this section will be collected and analyzed as indicated in the following discussion and as summarized in Table 6.4-1 of this section and Table E-4 of Appendix E. Surface sample and borehole locations will be established by standard land survey techniques to an accuracy of 1 ft (vertical and horizontal).

6.4.5.1 Area 5 Surface Soils Survey - SWMU 49-008(a)

The Area 5 field investigation will begin with a geophysical survey of the area inside the Area 5 fence to confirm both the location of the sumps (if possible) and the underground radiochemistry structure (see Figure 6.4-4). This survey also is intended to detect culverts, drainlines, and trenches as well as other buried structures and disturbed areas of interest that are not well documented.

Area radiological surveys of Area 5 will be conducted using hand-held-detectors or mobile gamma spectrometry systems. The survey will cover at least 90% of the fenced portion of Area 5. If hot spots are found, they will be located precisely by using a FIDLER, PHOSWICH, or similar systems and a soil sample will be collected to a depth of 6 in. Level III analysis will be conducted for gross alpha/beta, total uranium, isotopic plutonium, gamma spectrometry, and RCRA metals. The spatial variability at any detected hot spots will be determined from additional samples collected at a depth of 6 to 12 in. below the hot spot and to a depth of 6 in. at a lateral distance of 1 m from the hot spot.

Discrete soil sampling will be conducted on a grid with a 40 ft interval over the fenced area of Area 5, as indicated in Figure 6.4-4. Level III analysis will be performed as described above. Twenty-five percent of the grid locations will be sampled on a random basis. This grid is centered on the fenced enclosure because this was the area of maximum use in Area 5, and thus has the maximum likelihood for contamination above levels of concern. The grid size

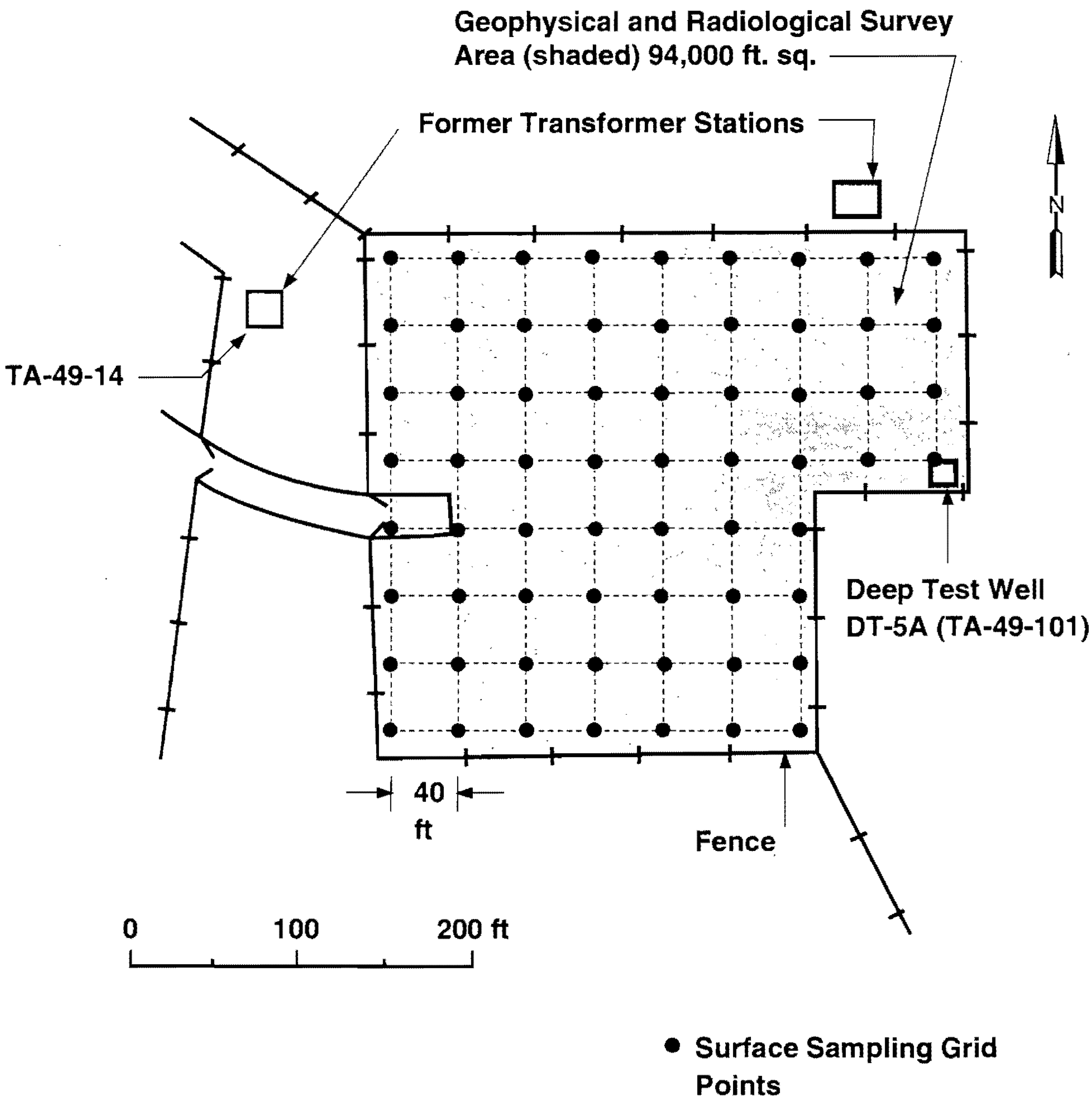


Figure 6.4-4 Proposed Area 5 RFI soil sampling locations; 25% of the grid points will be selected randomly for sampling.

and sampling frequency were chosen to ensure an adequate number of data points for subsequent statistical analysis of soil contamination levels and to supplement the historical information and radiological and geophysical surveys. The data also will be sufficient to allow a statistically based Phase II sampling plan to be developed, if necessary. Supplemental surface samples will be collected from locations of former radiochemistry and photography structures.

Gross alpha, gross beta, and gamma spectrometry measurements (using either the field laboratory or an off-site laboratory) will be conducted for all grid soil samples collected. One-half of these samples, plus all samples for which above-background levels of these analytes are indicated, also will be examined in an analytical laboratory for isotopic plutonium, total uranium, and RCRA metals.

6.4.5.2 Sumps - SWMU 49-006

Available engineering information [for example, Figure 6.4-1, Figure 6.4-2(a), and Figure 6.4-2(b)] and the geophysical survey will be used to locate the sumps, if possible. A single bore hole then will be drilled through each located sump to a level 5 ft below the level of the undisturbed tuff (total depth about 10 ft). The lowest 5 ft of the bore hole will be collected and Level III analysis will be performed for the suite of analytes as well as for SVOCs. Sampling of this core depth is proposed because, based on available information, the sump holes were open when (and if) discharges were made to them. Therefore, maximum contaminant levels should exist at the bottom of the sumps. Sampling of two sumps is assumed for planning purposes. If the sumps cannot be located with a reasonable amount of effort, no further action regarding the sumps will be taken in Phase I .

6.4.5.3 Drainlines

Near-surface drainlines definitively located by geophysical techniques will be removed (as appropriate) as a VCA and soils around the lines will be field screened for gross alpha/beta and gamma radioactivity. At least one soil sample associated with each 10-ft section of drainline will be collected for analysis as described for the sumps. Based on available information, 10-ft lengths are probably typical of drainline sections (distance between joints) in Area 5, and a 10 ft sampling interval is judged adequate for the intended use of the data. Ten such samples are assumed for planning purposes.

6.4.5.4 Transformers

At least two surface samples will be collected at each of the two former transformer locations and will be field screened for PCBs. This scheme ensures that a minimal but adequate level of sample redundancy is attained for each of these areas. If PCBs are detected by screening, Level III analysis will be conducted.

6.5 AREA 10 UNDERGROUND EXPERIMENTAL CHAMBER

Description, Data Needs and Objectives, and Sampling Plan for:
- SWMU# 49-002

6.5.1 Introduction

Section 6.5 describes the underground experimental chamber (SWMU# 49-002) located in Area 10 of TA-49 and provides the objectives and details of the field sampling investigation for this SWMU.

Data are needed to demonstrate the presence or absence of contaminants in the surface soil around these shafts and in material at the bottom of the shafts. As discussed in Chapters 4 and 5, the principal potential contamination-migration pathway at Area 5 is surface erosion (aerial resuspension and surface water runoff). The likelihood of significant contaminant transport from Area 10 is very low for the following reasons:

- this SWMU is located on a relatively flat portion of Frijoles Mesa, which minimizes runoff;
- the depth to the main aquifer is about 1200 ft and no aquifers are known or expected in the area;
- the distance to potential off-site receptors is large for the assumed exposure scenarios, and no credible pathways are known;
- access and use of Area 10 is controlled; and
- a significant inventory of contaminants is not likely to exist at Area 10.

The criteria for preliminary identification of potential response actions at Area 5 are presented in Chapter 5. The field investigation is likely to demonstrate that Area 10 is not a release site; in which case, removal of the concrete radiation shields and backfilling of the open shaft may be a sufficient and appropriate remedial action for this unit. If contamination above conservative action levels is found, Phase II sampling may be required to further characterize the nature and extent of contamination. In this case, potentially appropriate remedial alternatives could include selective removal/disposal of soils and capping/stabilization.

Future land use of Area 10 is assumed to be similar to that at present; that is, indefinite institutional control by the Laboratory is assumed. Recreational use by Bandelier National Monument is assumed if institutional control is lost.

6.5.2 Description and Site History

The general location of Area 10 is shown in Figure EXEC-4, and Figure 6.5-1 shows an engineering site drawing from the main period of site activity (August 1961). Figures 6.5-2, and 6.5-3 show engineering drawings and a photograph of the shafts is shown in Figure 6.5-4. A recent photograph of the surface area is shown in Figure 3.1-2(a).

At Area 10, two vertical shafts were drilled, each about 64 ft deep and 7 ft in diameter. These were connected at the bottom by a gallery 4 ft wide, 12 ft long, and 7 ft high. One shaft (the elevator shaft that was used to transport personnel and equipment) presently is covered by a heavy but removable concrete cover and the shaft probably is open at least part way to the bottom. The second shaft (the calibration shaft) was used to position a portable pulse neutron source over calibration samples placed at the bottom of the shaft and probably has been backfilled with local soil and crushed tuff (Eller 1992, 0035). A hydraulic platform was located at the bottom of the calibration chamber and a hydraulic line led to an oil reservoir at the surface. The underground hydraulic system is probably still in place but the surface components have been removed.

A 14-ft-diameter by 10-ft-high calibration room was constructed at the bottom of the calibration shaft. This room was lined with 8 in. of reinforced concrete faced with 1-in. steel plate. Figure 6.5-4 shows the tunnel connecting the shaft bottoms, including a potentially significant surge deposit that is discussed in Section 4.5 of this OU work plan. No surface structures remain at the calibration chamber area other than several large concrete radiation shields (used during operation of the pulse neutron source) and the concrete and steel pads around the tops of the shafts.

A disturbed soil area (see Figure 6.5-1) immediately to the south of the shaft complex and adjacent to the access road is believed to have been used solely as a parking and staging area (Eller 1992, 0035).

The calibration chamber unit was used primarily during the hydronuclear and related experiments in 1960 and 1961. Subsequent use was minor, was unconnected with the hydronuclear experiments, and apparently did not involve radioactive or hazardous materials, with the possible exception of small radioactive sources for radiochemical counting. These sources are believed to have been removed at the conclusion of the experiments.

6.5.3 Existing Information on Potential Source Terms

During operation of the pulse neutron source over the calibration shaft, small amounts (milligrams or less) of enriched uranium may occasionally have spalled off the critical assembly (Penneman 1991, 03-0047). When spallation was noticed during operations, this material routinely was collected, but very small amounts conceivably could have eluded cleanup and fallen to the bottom of the shaft or been dispersed onto adjacent soils. Slight activation of surrounding structures and soils occurred during operation of the pulse neutron source, but only short-lived radionuclides (most with half-lives of a few days or less) were generated and residual contamination from this source should be undetectable at the present time.

Other potential contaminant sources at Area 10 are canisters containing lead and lead shielding bricks that were used in the calibration chamber. Various low-level radioactive source materials were handled in the complex, and beryllium pieces also may have been used. It is believed that all such potential contaminants have been removed; however, there is no written documentation. Leakage of oil from the hydraulic lifts in the chamber is not known to have occurred and the possibility of contamination from this source is considered

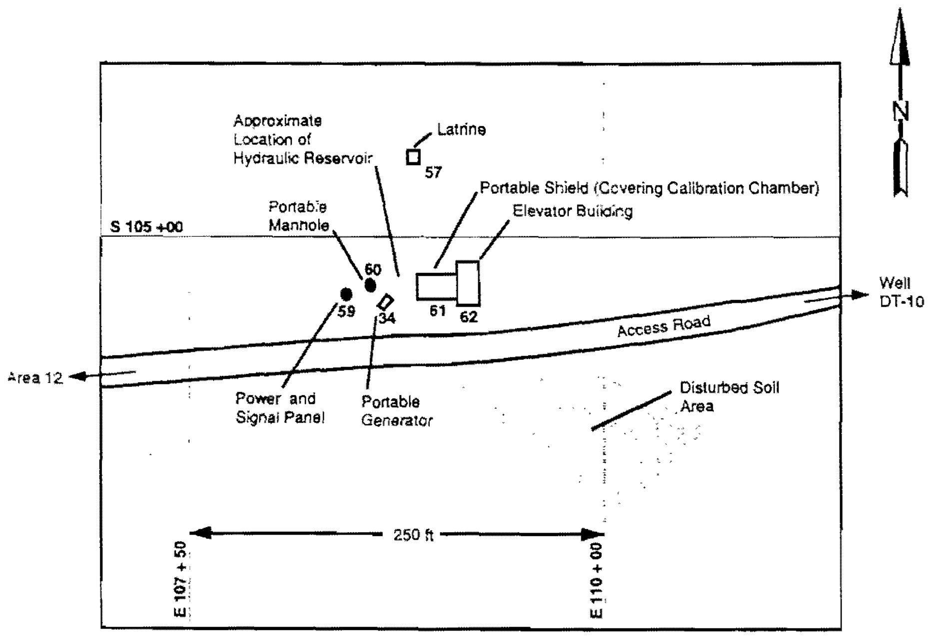


FIGURE 6.5-1 Area 10 engineering site drawing from the period of peak site activity (August 1961). Except for some concrete shields and pads and small quantities of metal debris, no surface structures exist in Area 10 at this time. [Adapted from engineering drawings ENG-R 2484, 8/15/61 (03-0019), and ENG-R 2486, 8/15/61 (03-0024)].

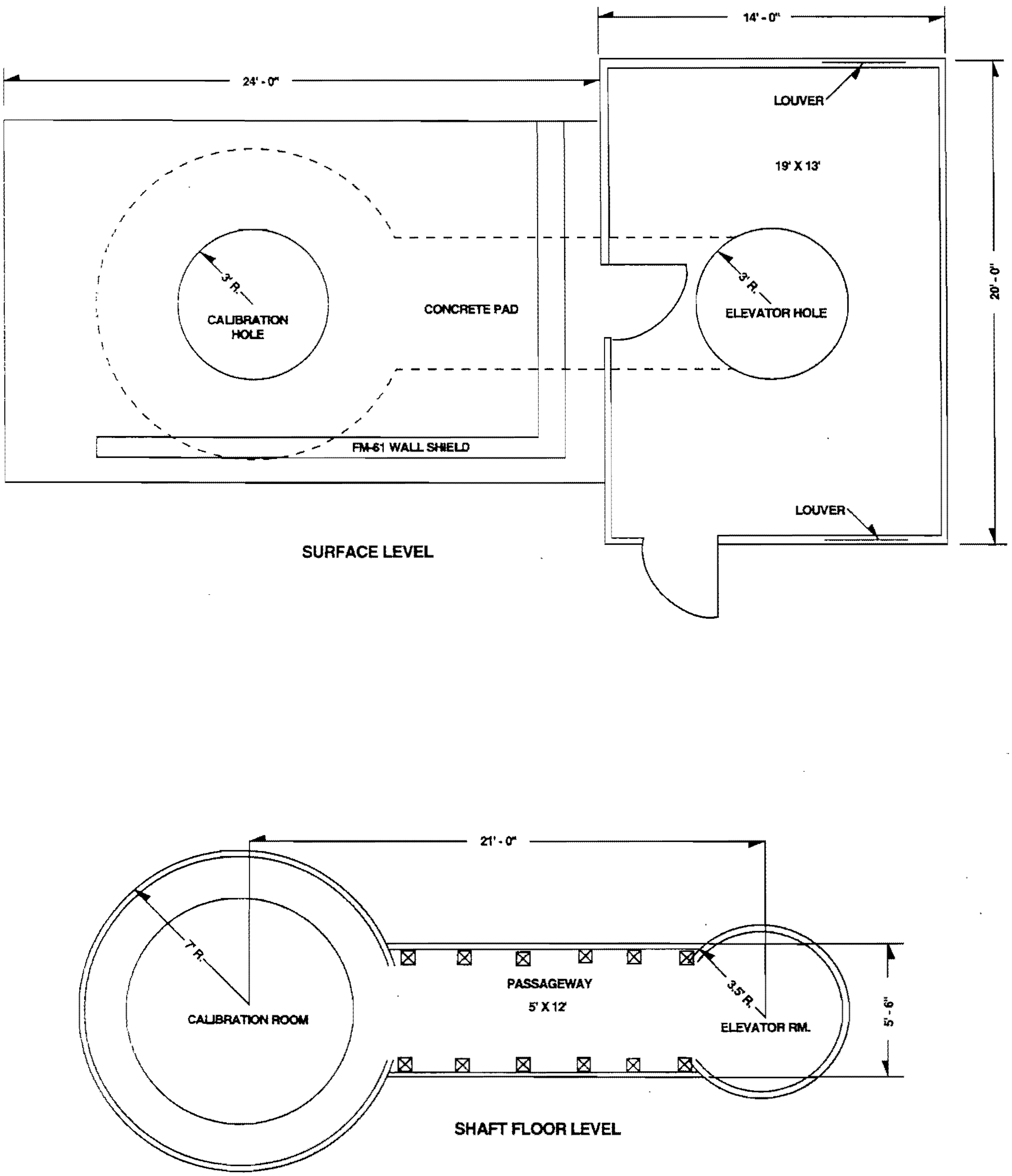


FIGURE 6.5-2 Engineering drawings of the underground chamber complex at Area 10. Plan view at surface and floor levels. [Adapted from engineering drawings ENG-R 3236, 3/11/64 (00-0045) and ENG-R 3337, 9/11/64 (03-0046)].

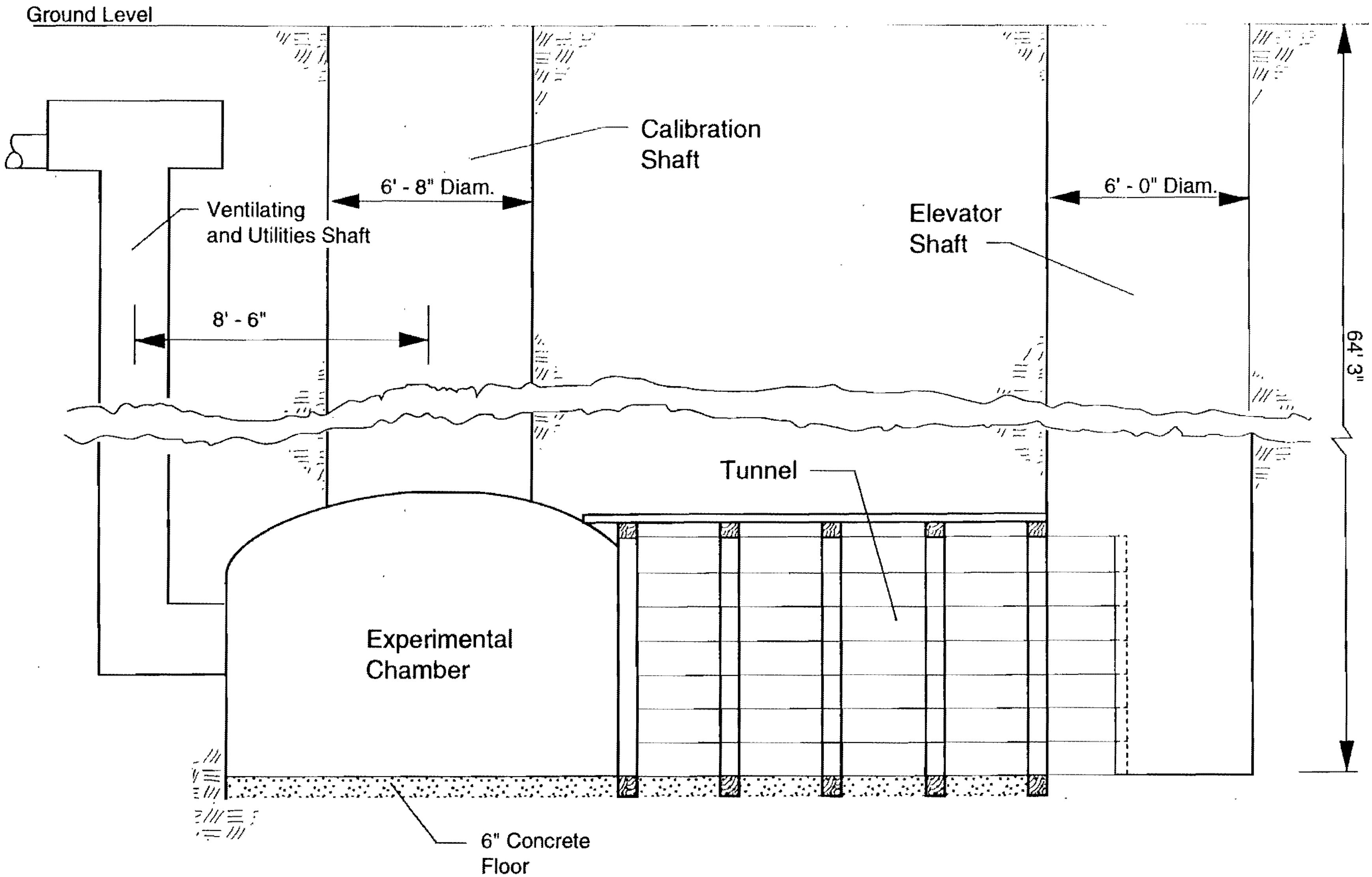


Figure 6.5-3 Cross section through the Area 10 shafts. [Adapted from unpublished engineering drawings.]

remote (Eller 1992, 0035). The total volume of hydraulic fluid in this system was less than 100 gal and it is considered improbable that the hydraulic fluid contained PCBs. There is no evidence that organics other than hydraulic fluid, or hazardous materials other than those mentioned above, ever were used in Area 10. During a 1991 field inspection, a few small shards of possible asbestos concrete were noted on the surface at Area 10 (Eller 1992, 03-0003).

Routine monitoring by field instruments was commonplace at Area 10 during site operations from 1959 to 1961 and sporadic thereafter. Documentation of environmental monitoring at Area 10 has not been located, except for the notes of health physics technicians associated with operation of the pulse neutron source. However, extensive interviews with operations personnel involved with Area 10 have given no indication that any significant radiological contamination was ever created or detected at Area 10, except that noted above.

6.5.4 Data Needs and Objectives and Investigation Rationale

The overall objective of the Area 10 field investigation is to demonstrate and document the suitability of Area 10 for unrestricted Laboratory use, subject to general site-wide restrictions that result from the use of TA-49 as a firing site buffer zone. The specific technical objective of the Phase I investigation is to demonstrate that contamination above action levels is not present in Area 11.

Based on existing information described above and in preceding chapters of this OU work plan, the observational approach implies that Area 10 characterization needs are limited to those that directly address the following decision question:

Do contaminants of concern exist above action levels in surface soils at Area 10?

This question will be answered by a combination of area radiological surveys and discrete sampling and Level III analysis of surface soils. The rationale for analysis at Level III is given in Subsection 5.8.1 of this OU work plan.

Specific aspects of the field investigation include the efforts outlined here.

- Field area radiological surveys will be carried out over at least 90% of the surface in the immediate vicinity of the Area 10 shafts to detect radiological hotspots.
- Discrete surface soil samples will be collected around the shafts and former structure locations at Area 10 for Level III analysis for radionuclides and RCRA metals. Surface soil samples from the former hydraulic reservoir location also will be analyzed for SVOCs and PCBs.
- Samples from the floors of the elevator shaft (if open to the bottom) will be collected for Level III analysis for radionuclides, RCRA metals, SVOCs, and PCBs.

Figure 6.5-4
Photograph of the underground experimental chambers and the interconnecting passageway at Area 10. Note the stratifications and fracture detail of the surge deposit.

- Gross alpha, gross beta, and gamma spectrometry measurements (using either the field laboratory or an off-site analytical laboratory) will be conducted for all samples collected. One-half of these samples, plus all samples for which above-background levels of these analytes are indicated, will be analyzed in an analytical laboratory for isotopic plutonium, total uranium, and RCRA metals.

Only a single phase of investigation is expected to be required at Area 10 because the likelihood of detecting contamination above conservative action or screening levels is very low. If this expectation is not borne out by the initial field investigation, Phase II investigation may be required that could involve surface and subsurface sampling over a larger area of the SWMU and possibly over a wider analyte suite.

Chapter 5 of this OU work plan addresses the potential consequences of type I and II errors.

6.5.5 Sampling Plan

Available information on past uses of Area 10 has led to the following assumptions in developing the sampling plan for Area 10.

- The highest surface contamination levels will exist in the immediate vicinity of the tops of the shafts. Therefore, the Phase I investigation focuses on this area and emphasizes surface soils.
- If surface contamination exists in Area 10, it will be highly discontinuous (particulate) in nature. If surface hot spots exist, they will be indicated reliably by a combination of surface area radiological screening and discrete soil sampling to a depth of 6 in.
- If contamination exists in the bottom of the shafts or in shaft backfill, the inventory is very small. Even if contamination exists in the shafts, no credible pathways are likely to exist for transporting minor amounts of shaft contaminants to receptors. (See the NFA criteria listed in Section 8.1). Therefore, the expense of sampling for contaminants in backfilled shafts is not warranted by the information likely to be gained.

Before sampling activities begin, the concrete shielding and pads around the Area 10 shafts will be removed, if feasible, to allow unrestricted access to the soils. Area radiological surveys of the area then will be performed using either manual detectors (for example, FIDLER and PHOSWICH systems) or a mobile gamma spectrometry system. At least 90% of the area outlined in Figure 6.5-5 will be covered in this survey. If hot spots are found, they will be located precisely and soil samples will be collected at these locations and analyzed as described above. The spatial variability around any hot spots that are detected will be determined from analysis of samples collected from a depth of 6 to12 in. beneath the hot spots and a depth of 0 to 6 in. at a lateral distance of 1 m from the hot spots.

TABLE 6.5-1

SUMMARY OF SAMPLES AND ANALYSES FOR PHASE I INVESTIGATIONS FOR AREA 10 [a]
(SWMU 49-002 Underground Experimental Chamber)

Number of Samples

	Soil Sample
Analytical Samples	18
QA/QC Samples	
Rinsate blank	1
Field duplicate	1
Field blank	1
Total number of field samples	21

[a]Routine field survey instruments will be used to screen for gross alpha and beta contamination. Where appropriate, and depending upon convenience and field laboratory availability, analysis of Area 10 samples will be performed in either the field laboratory or off-site analytical laboratory. Gamma spectrometry will yield gross gamma, americium-241, and cesium-137 levels.

Number of Laboratory Analyses

	Soil Sample	Level III Method
Total uranium	11	ICPMS
Isotopic plutonium	11	Alpha spectrometry
Gross alpha/beta	21	Gas flow proportional counter
Gamma spectrometry	21	Gamma spectrometry
SVOCs	6	SW 8270
PCBs	6	SW 8080
RCRA metals	11	SW 6010
Total number of analyses	87	

Other Characterization:

Radiological and geophysical surveys will be conducted over an area of 13,000 ft^2

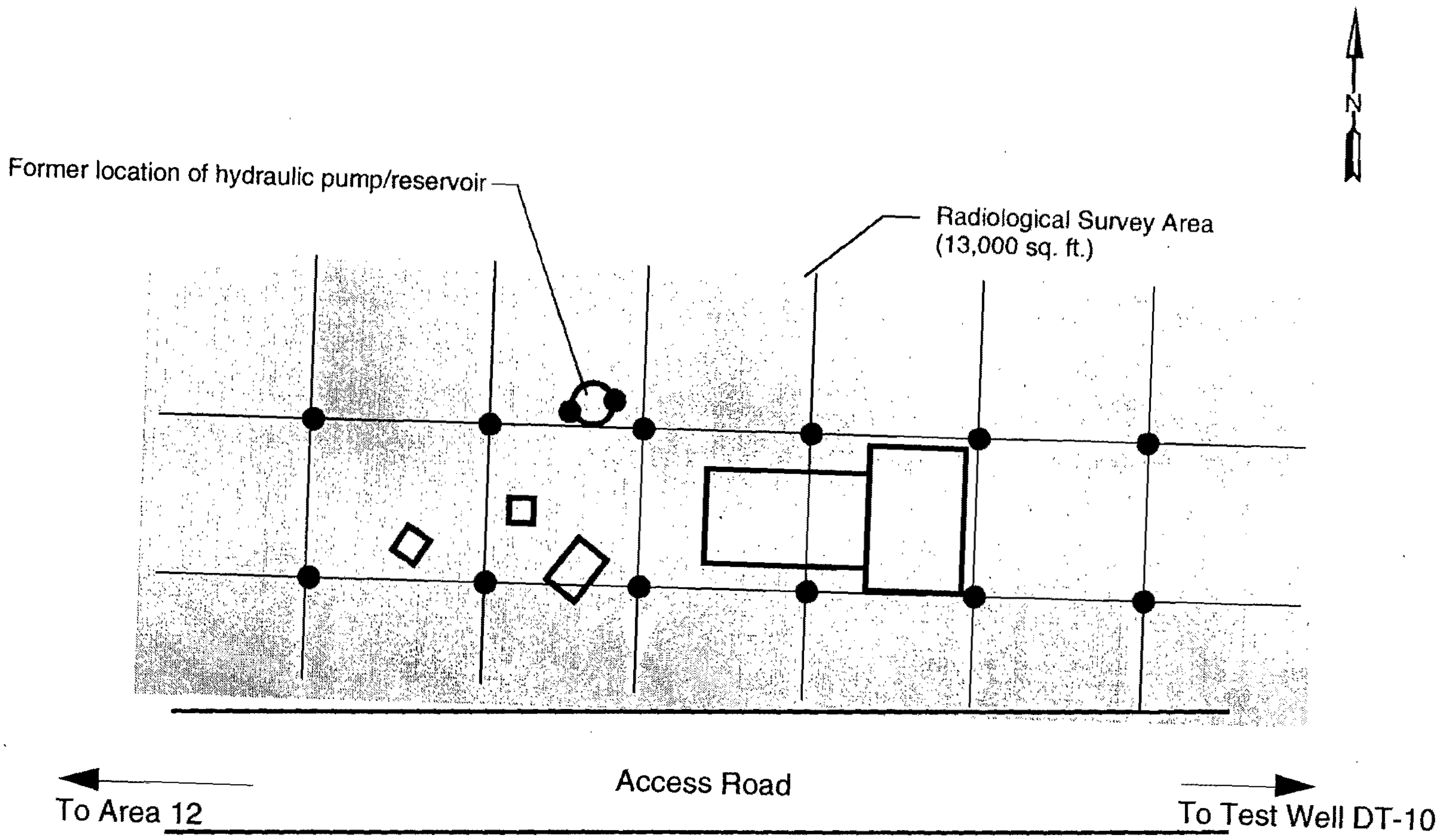


FIGURE 6.5-5 Proposed RFI sampling locations for Area 10. Rectangular shapes indicate former structure locations. Four samples will be collected from the elevator shaft floor, if accessible.

0 25 ft

● Discrete Soil Sampling Location

Discrete soil samples will be collected at the grid locations indicated in Figure 6.5-5 for analysis as described for hot spots. The radiological survey area and the grid spacing and placement are derived from knowledge of site operations (as discussed above) to ensure effective coverage of the area with the maximum likelihood of elevated surface contamination levels. Two additional samples will be collected from the most probable surface location where hydraulic fluid could have leaked (the former reservoir location). These samples will be analyzed for SVOCs and PCBs in addition to radioactive and metal contaminants, as discussed above.

If the floor of the elevator shaft is accessible after the concrete cover is removed, the shaft will be entered. Field instruments will be used to survey the shaft walls and bottom, as well as associated debris, for gross alpha, beta, and gamma radiation. If obvious and easily removed contaminants such as lead bricks or sealed radioactive sources are found, they will be removed as a VCA for disposal at an appropriate Laboratory waste disposal facility.

If the elevator shaft floor is exposed and sampling can be accomplished in a safe and reasonable manner, four soil samples from equal-area sectors of the shaft floor will be collected. The samples from the shaft floor will be analyzed as described for the surface grid samples, with the addition of SVOCs and PCBs (screening test). If access to the floor shaft is not feasible, no subsurface sampling will be conducted.

If the elevator shaft is safely accessible and is uncased, it provides a good opportunity for further geologic characterization of the soil horizon and the upper Bandelier Tuff at TA-49, as was described in greater detail in Section 6.1. Further characterization of the surge deposit shown in Figure 6.5-4 would be of particular interest.

Table 6.5-1 of this section and Table E-5 of Appendix E summarize the samples and analyses proposed for the Area 10 field investigation. Area 10 samples will be analyzed by the indicated methods in either the field laboratory or an off-site analytical laboratory, depending upon scheduling and convenience.

QA/QC samples indicated in Table 6.5-1 will be collected for analysis during the Area 10 investigation as indicated in Table 6.5-1.

6.6 Area 12 Bottle House Area

Description, Data Needs and Objectives, and Sampling Plan for:
-SWMU #49-008 (d) Soil Contamination and Backfilled Shaft

6.6.1 Introduction

This section addresses Area 12 of TA-49 including SWMU 49-008(d) (soil contamination) and a backfilled underground chamber. Available information on Area 12 is reviewed and the objectives and details of the Area 12 field investigation are described in detail in this section. Table 6.6-1 summarizes the samples and analyses for Phase I investigations for Area 12.

Data are needed for Area 12 to document the presence or absence of contaminants relative to levels of concern in surface soils around the existing structures TA-49-23 (referred to as the Bottle House) and TA-49-121 (referred to as the Cable Pull Test Facility). No sampling of the shaft under the Bottle House is proposed because historical data discussed below suggests that it is very unlikely that significant contaminant levels exist in the backfilled shaft, and credible pathways do not exist even if minor contamination is present. The principal potential contamination-migration pathway over the assumed period of institutional control is erosion (aerial resuspension and surface water runoff). A conceptual model for Area 12, including exposure routes and potential receptors for potential environmental transport pathways, is described in Section 4.11 of this OU work plan. The likelihood for significant contaminant transport from Area 12 is low for the following reasons:

- Area 12 is located on a relatively flat portion of Frijoles Mesa, so erosion is minimal;
- the depth to the main aquifer is about 1200 ft and there are no perched aquifers known or expected in the area;
- the distance to potential off-site receptors is large for the exposure scenarios assumed at TA-49 and no credible pathways are known;
- access and use of the site is controlled; and
- historical information and previous sampling suggest that it is unlikely that contamination levels in Area 12 exceed action levels discussed in Section 5.1.

Potential response actions for Area 12 are presented in Chapter 5 and are summarized in Table 5.4-1. The overall objective of the field investigation is to demonstrate and document that Area 12 is suitable for unrestricted Laboratory use, subject to general restrictions imposed by the continuing use of TA-49 as a firing site buffer zone. The suitability for unrestricted Laboratory use will be established by surface radiological surveys and discrete sampling and Level III analyses of surface soils.

The field investigation is likely to demonstrate that the no further action (NFA) alternative, other than minor removal of debris from the site, is a likely and appropriate remedial alternative for the unrestricted use objective for Area 12.

TABLE 6.6-1

SUMMARY OF SAMPLES AND ANALYSES FOR PHASE I INVESTIGATIONS FOR AREA 12[a, b]

	Surface Soil Samples
Number of analytical samples	20
Number of QA samples	
Ransite blank	1
Field duplicate	1
Field blank	1
Total number of analyses	23

[a]All samples will be field screened for elevated alpha and gamma contamination using routine field instruments. Where appropriate, and depending upon convenience and field laboratory availability, analyses of Area 12 samples will be performed in either the field laboratory or an off-site laboratory.

Number of Laboratory Analyses	Surface Soil	Level III Method
Total uranium	12	ICPMS
Isotopic Pu	12	Alpha spectrometry
Gamma spectrometry	23	Gamma spectrometry
Gross alpha/beta	23	Gas-flow proportional counters
RCRA metals	12	SW 6010
SVOCs	9	SW 8270
PCBs	9	SW 8080
Total number of analyses	100	

[b]Radiological surveys will be conducted over an area of 14,000 ft^2.

If significant contamination is found during the RFI, a statistically based Phase II investigation may be required to further define the contamination. If risk assessment then indicates that NFA is inappropriate, the most likely remedial alternative is selective soil removal and disposal.

To facilitate sampling, surface debris from the Bottle House and the Cable Pull Test Facility will be removed as appropriate for disposal elsewhere at a suitable Laboratory waste disposal facility.

6.6.2 Description, Site History, and Potential Source Terms

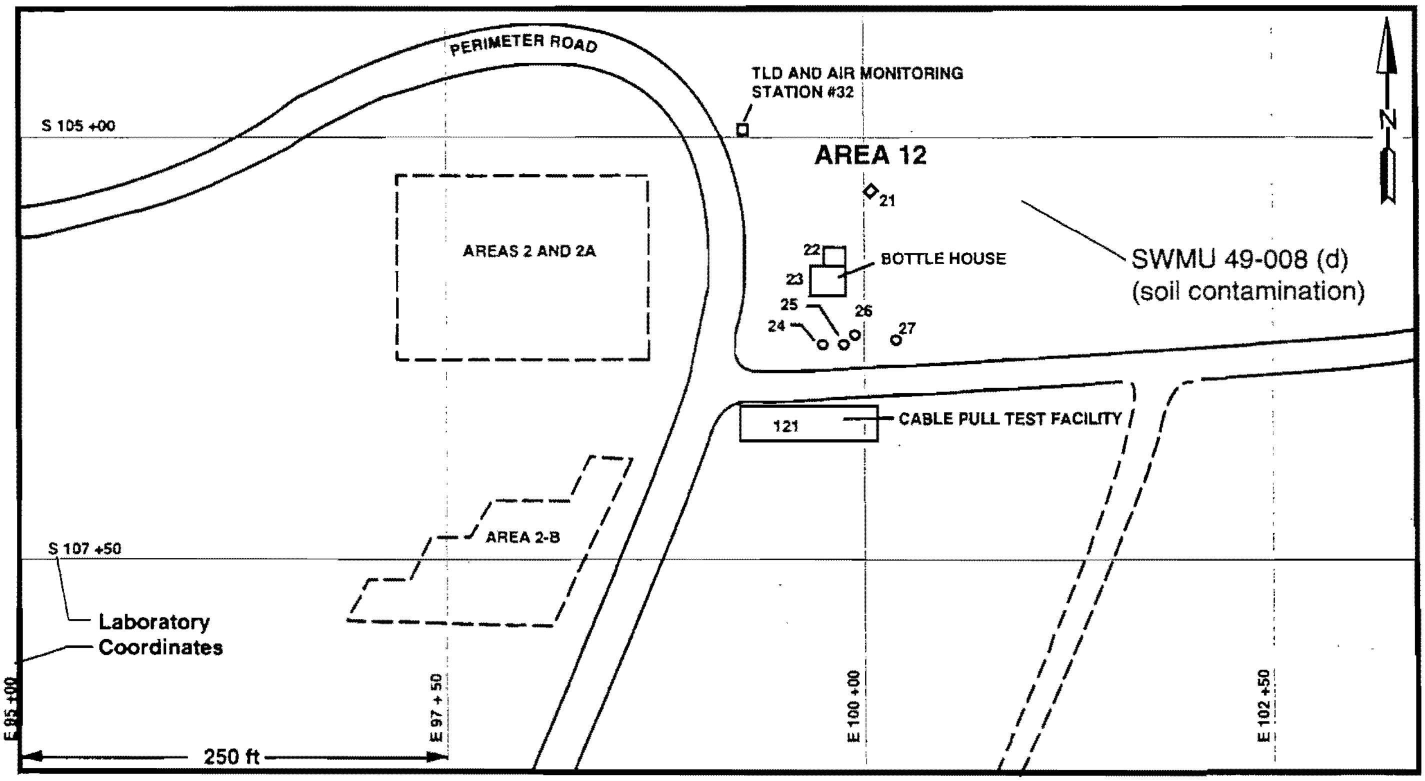
As is indicated in the site maps given in Figures EXEC-3 and 6.6-1, SWMU 49-008(d) is located in Area 12 of TA-49, immediately east of Area 2 of MDA AB. Figure 3.1-2(a) shows a recent view across Area 12.

The main historic activities in Area 12 were confinement experiments in 1960 and 1961 that were related to the TA-49 hydronuclear program. These experiments consisted of HE detonations in sealed metal "bottles" (up to 5-ft in diameter by 16-ft in length) placed in a 10-ft-diameter by 30-ft-deep shaft. The shaft was surrounded by the Bottle House, which is one of only two surface structures remaining in Area 12. There were small temporary structures to support the confinement experiments in Area 12, and these are evident in Figure 6.6-1 and in some early aerial and ground-level photographs.

Approximately 26 confinement experiments involving HE detonations were carried out in the Area 12 shaft. Several experiments involved a few kilograms of uranium-238. Six experiments involved a few microcuries of irradiated uranium tracer (typically 3.5 g of uranium-238, and in one case, 10.6 g of uranium-235). Up to 7 tons of road salt were used as an energy absorbant for each of the major experiments. In each experiment, after the HE was detonated, the containment vessel was unsealed and the salt was removed, sometimes with the help of jackhammers. According to several site employees, the salt was disposed of at the TA-54 waste disposal site. Following the final experiment, the containment bottle also was disposed of off-site, probably at TA-54.

During the containment experiments, the area was monitored routinely for the release of radiation. For example, field notes indicate that after several experiments in May 1961, low levels of gross alpha contamination were noted on the interior surfaces of the metal liner and the compressed salt. However, there is no indication from any records or interviews that contamination was released to the site environment from the confinement experiments or from any other Area 12 activities.

After the containment experiments were concluded in 1961, Area 12 structures were used to support operations at the Cable Pull Test Facility, which was constructed in the early 1960s just across the access road from the Bottle House. The Bottle House shaft was backfilled with crushed tuff and a hydraulic system, including a fluid reservoir, compressor, and hydraulic lines, was installed in the building (Eller 1992, 0035). A buried hydraulic line, which probably is still present, connected the Bottle House to the Cable Pull Test Facility. The site construction engineer responsible for Area 12 recalls that no



AREA 12 STRUCTURES

TA-49-21 LATRINE
TA-49-22 EQUIPMENT BUILDING
TA-49-23 BOTTLE HOUSE
TA-49-24 PORTABLE MANHOLE
TA-49-25 TRANSFORMER
TA-49-26 POWER PANEL
TA-49-27 PORTABLE MANHOLE
TA-49-121 CABLE PULL TEST FACILITY

FIGURE 6.6-1 Engineering drawing of Area 12 around the period of peak site activity. Area 12 structure numbers are indicated [adapted from engineering drawing ENG R- 2487, 8/15/61 (03-0025)].

spills of any type occurred and estimated that the total capacity of hydraulic fluid was less than 10 gal (Eller 1992, 0035). Field inspections in 1987 and 1991 noted that oil probably was still present in the Bottle House equipment and some leakage onto the Bottle House floor was noted (Eller 1992, 03-0003; Weston 1989, 03-0015). During these inspections, a sign indicating that the hydraulic equipment is free of PCBs was noted.

Inspection of the Cable Pull Test Facility in September 1991 did not reveal obvious spill areas, but the seriously deteriorating condition of the structure was noted. A 10-ft-diameter depression that contained an unmarked, empty 3-gal. drum and a small area of discolored soil also was noticed. Historical information indicates that this area was used only as a staging area for activities in Area 2 and Area 12 (Eller 1992, 03-0035) .

In 1987 as part of the A-411 survey of MDA AB, 12 soil samples and 11 vegetation samples were collected around the Bottle House area and analyzed for radionuclides (Soholt 1990, 0698). Area 12 data are not specifically cited in the A411 report but are available for evaluation and are presented in summary form in Table 6.6-2 and Figure 6.6-2. Although most samples had analyte levels near background or analytical detection limits, a few samples showed radionuclide levels slightly above background but well within the action levels discussed in Section 5.1. The most elevated contaminant level is for plutonium-239/240, for which one sample exhibited 0.69 pCi/g. The data indicate that surface contaminants at Area 12 are low level and highly discontinuous in distribution, which is typical for other SWMU areas at TA-49.

In 1990, soil samples from the roadway between the Bottle House and the Cable Pull Test Facility were surveyed for gross alpha/beta and gamma radioactivity (Romero 1990, 03-0040). Levels of radionuclides were found to be at or below regional background levels or analytical detection limits.

Air-monitoring and dosimetry Station 32, part of the Laboratory's environmental surveillance network, is located about 100 ft northwest of the Bottle House. Air concentrations of tritium, total uranium, plutonium-238, plutonium-239/240, and americium-241, as well as penetrating radiation dose rates (TLD exposure), are measured at this station and compared to results from similar stations at the State Road 4 entrance to TA-49 and at other Laboratory sites. Results are reported in the A-411 report (Soholt 1990, 0698) and in the annual Laboratory Environmental Surveillance reports (for example, ESG 1990, 0497). TLD dose rates at Area 12 have remained within the statistical range of regional background levels since Station 32 was installed in 1987.

A level of plutonium 239/240 slightly above background was recorded at Station 32 during one quarter of 1987 (Purtymun and Stoker 1987, 0204). However, radionuclide concentrations observed in this quarter and in all other periods since the station was installed have been less than 1% of DOE concentration guides for on-site areas (Soholt 1990, 0698; ESG 1990, 0204). The maximum ratio of measured TRU concentration to guideline concentration for any radionuclide was <<0.1% (32×10^{-18} mCi/ml for plutonium 239/240).

Area 12 is located immediately adjacent to Area 2, where surface soil contamination by radionuclides is documented (see Chapter 7). It is possible

TABLE 6.6-2

RADIONUCLIDE ANALYSES FOR AREA 12 SOILS AND VEGETATION[a,b]

(a) Area 12 Soils

Analyte	Number of Samples	Range	Arithmetic Mean	Regional Soil Background	Comment
U-235/238 ratio	5	0.0053-.0080	0.0065	0.0073	
Total U	12	2.3-73.6 ppm	11.0	3.8 (0.4)	One sample >14 ppm
Pu-239/240	8	0.04-0.69 pCi/g	0.31 pCi/g	0.019 (0.002) pCi/g	Three samples >0.23 pCi/g
Pu-238	8	0.002-0.014 pCi/g	0.0067 pCi/g	0.003 (0.003) pCi/g	
Gross gamma	12	8-67 pCi/g	15 pCi/g	10 (1) pCi/g	One sample >12 pCi/g
Am-241	12	BDL-0.45 pCi/g	0.072 pCi/g	—	Two samples >0.05 pCi/g
Cs-137	12	BDL-0.84 pCi/g	0.43	0.88 (0.18) pCi/g	

(b) Area 12 Vegetation

Analyte	Number of Samples	Range	Arithmetic Mean	Comment
Total U	10	0.2-3.1 ppm	1.1	One sample >1.5 ppm
Pu-239/240	10	0.002-0.013 pCi/g	0.005 pCi/g	
Pu-238	11	0.002-0.014 pCi/g	0.002 pCi/g	One sample >0.003 pCi/g
Am-241	10	0.002-0.006 pCi/g	0.003 pCi/g	
Cs-137	10	0.15-3.1 pCi/g	1.1 pCi/g	One sample >1.5 pCi/g

[a]Area 12 data are from the 1987 A411 study (Soholt 1990, 0698). BDL = below detection limit. The analytical quality level was essentially the same as that proposed for this RFI (that is., Level III; see Table 5.7-2 for detection limits and methods).

[b]Regional soil backgrounds are taken from Table G-32 of the 1989 ESG report (ESG 1990, 0308); the standard deviation is given in parentheses.

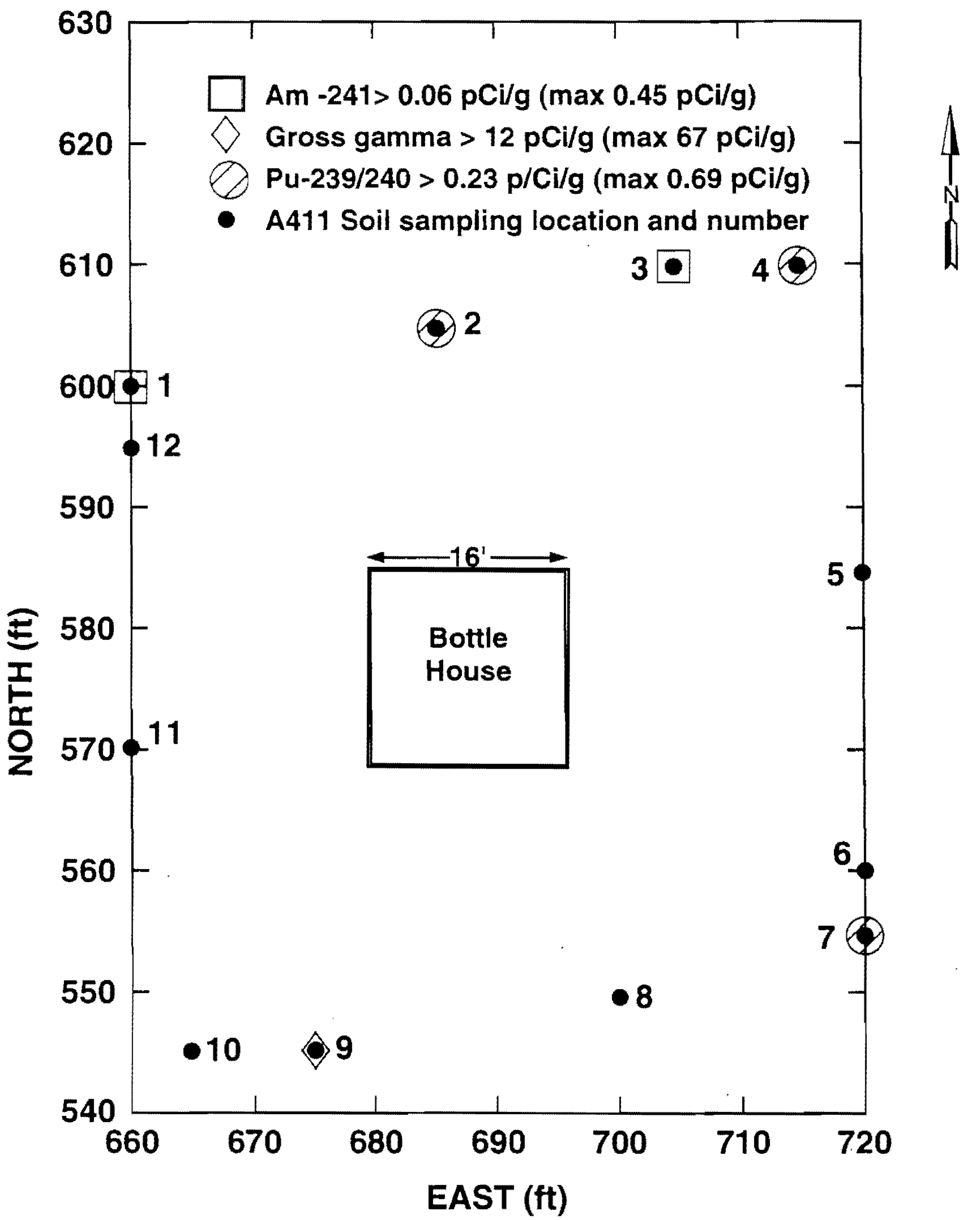


Figure 6.6-2 Area 12 soil sampling locations and summary of results from the 1987 A411 survey [adapted from Soholt 1990 (0698)].

that airborne transport of Area 2 soils is the source of the slightly elevated soil and air concentrations of radionuclides that have been observed in Area 12.

The 1990 Laboratory SWMU report also lists acids, organics, volatiles, and grease as potential contaminants in a grouping of TA-49 surface soil SWMUs including Area 12. However, the available historical information indicates no credible purpose for the past use of such materials in Area 12. Therefore, the likelihood that these contaminants are present at detectable levels at Area 12 is very low, except possibly for low levels of organics within the Bottle House and at the discolored soil area south of the roadway.

Current use of Area 12 is limited to air-monitoring at Station 32 and occasional use of portable microwave experimental equipment in the roadway between Area 10 and 12. Present use does not involve hazardous or radioactive materials, and no change in the use of Area 12 is foreseen for the indefinite future.

6.6.3 Data Needs and Objectives and Investigation Rationale

The technical objective of Phase I of the Area 12 field investigation is to further demonstrate and document that contaminants are not present above action levels, thereby verifying Area 12's suitability for unrestricted Laboratory use, subject to site-wide restrictions that result from the use of TA-49 as a firing site buffer zone. Based on existing information described above and in preceding chapters of this OU work plan, the observational approach implies that Area 12 characterization needs are limited to those that directly address the following decision question:

Do contaminants of concern exist above action levels in surface soils at Area 12?

This question will be answered by a combination of area radiological surveys and discrete sampling and Level III analysis of surface soils. The rationale for analysis at Level III is given in Chapter 5.

Specific aspects of the field investigation include:

- radiological surveys of the area indicated in Figure 6.6-3;
- collection of discrete surface soil samples (at a depth interval of 0 to 6 in.) around the Bottle House and Cable Pull Test Facility areas for Level III analysis for radionuclides and metals;
- collection of discrete soil samples (at a depth of 0 to 6 in.) from the Bottle House floor and the discolored soil area for Level III analysis for radionuclides, metals, PCBs, and SVOCs.

Based on site historical information, it is reasonable to focus the investigation primarily on the Bottle House area because this is the most likely location of Area 12 contamination at levels of concern, if it exists. It is assumed that area radiological surveys, discrete surface soil sampling, and Level III analyses for RCRA metals, total uranium, isotopic plutonium, gamma spectrometry (which yields gross gamma radioactivity, americium-241, and cesium-137 levels) and gross alpha/beta radioactivity will serve as sufficient indicators for Area 12 surface contamination above action levels. It is further assumed that sampling of the shaft is not required, as discussed in Section 6.6.1, and that soil sampling over a depth range of 0 to 6 in. will reliably indicate the presence of significantly elevated contaminant levels at Area 12.

Gross alpha, gross beta, and gamma spectrometry measurements (using either the field Laboratory or an off-site analytical laboratory) will be conducted for all samples collected. One-half of these samples, plus all samples for which above-background levels of these analytes are indicated, also will be analyzed at Level III in an analytical laboratory for isotopic plutonium, total uranium, and RCRA metals.

Only a single phase of investigation is likely to be necessary at Area 12 because the field investigation is likely to confirm that contamination levels above action levels do not exist (that is, a negative answer to the decision question). In this case, the RFI/CMS will cease and NFA will be proposed. If this expectation is not borne out by the initial field investigation (that is, a positive answer to the decision question), statistically based Phase II sampling may be required that would involve more extensive surface and subsurface sampling and a wider analyte suite.

6.6.4 Sampling Plan

The Bottle House and Cable Pull Test Facility have not been used in over 25 yr and have seriously deteriorated. Surface debris that would interfere with soil screening and sampling will be removed and disposed of before soil sampling activities. It is anticipated that radiologic surveys will show that the debris can be disposed of at a suitable Laboratory waste disposal facility. Subsurface hydraulic lines will not be removed in the RFI.

An area radiological survey then will be conducted using hand-held or tripod-mounted detectors or mobile gamma spectrometry systems. At least 90% of the area indicated in Figure 6.6-3 will be covered by this survey. If above-background levels are detected, the survey will be extended beyond the indicated area until background levels or the limits of detection are reached. If hot spots are detected, they will be located precisely and sampled to a depth of 6 in. for Level III as described above. The spatial variability around hot spots will be determined by survey instrumentation and by collection of samples at a depth of 6 to 12 in. below the hot spots and at a lateral distance of 1 m from the hot spots.

Discrete surface soil sampling will be carried out where indicated in Figure 6.6-3. The 11 sampling locations around the Bottle House were selected to complement the earlier A411 data by providing supplemental sampling points immediately adjacent to the structure and at a slightly greater distance than in the A411 sampling. The combination of analytical results from these locations and the data collected in the 1987 A411 survey should be sufficient to allow statistical analysis of Area 12 soil contamination levels. Sample collection and analysis for these samples will be conducted as described for hot spot samples.

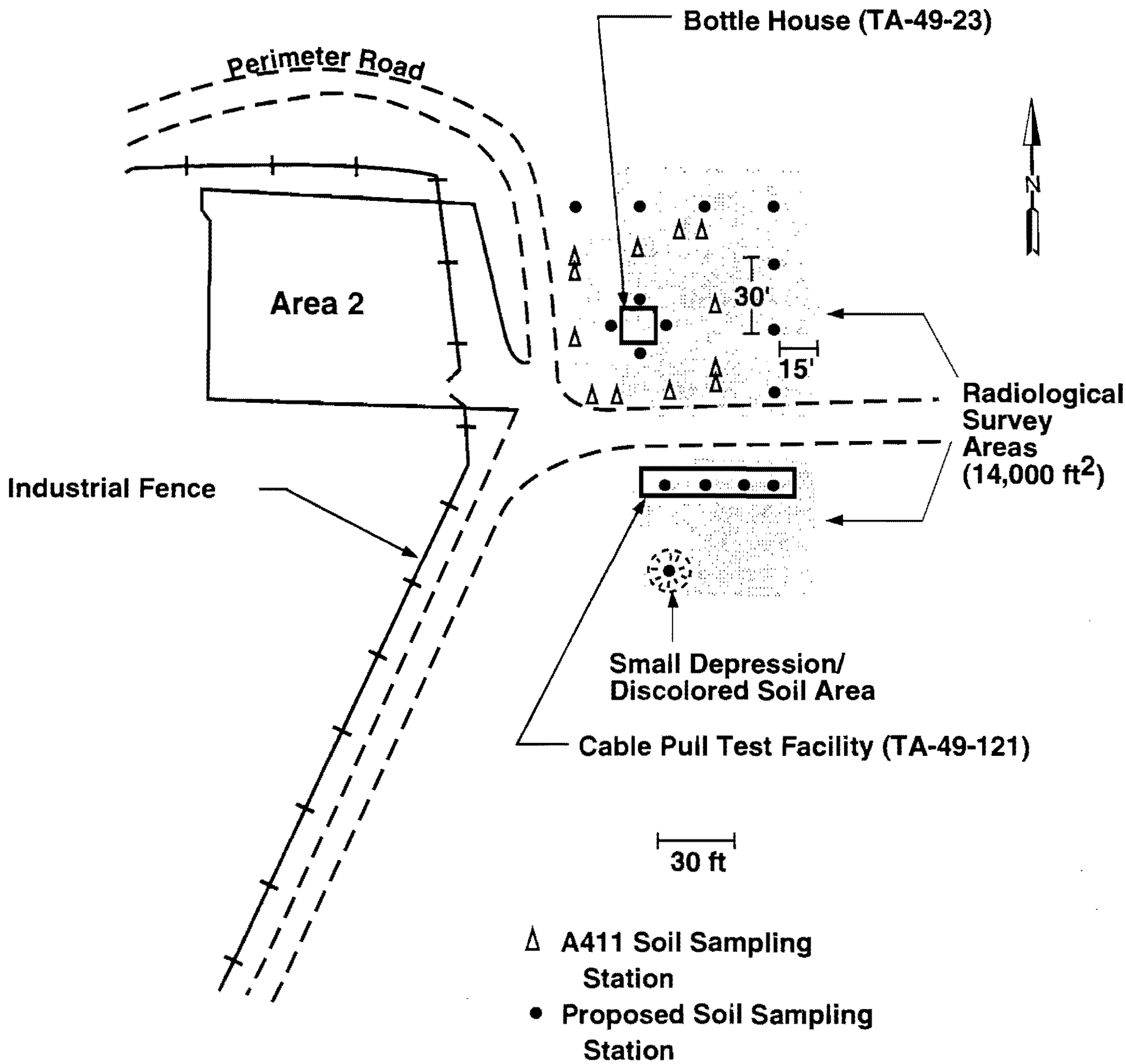


FIGURE 6.6-3 Proposed Area 16 RFI sampling locations. Four additional soil samples will be collected from the Bottle House floor.

Four soil samples each will be collected from the Bottle House floor and soils beneath the Cable Pull Test Facility in locations where hydraulic fluid leaks most probably would have occurred (for example, areas of discolored soil). These samples will be collected and analyzed as described for surface soil samples, with the addition of Level III analysis for SVOCs and field screening for PCBs. If positive indications are obtained for PCBs, Level III analysis will be performed.

One sample also will be collected from the discolored soil area indicated in Figure 6.6-3 and evaluated for the suite of analytes used for soils from the Bottle House floor.

QA/QC field samples will be addressed as indicated in Tables 6.6-1 and E-6 (Appendix E).

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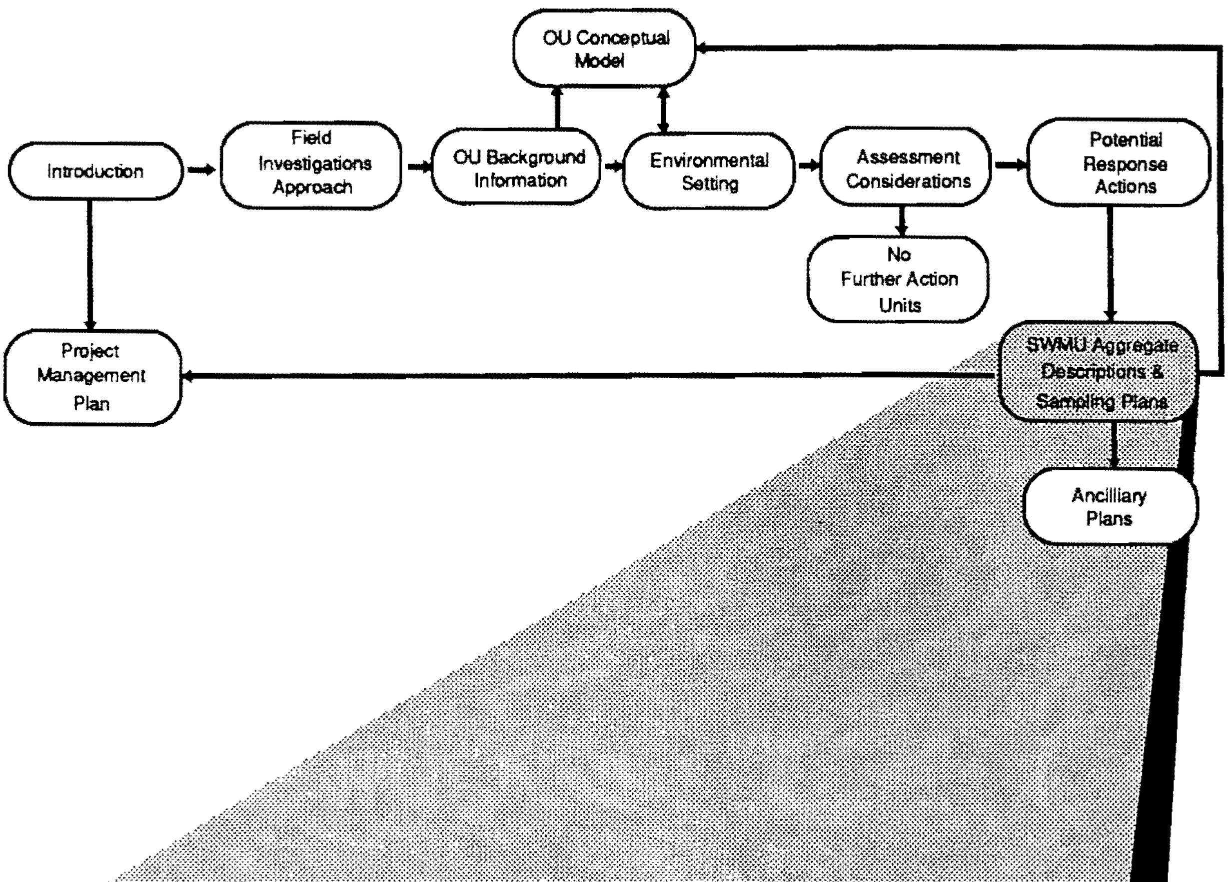
Chapter 7



SWMU Aggregate Descriptions and Sampling Plans

- Material Disposal Area AB

7.0 MDA AB-HYDRONUCLEAR SHAFTS AND RELATED AREAS

Description, Data Needs Objectives, and Sampling Plan for:
- SWMU 49-001 (a - g)
- SWMU 49-001 (miscellaneous)

7.1 Introduction

This chapter is concerned with Material Disposal Area AB (MDA AB), the most important waste unit at TA-49. The chapter outlines data needs and field investigation objectives for this unit and provides details of the field investigation to achieve these objectives. General historical and environmental information on TA-49 is given in Chapter 3 (TA-49 Background) and Chapter 4 (TA-49 Environmental Setting and Conceptual Model). Section 4.11 outlines a conceptual model for TA-49, with special focus on MDA AB, that includes consideration of exposure scenarios. Chapter 5 contains a discussion of assessment and remediation considerations pertinent to MDA AB and outlines the general data quality objectives (DQO) process used to develop the field characterization plan discussed in Chapter 7.

Chapter 7 is organized as outlined below.

- Section 7.2 provides the history and site description of SWMUs 49-001(a through g, and miscellaneous) located in or adjacent to experimental Areas 1, 2, 2A, 2B, 3, and 4, which make up MDA AB.
- Section 7.3 contains a detailed description of potential contamination and source terms in each of these areas.
- Section 7.4 addresses data needs, objectives, and the rationale of the field investigation.
- Sections 7.5 and 7.6 describe surface and subsurface investigations for Phase I of the RFI. Phase II investigations are described in Section 7.7.

Figure EXEC-3 and Appendix A show the location of MDA AB at TA-49. Figures 4.4-2 and 4.7-1 show the locations of permanent sediment sampling stations and boreholes deeper than 150 ft in the vicinity of MDA AB. Appendix B contains engineering drawings for this unit extending back to 1961. Survey coordinates and depths for boreholes at MDA AB and other areas of TA-49 are given in Table 4.4-2.

Figure 3.1-1 shows TA-49 aerial photographs that include MDA AB. These photographs were taken in October 1965 when most structures still remained from the hydronuclear experiments, in July 1977 after several surface cleanup campaigns and immediately after the La Mesa forest fire, and in September 1991.

A close-up view of MDA AB shortly after the period of peak site activity (late 1959 to mid-1961) is shown in Figure 7.1-1(a–d). Figure 3.1-2 shows recent low-altitude oblique aerial photographs of MDA AB. Table 7.1-1 correlates MDA AB experimental areas with SWMU numbers and gives contaminant inventories believed to be present in each experimental area.

Measurements and analyses for Phase I field investigations at MDA AB are summarized in Table 7.1-2 (a – e). A logic chart for the MDA AB field investigation is provided in Figure 7.1-2.

The shaft areas under Areas 1, 2, 2A, 2B, 3, and 4 makeup SWMUs 49-001 (a – f) respectively. SWMU 49-001 (g) comprises surface soil contamination in these areas. SWMU 49-001 (miscellaneous) is a nonspecific category mentioned in the 1990 SWMU report. In this OU work plan, this SWMU has been addressed under SWMUs 49-001 (a–g).

7.2 Description and History of MDA AB

7.2.1 General Information

MDA AB was the location of the hydronuclear and related experiments performed from late 1959 to mid–1961 that deposited virtually all the contaminants that are expected to exist at TA-49. As is discussed below in greater detail, very little other use has been made of MDA AB. In late summer of 1961, the hydronuclear and related experiments at TA-49 ceased, but for a while TA-49 continued to be employed as a staging and calibration area for equipment used at the Nevada Test Site. The final underground experiments at MDA AB were carried out in Area 4 in August 1961.

Except for Area 3, which is believed to contain little hazardous or radioactive materials, all of MDA AB currently is enclosed by a locked industrial fence, and access is controlled by the Laboratory's Environmental Management Division. The fenced portion of MDA AB also encloses Areas 5 and 11 and the enclosed units are managed together.

MDA AB comprises six separate experimental areas (1, 2, 2A, 2B, 3, and 4). As indicated in Table 7.1-1 and in subsequent sections of this chapter, all of these areas (except Area 3) contain significant TRU and heavy metal contamination from about 35 hydronuclear and 12 related calibration and equation of state experiments (Thorne and Westervelt 1987, 03-0014). At least 23 additional underground containment, equipment development, and mockup experiments were carried out, which involved high explosives and, in a few cases, very small amounts of uranium-238 or radioactive tracer but no fissile materials (SNM, or special nuclear materials). Figure 7.2-1(a–e) gives additional information on the contents, layout, and depths of the experimental holes.

The hydronuclear and related experiments involved high-explosive (HE) dispersal of significant quantities of SNM (uranium-235 and plutonium-239) as well as lead, beryllium, and uranium-238 at the bottom of the shafts. As a

Figure 7.1-1
October 1965 Aerial photograph of MDA AB.

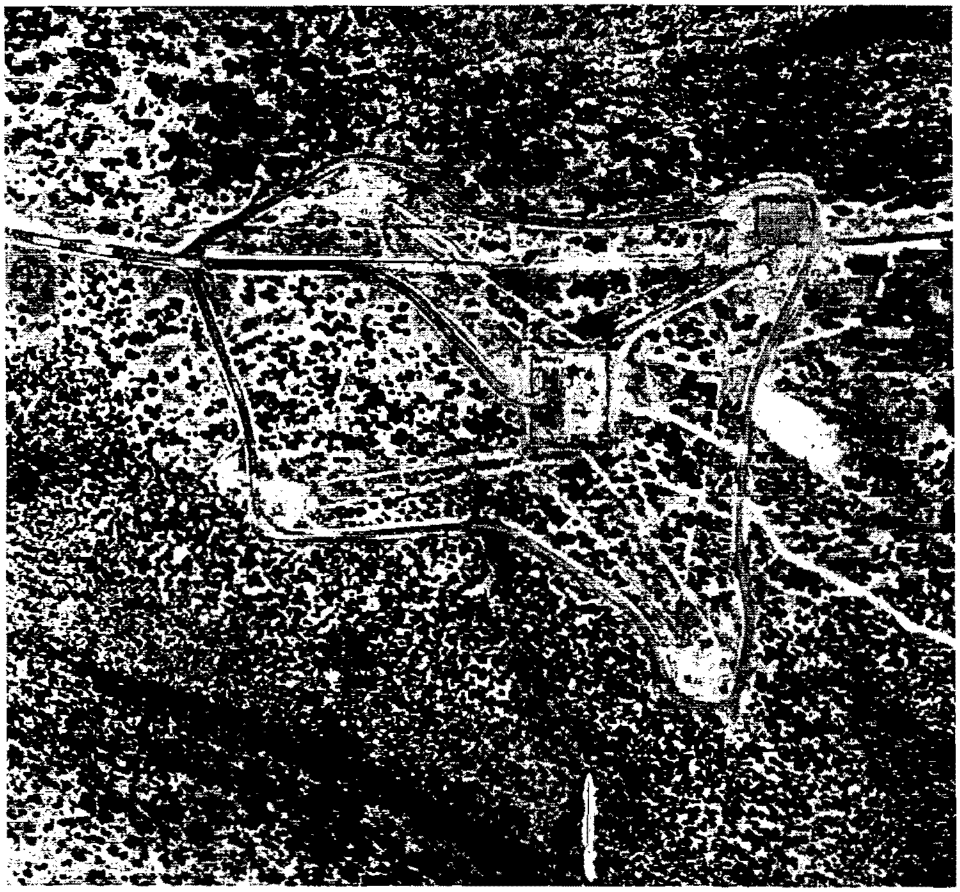


TABLE 7.1-1

CORRELATION CHART FOR MDA AB SWMU NUMBERS, AREA DESIGNATIONS, AND CONTAMINANT INVENTORIES

SWMU Number	MDA AB Area	Pu (kg)	U–235 (kg)	U–238 (kg)
49-001(a)	Area 1	1.06	0.00	62.3
49-001(b)	Area 2	12.62	47.4	52.5
49-001(c)	Area 2A	3.75	9.8	10.6
49-001(d)	Area 2B	5.67	6.4	14.7
49-001(e)	Area 3	0.00	0.005	0.030
49-001(f)	Area 4	17.04	29.4	29.0
	TOTAL	40.14	93.0	169.1

The range of isotopic composition (wt. %) of the plutonium is as follows:

239 (93.5-94.2%), 240 (5.30-6.05%), 241 (0.458-0.563)

The amount of lead estimated to be in underground shafts at MDA AB possibly exceeds 90,000 kg; 11 kg of beryllium also is believed to be present in the shafts.

Approximately 0.20 kg of americium-241 will have been produced in the shafts from the decay of plutonium-241; the present amount is about 0.15 kg. However, 0.20 kg of americium is never reached, because the americium also decays.

TABLE 7.1-2(a)

SUMMARY OF SAMPLES AND ANALYSES FOR PHASE I INVESTIGATIONS FOR AREA 1 OF MDA AB

Number of Samples

	Surface Soil Samples	Vertical Borehole Samples	Lateral Borehole Samples
Analytical samples	20	30	46
QA samples			
Rinsate blank	1	2	2
Field duplicate	1	2	2
Field blank	1	2	2
Total number of samples	23	36	52

All soil and core samples will be screened for alpha, beta, and gamma radioactivity using field survey instruments. Where appropriate, and depending upon convenience and field laboratory availability, analyses will be performed in either the field laboratory or off-site analytical laboratory. Gamma spectrometry yields americium-241, cesium-137, and gross gamma radioactivity levels.

Number of Laboratory Analyses

	Surface Soil	Borehole Core	Lateral Core	Level III Method
Total uranium	12	18	26	ICPMS
Isotopic plutonium	12	18	26	Alpha spectrometry
Gross alpha/beta	23	36	52	Gas-flow proportional counter
Gamma spectrometry	23	36	52	Gamma spectrometry
RCRA metals	12	18	26	SW 6010
Total number of analyses	82	126	182	

Number of vertical boreholes/linear feet: 1/700

Number of lateral boreholes/linear feet: 1/400

Geophysical and radiologic survey area: 18,750 ft^2

TABLE 7.1-2(b)

SUMMARY OF SAMPLES AND ANALYSES FOR PHASE I INVESTIGATIONS FOR AREA 2 OF MDA AB

Number of Samples

	Surface Soil Samples	150 ft Vertical Borehole Samples	Lateral Borehole Samples	Shallow Borehole Samples
Analytical Samples	48	62	46	12
QA Samples				
Rinsate blank	2	3	2	1
Field duplicate	2	3	2	1
Field blank	2	3	2	1
Total Number of Samples	54	71	52	15

All soil and core samples will be screened for alpha, beta, and gamma radioactivity using field survey instruments. Where appropriate, and depending upon convenience and field laboratory availability, analyses will be performed in either the field laboratory or off-site analytical laboratory. Gamma spectrometry yields americium-241, cesium-137 and gross gamma radioactivity levels.

Number of Laboratory Analyses

	Surface Soil	150 ft Borehole	Lateral Borehole	Shallow BoreHoles	Level III Method
Total uranium	27	36	26	8	ICPMS
Isotopic plutonium	27	36	26	8	Alpha spectrometry
Gross alpha/beta	54	71	52	15	Gas-flow proportional counter
Gamma spectrometry	54	71	52	15	Gamma spectrometry
RCRA metals	27	36	26	8	SW 6010
Total number of analyses	189	250	182	54	

Number of vertical boreholes/linear feet: 2/850

Number of shallow boreholes/linear feet: 4/36

Number of lateral boreholes/linear feet: 1/400

Area screened radiologically: 45,000: ft^2

Geophysical survey area: 38,000 ft^2

Number of core fluid samples: 4

Number of soil characteristic samples: 3

TABLE 7.1-2(c)

SUMMARY OF SAMPLES AND ANALYSES FOR PHASE I INVESTIGATIONS FOR AREA 3 OF MDA AB

Number of Samples

	Surface Soil Samples	Vertical Borehole Samples
Analytical samples	20	30
QA samples		
Rinsate blank	1	2
Field duplicate	1	2
Field blank	1	2
Total number of samples	23	36

All soil and core samples will be screened for alpha, beta, and gamma radioactivity using field survey instruments. Where appropriate, and depending upon convenience and field laboratory availability, analyses will be performed in either the field laboratory or off-site analytical laboratory. Gamma spectrometry yields americium-241, cesium-137, and gross gamma radioactivity levels.

Number of Laboratory Analyses

	Surface Soil	Borehole Core	Level III Method
Total uranium	12	18	ICPMS
Isotopic plutonium	12	18	Alpha spectrometry
Gross alpha/beta	23	36	Gas-flow proportional counter
Gamma spectrometry	23	36	Gamma spectrometry
RCRA metals	12	18	SW 6010
Total number of analyses	82	126	

Number of vertical boreholes/linear feet: 1/150

Geophysical and radiological survey area: 18,750 ft^2

TABLE 7.1-2(d)

SUMMARY OF SAMPLES AND ANALYSES FOR PHASE I INVESTIGATIONS FOR AREA 4 OF MDA AB

Number of Samples

	Surface Soil Samples	Vertical Borehole Samples
Analytical samples	20	30
QA samples		
Rinsate blank	1	2
Field duplicate	1	2
Field blank	1	2
Total number of samples	23	36

All soil and core samples will be screened for alpha, beta, and gamma radioactivity using field survey instruments. Where appropriate, and depending upon convenience and field laboratory availability, analyses will be performed in either the field laboratory or off-site analytical laboratory. Gamma spectrometry yields americium-241, cesium-137, and gross gamma radioactivity levels.

Number of Laboratory Analyses

	Surface Soil	Borehole Core	Level III Method
Total uranium	12	18	ICPMS
Isotopic plutonium	12	18	Alpha spectrometry
Gross alpha/beta	23	36	Gas-flow proportional counter
Gamma spectrometry	23	36	Gamma spectrometry
RCRA metals	12	18	SW 6010
Total number of analyses	82	126	

Number of vertical boreholes/linear feet: 1/150

Geophysical and radiological survey area: 18,750 ft^2

TABLE 7.1-2(e)

SUMMARY OF SAMPLES AND ANALYSES FOR PHASE II INVESTIGATIONS OF MDA AB

Number of Samples

	Surface Soil Samples	Vertical Borehole Samples
Analytical samples	100	120
QA samples		
Rinsate blank	5	6
Field duplicate	5	6
Field blank	5	6
Total Number of Samples	115	138

All soil and core samples will be screened for alpha, beta, and gamma radioactivity using field survey instruments. Where appropriate, and depending upon convenience and field laboratory availability, analyses will be performed in either the field laboratory or off-site analytical laboratory. Gamma spectrometry yields americium-241, cesium-137, and gross gamma radioactivity levels.

Number of Laboratory Analyses

	Surface Soil	Borehole Core	Level III Method
Total uranium	58	69	ICPMS
Isotopic plutonium	58	69	Alpha spectrometry
Gross alpha/beta	115	138	Gas-flow proportional counter
Gamma spectrometry	115	138	Gamma spectrometry
RCRA metals	58	69	SW 6010
Total number of analyses	404	483	

Number of vertical boreholes/linear feet: 4/600

Geophysical and radiological survey area: 60,000 ft^2

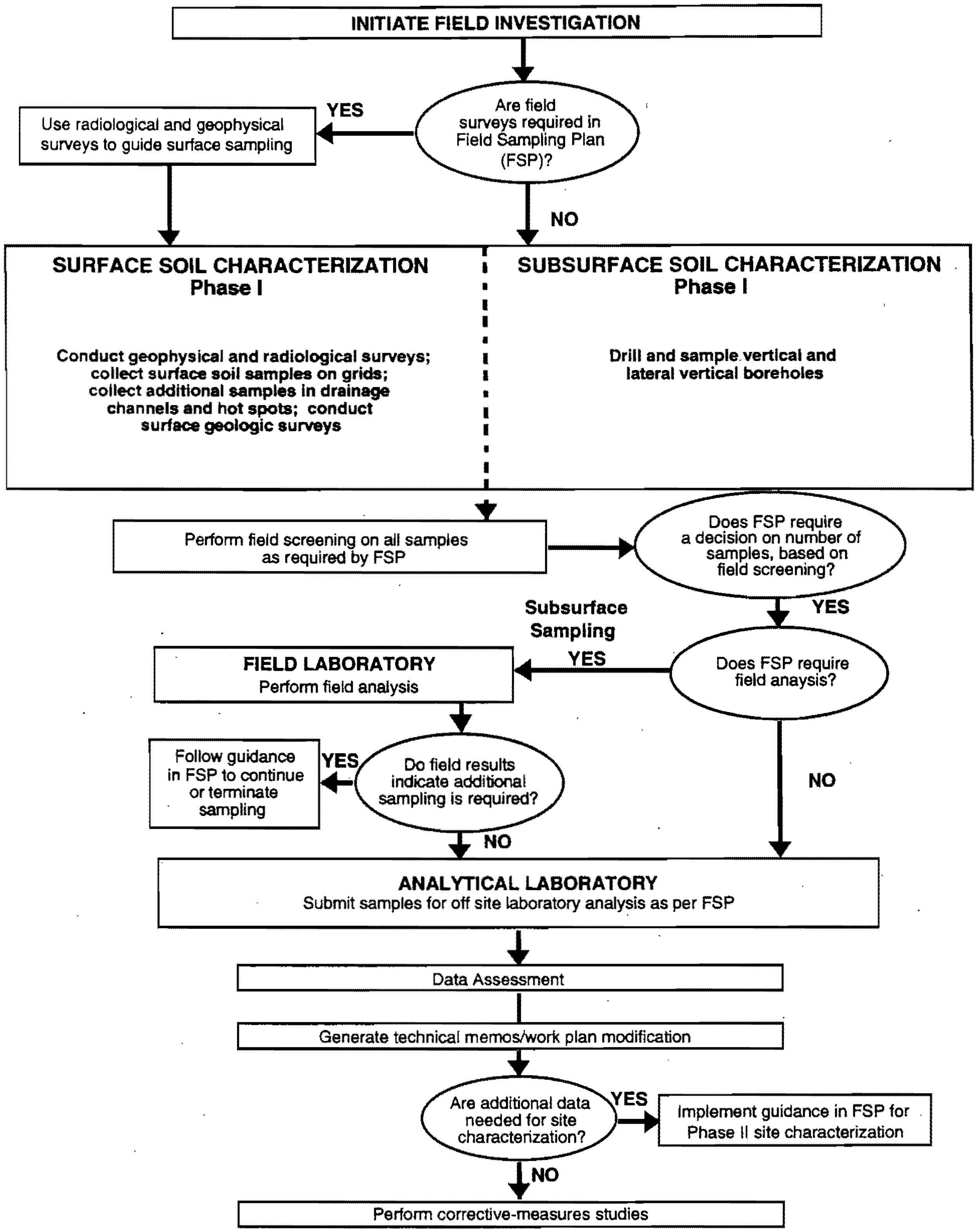
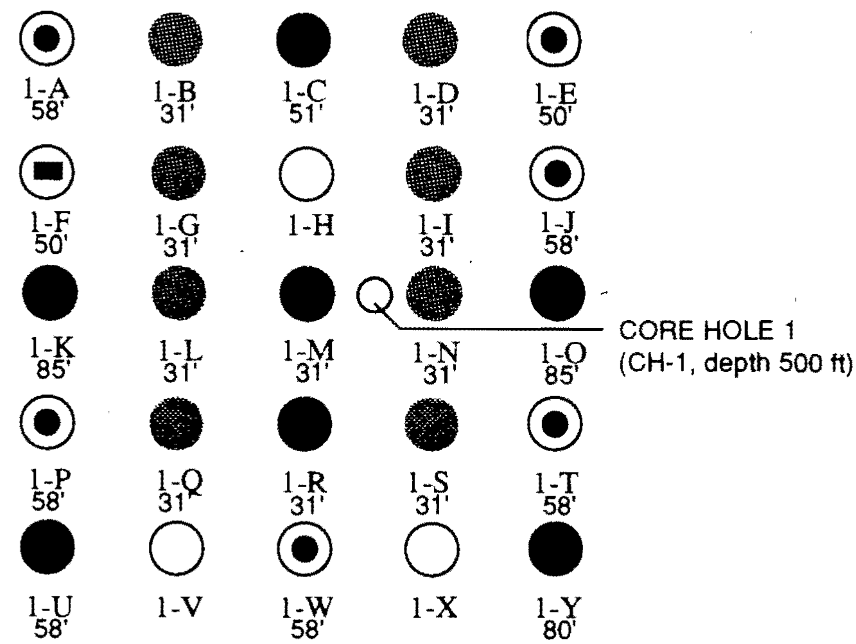
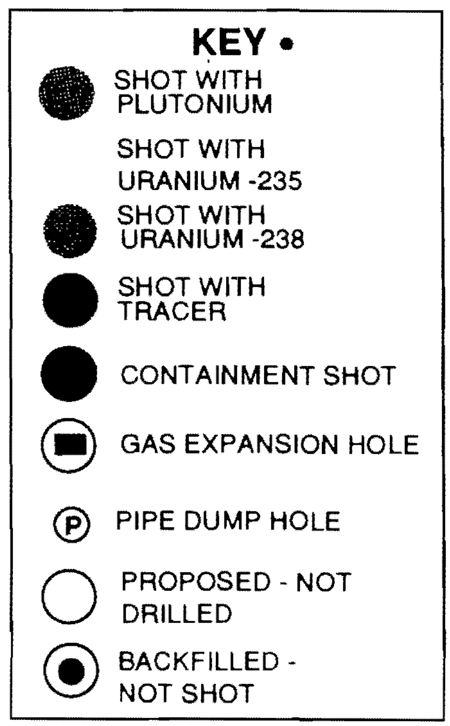


Figure 7.1-2 Logic flow for field investigations at MDA AB.

FIGURE 7.2-1 MDA AB SHOT HOLE PATTERNS &DEPTH

(a) AREA 1





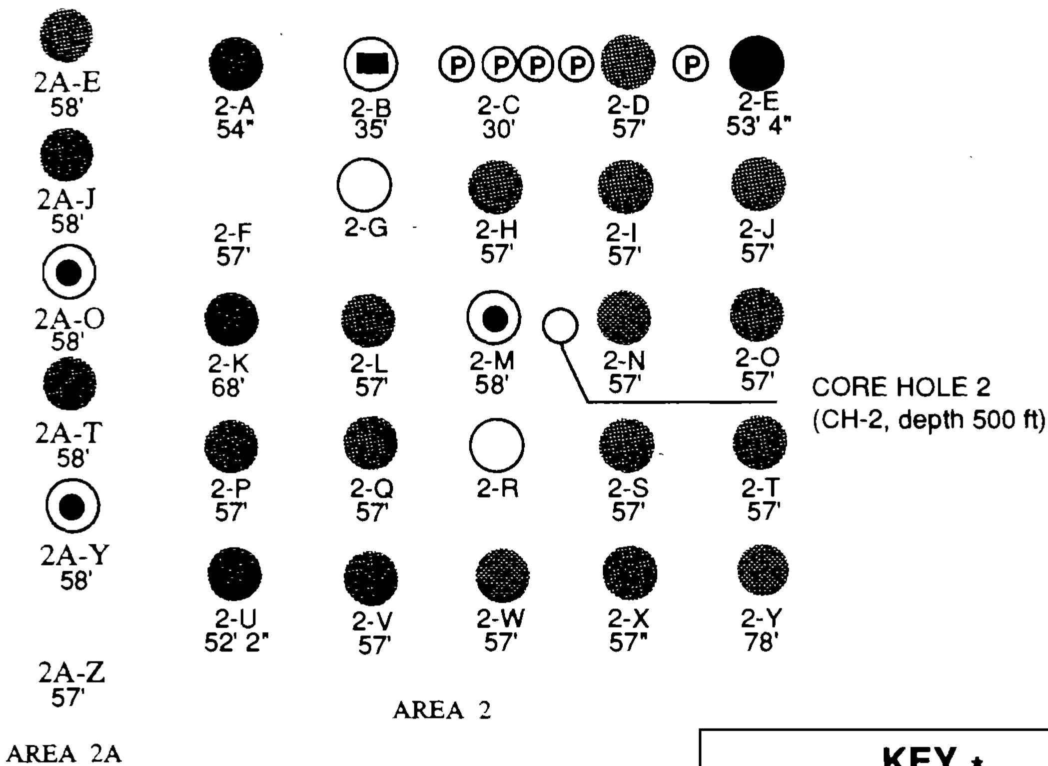
HOLES MAPPED: A, C, E, K, O, U, Y

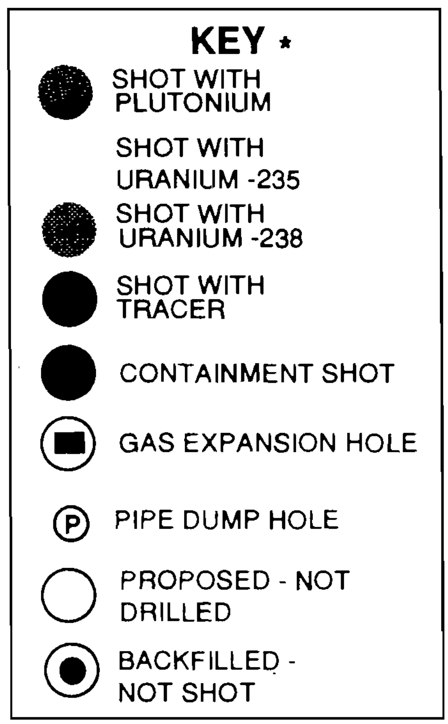
HOLES DESCRIBED IN RECONNAISSANCE NOTES: J, P, T, W (WEIR AND PURTYMUN, 1962)

- SHOTS WITH PLUTONIUM MAY HAVE ALSO HAVE INCLUDED URANIUM -235 AND/OR -238. SHOTS WITH URANIUM -235 MAY HAVE INCLUDED URANIUM -238.

FIGURE 7.2-1 MDA AB SHOT HOLE PATTERNS &DEPTH

(b) AREA 2 & 2A





HOLES MAPPED (AREA 2) : A, E, K, V, Y

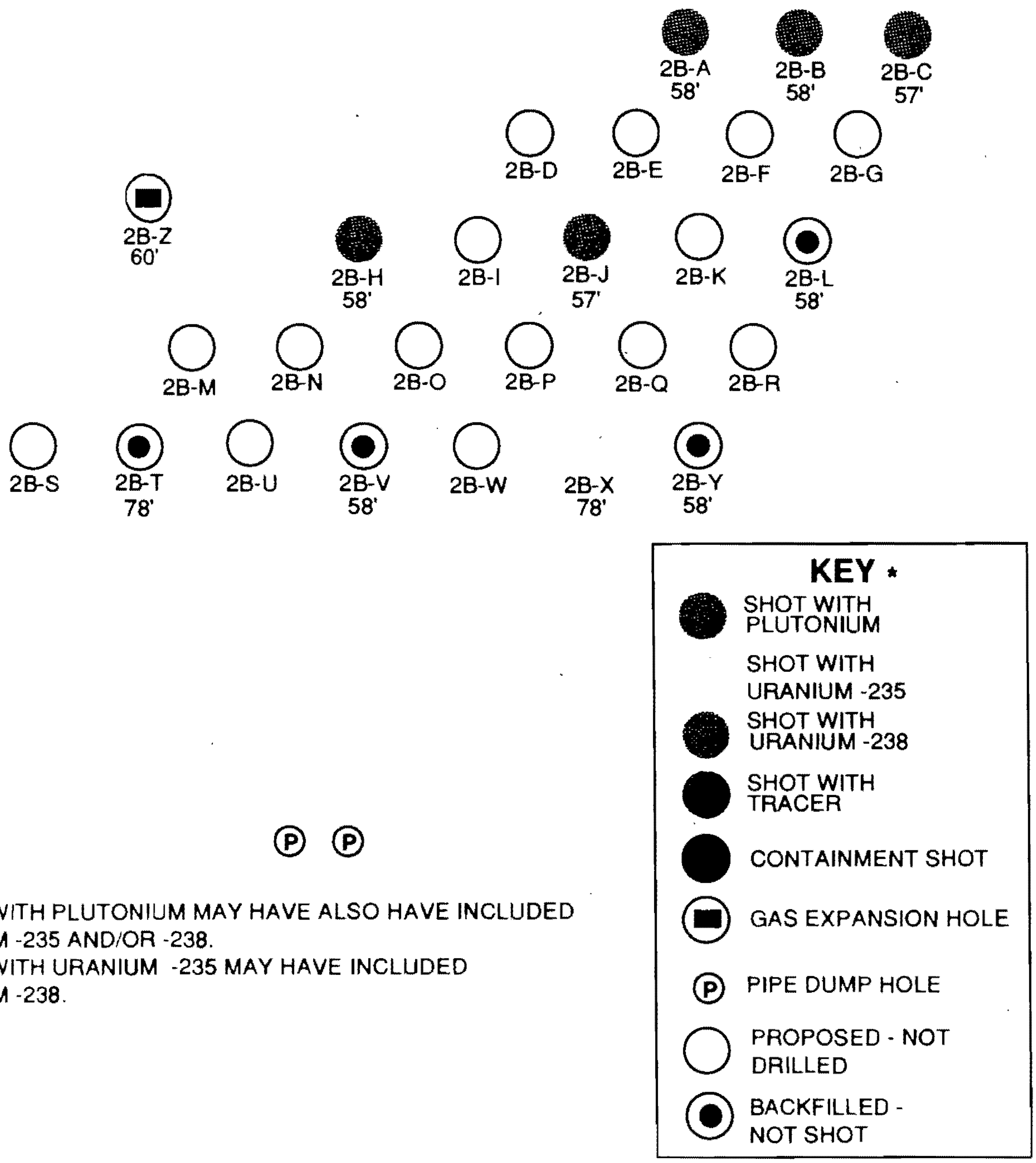
HOLES DESCRIBED IN RECONNAISSANCE NOTES (AREA 2) : D, F, H, J, L, O, S, V, W, X
(WEIR AND PURTYMUN, 1962)

* SHOTS WITH PLUTONIUM MAY HAVE ALSO HAVE INCLUDED URANIUM -235 AND/OR -238.
SHOTS WITH URANIUM -235 MAY HAVE INCLUDED URANIUM -238.

HOLE 2-M WAS CONTAMINATED BY SURROUNDING SHOTS

FIGURE 7.2-1 MDA AB SHOT HOLE PATTERNS &DEPTH

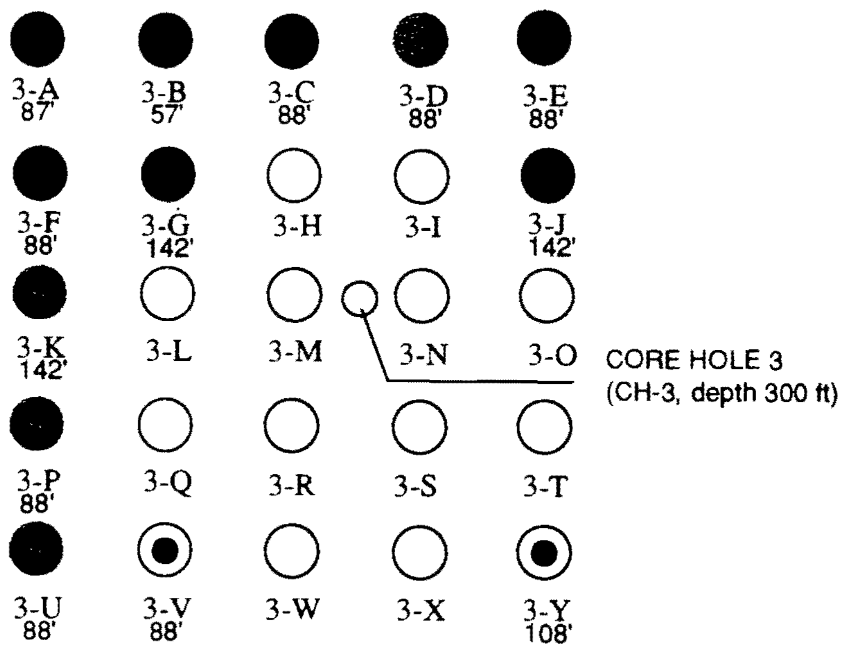
(c) AREA 2B



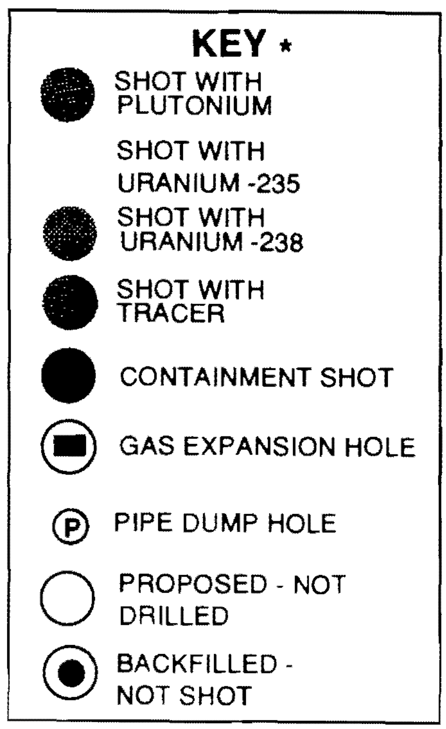
* SHOTS WITH PLUTONIUM MAY HAVE ALSO HAVE INCLUDED URANIUM -235 AND/OR -238.
SHOTS WITH URANIUM -235 MAY HAVE INCLUDED URANIUM -238.

FIGURE 7.2-1 MDA AB SHOT HOLE PATTERNS &DEPTH

(d) AREA 3

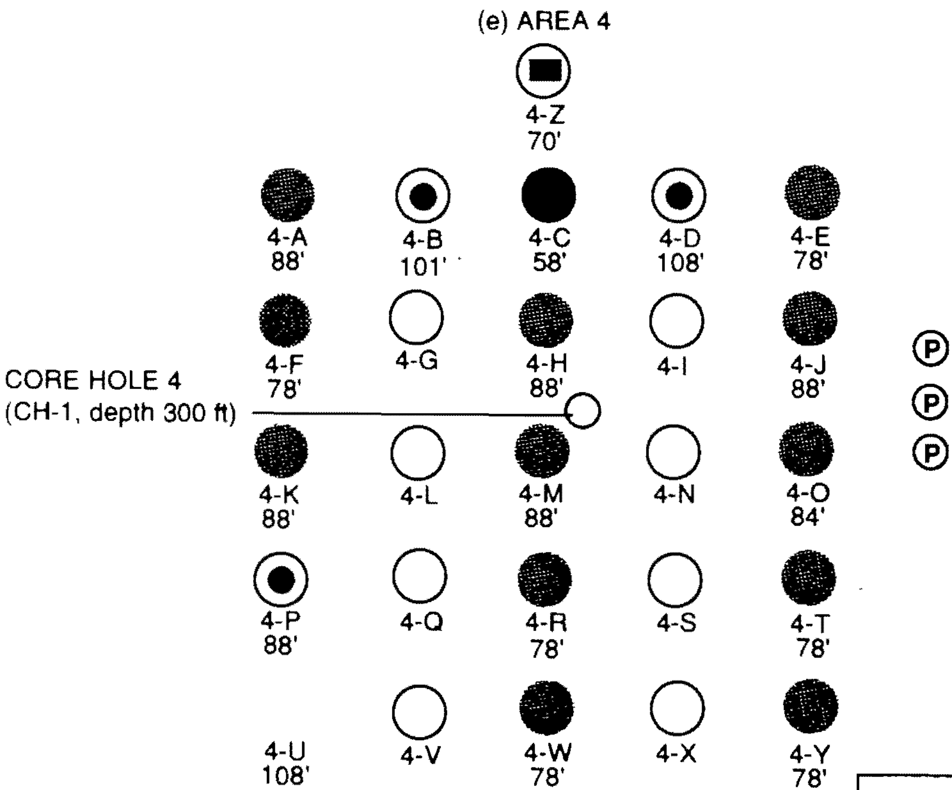


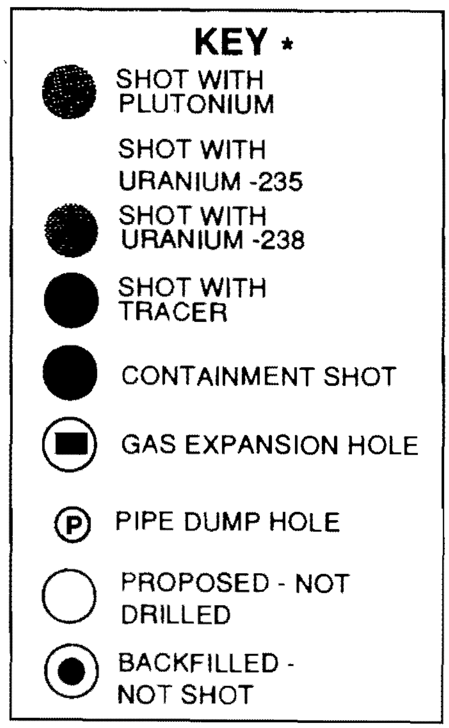
HOLES MAPPED: A, U, Y
HOLE DESCRIBED IN RECONNAISSANCE
NOTES: C (WEIR AND PURTYMUN, 1962)



* SHOTS WITH PLUTONIUM MAY HAVE ALSO HAVE INCLUDED URANIUM -235 AND/OR -238.
SHOTS WITH URANIUM -235 MAY HAVE INCLUDED URANIUM -238.

FIGURE 7.2-1 MDA AB SHOT HOLE PATTERNS &DEPTH





HOLES MAPPED: A, E, V, W

HOLES DESCRIBED IN RECONNAISSANCE
NOTES: K, M, O, Y (WEIR AND PURTYMUN, 1962)

* SHOTS WITH PLUTONIUM MAY HAVE ALSO HAVE INCLUDED URANIUM -235 AND/OR -238.
SHOTS WITH URANIUM -235 MAY HAVE INCLUDED URANIUM -238.

result, MDA AB is believed to contain about 40 kg of plutonium, 93 kg of uranium-235, 170 kg of uranium-238, 11 kg of beryllium, and perhaps 90 000 kg or more of lead. Approximately 0.20 kg of americium-241 has grown in from decay of plutonium-241 (see Table 5.3-1). During the entire series of experiments, the maximum fission energy released from a single experiment was equivalent to four-tenths of a pound of HE, which is an insignificant energy release compared to the energy released by the HE used in the experiments. As discussed below, the maximum radius of underground contaminated zones directly resulting from the detonations is believed to be limited to about 10 to 15 ft, and less in most cases.

7.2.2 Hydrogeologic Studies at MDA AB

As described in Chapters 3 and 4, site hydrogeologic characterization and periodic monitoring of TA-49 were conducted during a cooperative effort between the USGS and the Laboratory, starting before TA-49 experiments began in late 1959 and continuing until 1970. The initial investigation focused on ensuring that residual materials that would be left in the experimental holes now included in MDA AB would be contained indefinitely in the shafts. The results of this extensive investigation are reported in Weir and Purtymun (1962, 0228), Purtymun and Ahlquist (1986,03-0013), and Purtymun and Stoker (1987, 0204). Additional information is contained in a number of internal Laboratory reports.

The fundamental conclusion of these studies was that "recharge to the ground water from Frijoles Mesa is very small or nonexistent; thus no contaminants in solution are likely to be carried to the ground water beneath TA-49." These conclusions are based in part on detailed study of a number of boreholes drilled in and around the experimental areas now included in MDA AB.

Before the TA-49 hydronuclear experiments began, deep test wells DT-5A, DT-9, and DT-10 were drilled through Frijoles Mesa into the main aquifer to determine the thickness of the tuff and volcanic sediments, the hydrologic characteristics of the main aquifer, and the presence or absence of perched water (none was found). Well DT-5A (1821 ft deep, cased to 1821 ft) is located in Area 5 near the center of the experimental areas now included in MDA AB. Wells DT-9 (1501 ft deep, cased to 1501 ft) and DT-10 (1409 ft deep, cased to 1409 ft) are located about 1 mile downgradient with respect to flow in the main aquifer (see Figure EXEC-3 and Appendix A). Two other deep boreholes (DT-5P, 692 ft deep, plugged and abandoned; DT-5, 962 ft deep, cased 0 to 180 ft, open 180 to 962 ft) were drilled within 100 ft of DT-5A but did not penetrate the main aquifer. Stratigraphic diagrams derived from logs of these deep boreholes are shown in Figure 4.5-3 and available logs and well characteristics are listed in Table 4.4-2.

During the initial site characterization, four boreholes (Core Holes 1–4, or CH-1, CH-2, CH-3, and CH-4) were drilled beneath MDA AB and cased with 2-in. galvanized pipe. These boreholes, ranging in depth from about 300 ft (Areas 3 and 4) to 500 ft (Areas 1 and 2), were drilled in the centers of the four main experimental areas to detail the geologic and hydrologic characteristics of the underlying tuff. As was the case with the deep test wells, no perched water was found at the time of well construction. The boreholes have been used to the present day for subsurface monitoring. Surface geology of the area was mapped and correlated with subsurface geology, as determined from logs of the test wells and other holes around MDA AB.

Before pipe was set in Core Hole 1 and Core Hole 2, the holes were filled with fluid to facilitate geophysical logging. A large but unquantified volume of fluid was lost in Core Hole 2, as described later in this chapter. This fluid provides a possible source of standing water observed occasionally in this borehole. Large volumes (perhaps as much as 2.5 to 10 million gal.- see ensuing discussion) of fluids also were lost in hole DT-5A below a level of about 285 ft during logging, further demonstrating the presence of highly permeable zones beneath MDA AB.

Neutron probes were used on several occasions to measure subsurface moisture in monitoring holes in and around MDA AB. The locations of existing moisture monitoring holes are indicated in Figure 4.7-1. As discussed in Chapter 4, in well-drained areas where the protective soil cover is relatively undisturbed, evapotranspiration processes dominate infiltration processes. Below a depth of about about 10 to 20 ft, the tuff moisture content typically is less than about 10% by volume and is hardly affected by precipitation at the surface.

In addition to logs from the deep holes mentioned above, soil and tuff characteristics were examined and mapped to a maximum depth of about 120 ft for many 6-ft-diameter holes drilled in MDA AB (Weir and Purtymun 1962, 0228). Numerous Laboratory photographs, fracture maps, and field notes are still available from the mapping of the experimental holes, as indicated in Table 4.4-2 and Appendix D.

In addition to the boreholes mentioned above, 2-ft-diameter observation holes were drilled at TA-49. Appendix D contains logs for these holes, which are referred to as "Alpha Hole" (189 ft deep, south of Area 12) and "Beta Hole" (180 ft deep, in Water Canyon directly north of Area 5). A third hole, referred to as "Gamma Hole," was drilled to a depth of 54 ft in Ancho Canyon southeast of Area 4. When they were drilled, none of these holes contained perched water. Alpha and Beta holes have been dry during numerous observations since 1961, but about 50 ft of water was found in Gamma Hole in the spring of 1960 shortly after installation. This water was attributed to infiltration of snowmelt through the canyon alluvial material through which the upper portion of the well was drilled (Purtymun and Ahlquist 1986, 03-0013).

7.3 Existing Information on Potential Contamination and Source Terms

7.3.1 General

Almost all the waste residues at MDA AB were dispersed by detonation and are believed to remain in the shaft bottoms in the immediate vicinities of the detonation points. It was reported in 1986 that ".... the material in the shafts represents 80% of the Laboratory's inventory of transuranic waste..." (Purtymun and Ahlquist 1986, 03-0013). This statement refers to radioactivity content (not waste volume) and still is qualitatively true. Unlike in Areas 1, 2, 2A, 2B, and 4, SNM never was used in Area 3, and only a few tens of grams of uranium were deposited (see Table 7.1-1). For this reason, Area 3 was not enclosed by the industrial fence that presently encompasses the rest of MDA AB.

Less than 10 mCi of fission products are believed to remain from the hydronuclear and related experiments and only a few curies (or less) of tritium (now decayed through almost three half-lives) were expended in the experimental shafts (Barr 1991, 03-0001). Explosives containing RDX, HMX, barium nitrate, and TNT were used in the downhole experiments and (excluding the barium component) are believed to have been consumed with high efficiency in the detonations. While HE residuals may be present in the shafts, they are believed to be negligible in quantity and hazard when compared to the substantial radionuclide and heavy metal contamination known to be present.

Individual downhole assemblies in the experimental shafts weighed as much as 8 tons and consisted of cable, steel, iron, aluminum, and other structural materials. Such large quantities of structural debris existing in the shafts could cause serious complications for any type of drilling, recovery, or stabilization remedial activities that might be contemplated for the deeply buried contaminants.

Before the underground experiments involving SNM were conducted, containment experiments involving "quarter-scale" quantities of HEs were carried out in Area 11, as described in Section 6.2 of this OU work plan. Subsequently, "full-scale" containment experiments, carried out in Areas 1, 2, 3, and 4, used much larger quantities of HE than were used in any ensuing experiment with SNM. The purpose of the containment experiments was to characterize tuff fracturing caused by the underground detonations, thus providing information that would be used for the following purposes:

- to ensure that experimental hole depth and shaft backfilling methods were sufficient to prevent venting of contaminants to the surface;
- to ensure that experimental holes were adequately spaced so that, during the excavation of new experimental holes, contaminated tuff would not be encountered from a previous experiment; and
- to develop sample recovery procedures.

The containment experiments were highly successful because venting of radioactively contaminated gases to the surface was not observed at any time during the experimental program and, with a single exception discussed below in Section 7.3.6, contaminants were never encountered during excavation of new experimental holes adjacent to previously contaminated holes.

Appendix B contains field sketches of the damage to the tuff caused by two HE containment experiments that used much larger amounts of HE than were present in any SNM experiments. Photographs of shaft walls after detonation also are available in the Laboratory archives. The containment experiments (in combination with subsequent hydronuclear experiments with SNM) serve to constrain the maximum radius of tuff fracturing and contaminant dispersal to about 10 to 15 ft from the points of detonation. In most cases, the radius is almost certainly much less than 10 to 15 ft because much smaller quantities of HE generally were used in experiments with SNM than in containment experiments. These conclusions are strongly supported by the fact that contamination was never encountered (with the exception noted above) during many drilling operations adjacent to previously contaminated holes. Detailed modeling of explosive-driven contaminant movement into Bandelier tuff has not been performed, but a rough calculation based on known or estimated engineering properties of Bandelier Tuff confirms the fracture zone radius deduced from the experimental program (Gardner 1992, 03-0007).

Experimental holes in Areas 1, 2, 3, and 4 were spaced at 25-ft intervals on 100-ft square grid patterns. Areas 2A and 2B have irregular shapes. Figure 7.2-1 (a-e) shows the hole layouts, depths, and designations by experimental area. Experimental holes were typically 6 ft in diameter (but there were exceptions) and ranged from 31 to 142 ft in depth. These holes are referred to as "experimental holes" to differentiate them from the many other types of holes (usually smaller) that were drilled in and around the experimental shaft areas and that did not involve the implacement of experimental configurations. The experimental holes were not all drilled at one time, and holes were not drilled at all grid locations. Although most holes were used for experiments, some holes were drilled and backfilled without further use and some were used to bury contaminated debris.

Auxiliary small-diameter holes were used for other purposes in all primary experimental areas within MDA AB. In particular, associated with many experimental holes in Areas 2 and 4 were small-diameter holes containing pipes that led from the main shaft base to sealed steel boxes placed near the surface to collect samples of radioactive particulates entrained in the explosive gases. These sampling boxes were connected by other pipes to large-diameter holes ("gas expansion holes") to reroute detonation gases back underground. The sampling boxes and piping must be assumed to be contaminated. In addition, a number of "pipe dump" holes were excavated, filled with debris (sometimes contaminated), and backfilled. It is believed that available information does not necessarily account for all of the auxiliary holes.

<u>IMPORTANT NOTE:</u> In general, it must be assumed that all holes in and around the experimental shaft areas of MDA AB contain contaminated material. Not all holes and contaminated equipment currently existing in MDA AB are necessarily accounted for in Appendix B, Figure 7.2-1 (a-e) and other existing information as summarized in the preceding discussion. In addition, the interior of all near-surface piping and associated equipment that presently remains at MDA AB (and, in particular, that associated with radiochemical sampling), must be assumed to be contaminated.

In typical hydronuclear-related experiments, an experimental configuration was placed in the bottom of a hole, instrument cables leading to the surface were installed, and the hole was backfilled with sand or crushed tuff. Usually, the downhole package was encased in a steel container with substantial amounts of metallic lead. After detonation and completion of measurements and radiochemical sample collection (if required), the cables were severed and hole

subsidence caused by the detonation was backfilled with sand or crushed tuff. Holes containing SNM routinely were capped with concrete. In most cases, the steel sampling boxes (when used) also were filled with concrete and left in place.
To minimize radiation exposure of personnel from pulsing of a portable neutron source used in some experiments, large, portable concrete radiation shields were used. Short-lived activation products, which by now have decayed to undetectable levels, would result from operation of the neutron source. Occasional monitoring with routine field instrumentation has confirmed that the concrete shields have no detectable surface contamination. Approximately ten of the concrete radiation shields still remain in the vicinity of Area 2 and elsewhere at TA-49.

According to Laboratory records and interviews of employees knowledgeable about this aspect of the TA-49 operations, the SNM expended at MDA AB agrees with the total amount listed as taken from the Laboratory's inventory. This agreement strongly suggests that all experiment holes and their contents have been properly recorded. In addition, the experimental shots reported in the Zia Diary covering TA-49 activities at this time agree with those listed as fired in Laboratory records (Zia Diary 1959-1962, 03-0016). However, as an additional precaution for future activities at TA-49, it should not be assumed that this information is complete and accurate in all detail. Therefore, **before intrusive activities are initiated in the future at MDA AB, field geophysical and other investigations should attempt to verify the archival information on past use of the area** being investigated. For example, it would be advisable to try to confirm that shafts for which there are work orders and/or engineering drawings but no inventory listing, indeed never were used.

7.3.2 Sediment Sampling from MDA AB Drainages

Sections 4.7 and 6.1 of this OU work plan discuss environmental monitoring for a network of 12 annually sampled sediment stations established in all the significant drainages leading from MDA AB. Surface soil and vegetation analyses from the A411 survey in 1987 for each experimental area within MDA AB are summarized in Table 7.3-1 and are discussed in greater detail later in Section 7.3. Several special studies of soil contamination near Area 2 also have been carried out in recent years.

Data collected from the sediment stations over a period of about 15 yr have shown that contaminant levels significantly above background are limited to a few stations near Area 2, adjacent to known surface contamination from an Area 2 drilling incident in 1960 (see Section 7.3.6). In particular, Station A3 near Area 2 (see Figure 4.3-3) generally has shown the highest radionuclide concentrations.

The highest radionuclide concentration measured in a surface soil sample at MDA AB is about 1660 pCi/g of plutonium-239/240 for an individual sample that was collected near the Area 2 asphalt pad during a recent special study (see Section 7.3.6). This individual value far exceeds TRU action levels discussed in Section 5.1 of this OU work plan.

Elevated radionuclide levels in soils and sediments collected near and

TABLE 7.3-1

SUMMARY OF 1987 A411 SOIL SURVEY RESULTS FOR MDA AB, AREA 11, AREA 12, AND THE OPEN BURNING/LANDFILL AREA

	Number of Soil Samples	(pCi/g) Am-241 Max/ Mean	(µg/g) Be Max/ Mean	(pCi/g) Cs-137 Max/ Mean	(pCi/g) Gross Gamma Max /Mean	(µg/g) Pb Max/ Mean	(pCi/g) Pu-238 Max/ Mean	(pCi/g) Pu239/240 Max/ Mean	(µg/g) Total Uranium Max /Mean	Uranium Isotope Ratio Max/ Mean
Area 1	34	1.4/0.09	4.8/2.4	0.90/0.52	42/23	75/24	0.003/0.001	0.024/0.014	5.6/3.1	0.0104/0.0073
Area 2	20	53.98/2.801	43.7/7.4	3.56/0.14	51/7.9	63/49	0.007/0.003	0.143/0.057	4.4/3.1	0.0079/0.0066
Area 2A	25	0.790/0143	4.8/3.2	1.25/0.58	10.0/54	35/23	0.097/0.011	4.590/0.362	5.0/3.1	0.0078/0.0067
Area 2B	22	0.151/0.041	6.0/3.5	1.66/0.54	8.0/3.5	108/36	0.013/0.005	24.0/1.48	3.2/2.8	0.0080/0.0070
Area 3	42	0.110/0.026	1.6/1.0	2.0/0.47	12/4.6	16/10	0.006/0.003	0.049/0.015	6.5/3.6	0.0087/0.0070
Area 4	71	1.50/0.41	3.2/1.8	24.2/0.79	20/7.8	119/41	0.041/0.004	2.090/0.081	14.2/2.7	0.0293/0.0073
Area 11	14	22.4/1.39	1.0/0.38	1.24/0.48	37/11	3.2/2.2	3.31/0.36	121/9.30	8.6/4.5	0.0137/0.0080
Area 12	12	0.446/0.072	----	0.841/0.430	67/15	----	0.014/.007	0.69/0.31	74/11	0.0080/0.0065
Landfill	65	3.22/0.33	3.5/2.4	3.5//0.73	17/9.3	55/36	0.031/0.003	0.81/0.08	27.3/6.4	0.0083/0.0067
Area Total	305									
Regional Background		----	1.9	0.88	10	24	0.003	0.019	2.4	0.0073

Data are adapted from the A411 Survey data (Soholt 1990, 0698). Arithmetic means are given. Data quality levels are approximately Level III (see Table 5.1-1 of this OU work plan). Detection limits are approximately the same as those given in Table 5.1-1. Radionuclide backgrounds are maximum values taken from Table G-32 of the 1989 ESG report (ESG 1990). Lead and beryllium backgrounds are from Ferenbaugh et al. (1990, 0099).

downgradient from the asphalt pad apparently are associated with excavation by pocket gophers of contaminated soil covered by the fill beneath the asphalt pad. This contamination is believed to have been caused by the aforementioned drilling incident. From this source, it is conceivable that very small amounts of radionuclides attached to sediments may have been transported into Water Canyon. If so, the contaminants are dispersed over such a large area that resulting concentrations are indistinguishable from background. This conclusion is substantiated by the fact that sediment samples from station A-9, located about 1500 ft downgradient from Station A-3, have shown only background levels of radionuclides. The precise downgradient limit of above-background radionuclides between A-3 and A-9, however, has not been defined.

7.3.3 Ground and Surface Water Monitoring

As already discussed in Section 4.7, groundwater samples have been collected from deep well DT-5A, located in the center of MDA AB, for over 30 yr. In addition, surface runoff samples have been collected from MDA AB drainages on occasion. Analysis of these samples has shown no evidence of water contamination from MDA AB or any other portions of TA-49, with the exception of Core Hole 2 (see Subsection 7.3.6).

7.3.4 Air Monitoring

Air Monitoring Station 32 is located about 100 ft northeast of Area 2. As discussed in Sections 4.7 and 6.6 of this OU work plan, on one occasion Station 32 recorded airborne levels of americium and plutonium that are above regional background but orders of magnitude below DOE Concentration Guides for onsite areas (Soholt 1990, 0698). It is highly probable that this airborne radioactivity is derived from the transport of known low level soil contamination in Area 2 during dry, windy periods.

In 1987, dose measurements from 10 thermoluminescent dosimeters (TLD) distributed around MDA AB showed exposures of 96 to 114 mrem (mean value 106, with an error of about 15%), which is statistically the same as the mean value of 103 mrem for 12 stations located at the perimeter of the Laboratory (Soholt 1990, 0698). These results are representative of TLD measurements obtained around MDA AB since 1987.

7.3.5 Area 1

Area 1 was developed initially for containment studies and was used later for downhole studies involving uranium-238 and plutonium. As Table 7.1-1 and Figure 7.2-1(a) show, these activities deposited significant quantities of uranium-238 and plutonium at the bottoms of several experimental holes in Area 1. Six of these holes were shot with small amounts of plutonium and four were shot with uranium-238 or radioactive tracers as the only radioactive material. (The plutonium holes also contain uranium-238.) Six holes were used for containment experiments and should be contaminated only by HE residuals and, in a few cases, small quantities of tracer [for example, Hole 1-Y as shown in Figure 7.2-1(a)]. Of the other Area 1 holes that were drilled, six were backfilled without further use and one was used as a gas expansion hole. Three grid locations were never used.

Other than the initial logging of Area 1 boreholes as they were drilled and checking of Core Hole-1 for water on an approximately annual basis, no subsurface sampling of Area 1 has been carried out.

Available information indicates that sample recovery and similar operations, which could have caused significant surface contamination were not conducted in Area 1. Site monitoring during and after the experimental program also suggests strongly that significant levels of surface contamination are unlikely to exist at Area 1. However, firm documentation of this point is essentially limited to the 1987 A411 surface soils survey discussed below. There is some indication that slight contamination of an Area 1 structure was found on at least one occasion (see Subsection 7.3.7).

As described in Section 5.3.2 of this OU work plan, a detailed soils survey (the A411 survey described in Section 5.3) was conducted at MDA AB in 1987 (ESG 1990, 0497). Results are summarized in Table 7.3-1 and described for each experimental area in Sections 7.3.5 through 7.3.8. Soil sampling and analysis methods for the A411 were essentially the same as those proposed for use by this OU work plan (that is, Level III data quality).

The A411 survey included the collection of 34 surface samples on a grid with 25-ft intervals centered on Area 1, as shown on Figure 7.3-1. Ten vegetation samples also were collected in and around Area 1. Analytical results and sampling locations are summarized in Table 7.3-2. Except those of americium, the mean levels of all soil analytes were near regional background levels. Twenty six of the soil samples showed americium below detection limits, and only one sample indicated a level above 0.7 pCi/g (1.4 pCi/g). The vegetation samples essentially showed background levels except for one anomalous sample that gave 24 pCi/g ash for cesium-137. The A411 results therefore strongly support the historical information, which indicates that surface contamination at Area 1 is negligible.

7.3.6 Areas 2, 2A, and 2B

7.3.6.1 General Description

Areas 2, 2A, and 2B were used for hydronuclear and related experiments, as described generally in Section 7.2. As Figures 7.2-1(b) and (c) and Table 7.1-1 indicate, significant quantities of plutonium, uranium, beryllium, and lead remain at the bottom of the shafts used in these experiments. (Only three shafts in Areas 2, 2A, and 2B are believed to contain beryllium). Twenty shafts were used for plutonium experiments. These shafts also contain uranium-238 and, in some cases, uranium-235. Three shafts were used with uranium-235 and uranium-238, and three shafts contain only uranium-238 (these six shafts contain no plutonium). Four shafts should contain only HE residuals and or tracer as contaminants. Seven experimental shafts were backfilled after drilling and not otherwise used, and seventeen grid locations were never used. (Hole 2-M is treated separately in Section 7.3.6.2.) Several gas expansion and

TABLE 7.3-2

SUMMARY OF 1987 A411 SURVEY RESULTS FOR AREA 1

	Units	Number of Samples	Maximum	Minimum	Arithmetic Mean	Background
Soils						
Am^{241}	pCi/g	34	1.4	BDL	0.09	-
Cs^{137}	pCi/g	34	0.90	0.19	0.52	0.88
Pu^{238}	pCi/g	19	0.003	BDL	0.001	0.003
$Pu^{239/240}$	pCi/g	18	0.024	0.005	0.014	0.019
total uranium	µg/g	34	5.6	1.7	3.1	3.8
$U^{235/238}$	ratio	34	0.0104	0.0042	0.0067	0.0073
gross gamma	pCi/g	34	42	4.9	23	10
Be	µg/g	34	4.8	0.6	2.4	1.9
Pb	µg/g	34	75	BDL	26	24
Vegetation (ashed sample)						
Am^{241}	pCi/g	10	0.004	0.007	0.002	-
Cs^{137}	pCi/g	10	24.2	BDL	3.2	-
Pu^{238}	pCi/g	10	0.007	BDL	0.002	-
$Pu^{239/240}$	pCi/g	10	0.004	0.002	0.002	-
Total U	µg/g	10	0.80	0.10	0.30	-

Data are adapted from the 1987 A411 Survey data (Soholt 1990, 0698). Data quality levels are approximately Level III and detection limits are approximately the same as those given in Table 5.1 -1. (See Subsection 5.3.2 of this OU work plan.) Radionuclide backgrounds are maximum values taken from Table G-32 of the 1989 ESG report (ESG 1990, 0497). Lead and beryllium backgrounds are from Ferenbaugh et al. (1990, 0099). BDL=below analytical detection limits.

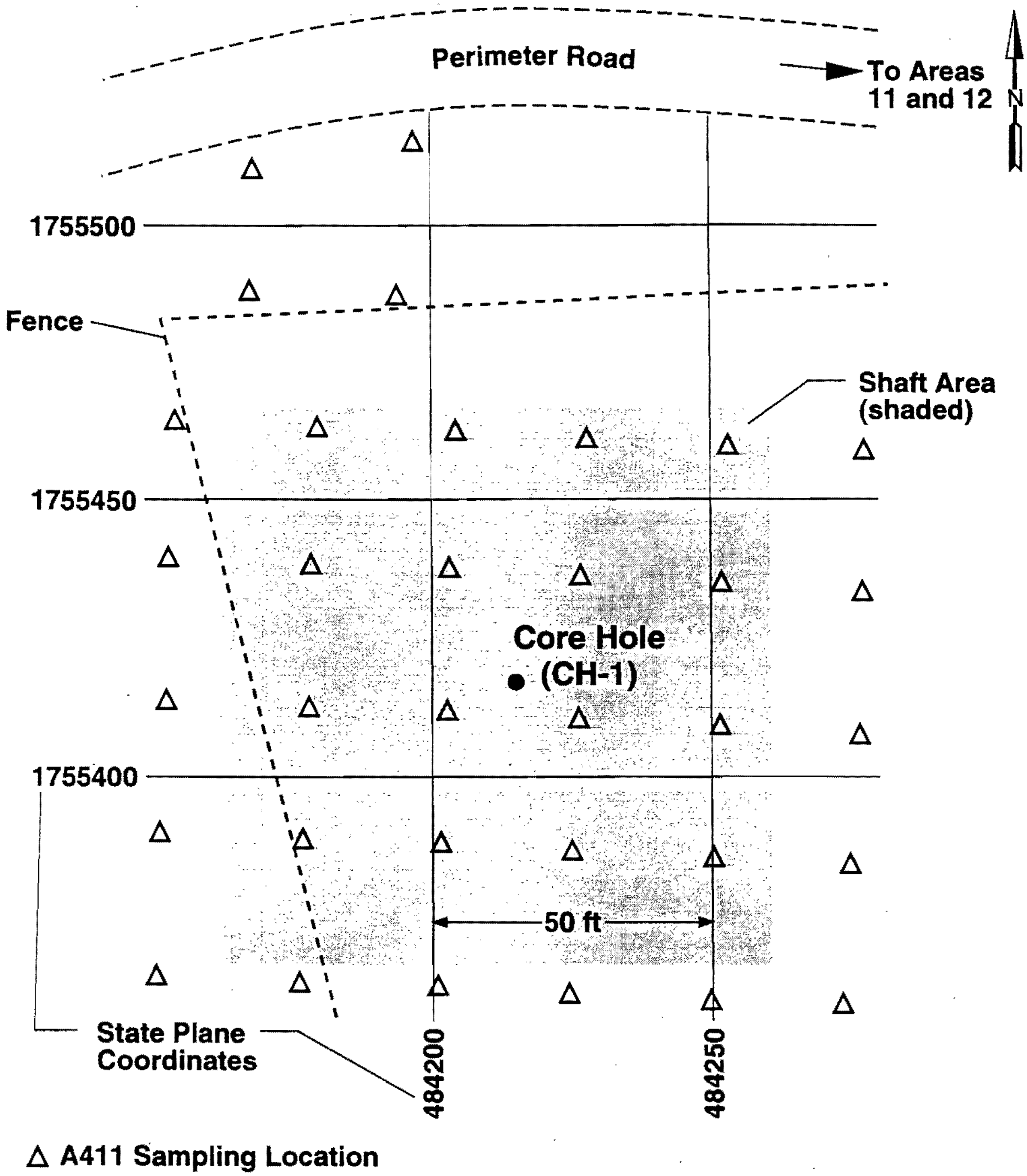


Figure 7.3-1. 1987 A411 Survey soil sampling locations for Area 1 (Soholt 1990, 0698).

pipe dump holes are documented in Areas 2, 2A, and 2B and others may be present as well.

Experiments in Areas 2, 2A, 2B, and 4 were distinguished from those in Areas 1 and 3 by the use of a pulse neutron source and radiochemical sample recovery techniques. Some Area 2 experiments also used a downhole neutron sources, that expended a total of a few curies of tritium, now decayed through almost three half-lives.

In Areas 2, 2A, 2B, and 4, short horizontal side-drifts off the bottoms of the main shafts were used to direct explosive gases through piping to sealed steel radiochemical sampling boxes at the surface. In some cases, sampling pipes in Area 2 directly intersected the main shaft. Contaminated residual gases were directed back underground through pipes into a gas expansion hole that served a number of experimental holes. Surface piping to a gas expansion hole is still visible in Area 4. These operations almost certainly have left sampling pipes and boxes with contaminated interiors near the surface of Areas 2, 2A, 2B, and 4.

To collect a sample for subsequent radiochemical analysis, researchers would detach the sampling box cover and remove the collection device. According to site personnel involved in these operations, despite the use of tarpaulins and tents over the sampling box, highly localized surface contamination occasionally resulted when the sampling boxes were opened. When this occurred, the resulting contamination was cleaned to field detection limits or covered with clean soil.

After completion of the experiments, the sampling pipes usually were disconnected from the sampling box and expansion hole and then either reused or buried in waste disposal holes (the aforementioned "pipe dumpholes," 3-ft diameter by 30-ft depth) around the experimental area. The engineering diary covering site operations during this period, as well as other engineering documents, indicate that at least four dump holes were drilled in Area 2B. These holes are presumed to be located as shown in engineering drawings [for example, see ENG-C28506 (1963, 03-0023)]. However, as noted above, other undocumented holes of this type may exist in Areas 2 and 4, and possibly in Area 1.

Minor contamination from oxidation of lead bricks stored around experimental holes also may have occurred.

7.3.6.2 Surface Contamination from Experimental Hole 2-M

The most significant unexpected contamination incident during the entire hydronuclear program at TA-49 occurred during the drilling of Hole 2-M after experiments were conducted with SNM in Hole 2-L in April 1960 (Purtymun and Stoker 1987, 0204). The succeeding experimental hole (2-M) was completed 25 ft to the east of Hole 2-L in October. In November, a drift toward the southwest was constructed in Hole 2-M. This drift was oriented (probably by mistake) toward the southeast-trending drift for Hole 2-L. If drift orientation is accurately indicated in the drift diagram shown in Appendix B, the ends of the drifts for Holes 2-L and 2-M are only about 6 to 7 ft apart. This separation apparently was small enough for the HE detonation to disperse contamination through fractures in the tuff from the Hole 2-L drift to the Hole 2-M drift.

In December 1960, alpha contamination in excess of 100,000 counts/min (cpm) was noted in the as-yet empty shaft 2-M. Monitoring indicated that surface contamination was as high as 800,000 cpm. Lower levels of contamination were found on clothing, tools, and vehicles. Contamination as high as 10,000 cpm and traceable to Area 2 was found in Area 6 and in the main engineering craft shops at TA-3. An investigation of the incident indicated that no personnel were contaminated.

Equipment from this incident that could not be decontaminated, or was of little value, was placed in Hole 2-M with contaminated surface soil (as determined using field survey instruments available at that time. (See Section 3.3 of this OU work plan for definitions of the terms "contaminated" and "uncontaminated" in this context.) Other contaminated items were sent to low-level radioactive waste disposal areas at other TAs.

Apparently, in this incident the detonation in Hole 2-L drove the contamination through joints or fractures (either naturally occurring or produced by the detonation) into the area subsequently excavated for the Hole 2-M drift. Because downhole cross contamination was never again encountered unintentionally in the TA-49 hydronuclear program (the minimum distance between holes or drifts was about 15 ft in most other cases), the maximum probable downhole radius of contaminated zones resulting from the detonations can be inferred to be less than about 10 to 15 ft. This conclusion is consistent with containment experiments described earlier in this chapter.

In January 1961, the surface of Area 2 was capped with compacted clay and gravel after all the open holes were filled with sand and crushed tuff. Historical estimates of the fill thickness range from 1 to 6 ft, and recent field inspection suggests a maximum fill thickness of about 6 ft. The cap was extended 12.5 ft beyond the outermost shafts and then paved with 4 to 6 in. of asphalt in September 1961 in an effort to retard infiltration of moisture. In April 1961 after snowmelt, a radiological survey was made of the surface from Area 2 to the wall of Water Canyon. In addition, the floor of Water Canyon and the canyon wall were checked for contamination. No detectable alpha activity was found.

The Hole 2-M contamination incident left near-surface radionuclide contamination beneath the Area 2 asphalt pad. It is almost certain that this is the source of most or all of the above-background levels of radionuclides now observed in surface soils around the Area 2 pad and at short distances down the natural drainage toward Water Canyon [SWMU 49-001(g)]. It is estimated that approximately 0.8 acres in this drainage downgradient from the TA-49 exclusionary fence is contaminated with very low levels of plutonium and americium from this source (Purtymun and Stoker 1987, 0204).

After the Area 2 contamination incident, newly drilled holes were carefully monitored as they were created and previously drilled holes were checked. In no other case was contamination found.

Area 2 was abandoned in the spring of 1961 and experiments were continued in adjacent experimental Areas 2A and 2B.

The only sampling of the intact fill under the asphalt covering Area 2 was conducted in September 1987 when a power pole was installed 2 ft northeast of Experimental Hole T (Romero 1987, 03-0040). Four samples were collected to a depth of 5 ft and were analyzed for gross alpha and gross beta radioactivity. A uniform distribution of 44 ± 18 pCi/g alpha was found. A second power pole hole 27 ft north of Hole B - Z in Area 2 B also was sampled. Results from this hole were below detection limits (25 pCi/g) for both alpha and beta constituents.

7.3.6.3 Water in Core Hole 2 (1975 to 1980)

Core Hole 2 originally was drilled to a depth of about 501 ft (see Table 4.4-2). After the asphalt pad was raised to cover the surface contamination from Hole 2-M, the casing was extended through the fill to the top of the pad. After it was partly filled with fluids to facilitate logging, the hole was cased with 2-in. galvanized pipe, of which the bottom 20 ft was slotted. Currently, only about 10 ft of slotted section is available as a result of backfilling with sediment. As mentioned earlier in this chapter, a large but unquantifiable amount of fluid was lost to Core Hole 2 during these operations. No attempt was made to clear the fluid and lost circulation material from the hole before setting the pipe. As reported in USGS geophysical logs, fluid levels in Core Hole 2 gradually declined from 146 ft below land surface during logging in December 1959 to no standing fluid in June 1960.

In March 1975, it was found that the asphalt pad over the backfilled Hole 2-M had collapsed, leaving an opening about 6 ft long by 3 ft wide and 3 to 4 ft deep in the asphalt and underlying fill (Purtymun and Ahlquist 1986, 03-0013; Purtymun and Stoker 1987, 0204). Figure 7.3-2 shows the appearance of this hole. Inspection of Core Hole 2 indicated that the fluid level had risen since the previous inspection to give about 50 ft of standing water (about 10 gal of water; water surface about 450 ft below land surface). The hole in the asphalt probably formed in the fall of 1974 and apparently collected snowmelt throughout the winter. A check of Core Hole 2 in December 1975 again indicated about 50 ft of standing water. In September 1976, the opening over Hole 2-M was filled with crushed rock and clay and the entire pad covering Area 2 was repaved with another 4 to 6 in. of asphalt (Purtymun and Ahlquist 1986, 03-0013).

Unfiltered samples of the water bailed from Core Hole 2 in October 1977 and August 1978 contained 1.7 to 3.1 pCi/g of plutonium-239, which is above background but far below the DOE guideline of 100 000 pCi/l for controlled areas (Purtymun and Stoker 1987, 0204). It was evident that water in Core Hole 2 had come into contact with contamination beneath Area 2. It was concluded that the opening in the asphalt pad had allowed water to collect, penetrate the pad, and contact subsurface contamination (possibly contaminated backfill in Hole 2-M). The contaminated water presumably moved through fractures to the Core Hole 2 borehole and sank down the annular spacing between the casing and the borehole. (Note that Core Hole 2 is located only about 10 ft from Experimental Hole 2-M.)

Figure 7.3-2
Appearance of the collapsed section of asphalt over Area 2 in 1975, viewed to the west. Hole area was about 3 ft by 6 ft and the depth was about 3 to 4 ft.

At several times in April and May of 1979 and from April to June of 1980, about 150 ft of standing water was measured in the bore hole. During this period, water from several levels was bailed from Core Hole 2 and the filtered water and suspended sediments were checked for plutonium content, with the results shown below.

Depth Below Land Surface to Water (ft)	Plutonium Content of Bailed Sample	
	Solution pCi/l	Suspended Sediment (0.45 μ filter) pCi/g
350	2.5	0.54
420	0.1	0.72
495	5.5	0.55

Core Hole 2 was bailed dry in June 1980 and the bailed water was discarded at a radioactive waste disposal facility elsewhere at the Laboratory. From 1980 through 1987, Core Holes 1 through 4 were checked for standing water on an approximately annual basis. No standing water was detected during this period in any TA-49 borehole, including Core Hole 2.

It seemed conceivable that the water in Core Hole 2 originated from local recharge other than from infiltration through the hole in the asphalt pad. In particular, some experimental holes in Areas 2, 2A, and 2B, which had been backfilled with sand and crushed tuff, were considered to be possible recharge conduits. Accordingly, in the spring of 1980, access tubes for moisture measurements were installed to a depth of 68 to 80 ft in Holes 2A-0, 2A-Y, and 2B-Y, as shown in Figure 7.3-3 (these holes were not used for experiments and therefore should contain no contaminants). In addition, five similar monitoring holes were drilled immediately adjacent to Areas 2, 2A, and 2B, as indicated in Figure 7.3-3. These five holes penetrated the upper ashflow unit (designated as Unit 6 by Weir and Purtymun) and the surge deposit at about 60 to 80 ft below the surface (Unit 5) and were completed in the lower ashflow unit at a depth of about 120 ft (Unit 4). Neutron moisture logging of the eight access holes showed that at depths greater than about 10 ft, moisture levels were about 5% by volume or less (see Figure 7.3-4). The moisture measurements gave no indication of any recharge or movement of water through the backfilled shafts or through the adjacent tuff.

In 1981, the upper 2 ft of sand in the sand-filled holes in Areas 2A and 2B was replaced with concrete.

7.3.6.4 Standing Water in Core Hole 2 (1991 and 1992)

In May 1991, cracks were noted in the Area 2 asphalt pad, and vegetation several feet tall was observed to be growing through the cracks see [Figure 3.1-2(a)]. Inspection of Core Hole 2 indicated the presence of about 100 ft of standing water. The previous check of the hole (on October 28, 1987) showed no standing water but did find condensation in the shaft. Through the summer and fall of 1991 and spring of 1992, the depth to the water level was measured approximately once a month, with results shown below.

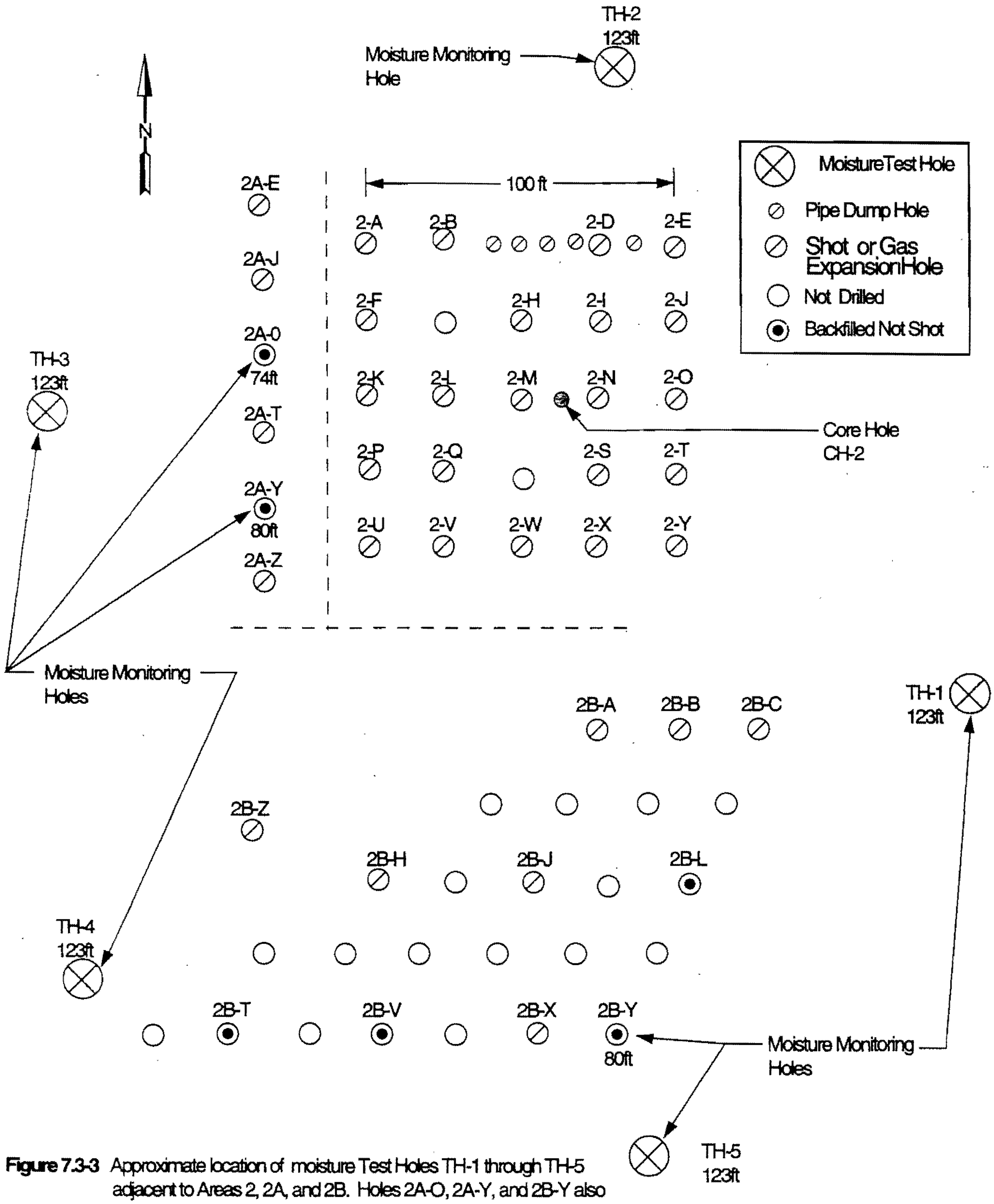
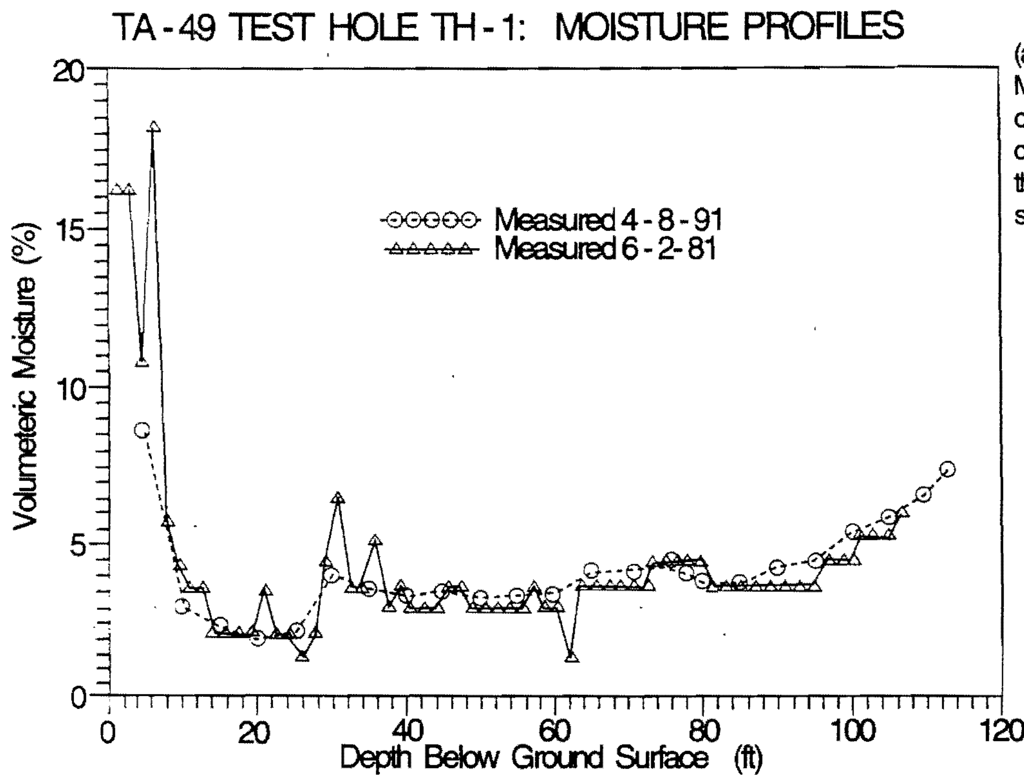
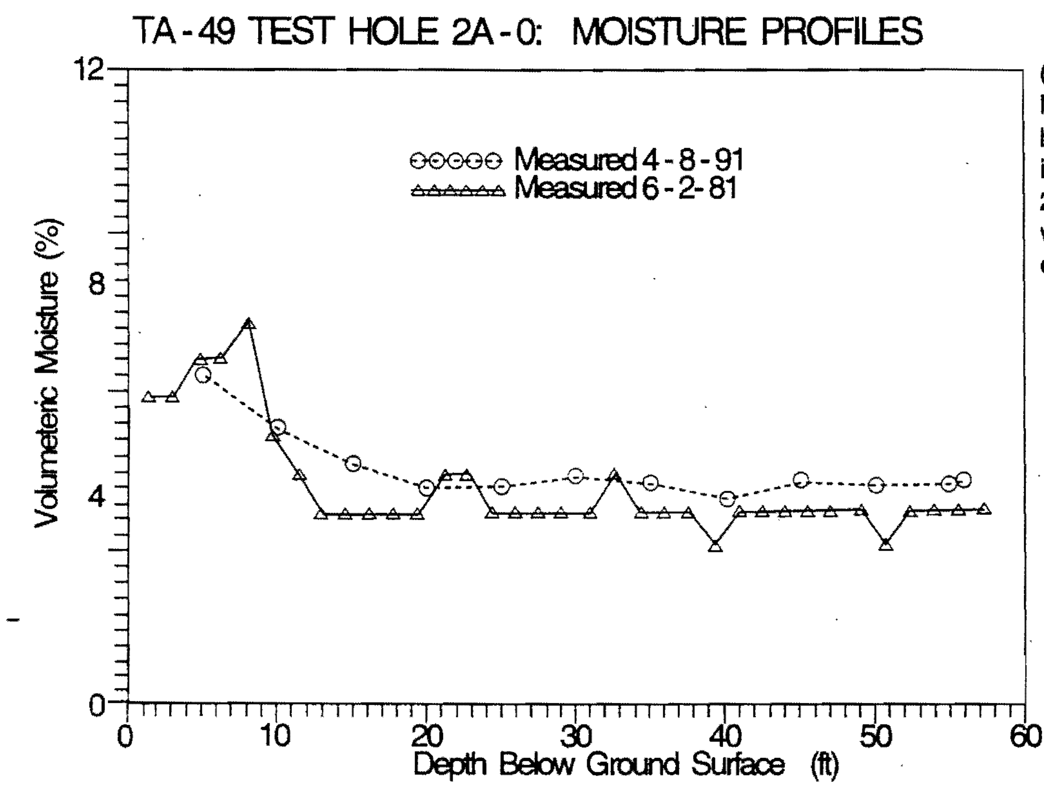


Figure 7.3-3 Approximate location of moisture Test Holes TH-1 through TH-5 adjacent to Areas 2, 2A, and 2B. Holes 2A-O, 2A-Y, and 2B-Y also were used for subsurface moisture measurments. Test hole depths are indicated.



(a)
Moisture access hole outside Area 2, completed through the upper 120-ft section of tuff.



(b)
Moisture access hole completed in backfill of shaft 2A-O. The hole was not used for experimental tests.

Figure 7.3-4 Moisture profiles measured in Area 2 Test Holes TH-1 and 2A-O in 1981 and 1991.

Date	Depth from land surface to water level (ft)	Depth of standing water (ft) by sounding
4/3/91	398.6	97
5/31/91	423.8 (depth to water level is cleared to 432.2 ft by sample collection)	72 64
7/2/91	431.6	64
8/22/91	430.8	65
12/17/91	434.7	61

In December 1991, a transducer was inserted in Core Hole 2 for continuous monitoring of the water level. The transducer was placed about 14 ft from the bottom of the hole. As shown below, the transducer readings indicate that the water level remained remarkably stable during this four month period. Additional water level data for Core Hole 2 is included in Appendix D of this OU work plan.

Date	Depth from land surface to water level (ft)	Depth of standing water (ft) from transducer reading
1/17/92	434.7	61.0
2/17/92	435.2	60.5
3/17/92	435.6	60.1
4/08/92	435.8	59.9

The current stability of the water level in Core Hole 2 is very significant because it indicates that the response (if any) is very sluggish to both the intense rainfall that occurred throughout the summer of 1991 and the snowmelt in the spring of 1992. In addition, if the water is derived from a perched zone, then the source is either very small or the level is well defined by the observed level of the water. Further, if the source of water is intermittent, the stability of the water level shows that the borehole is well sealed from the surrounding tuff. The available data thus suggests that infiltration at the present time may not be significant.

Water quality analyses for a sample bailed from Core Hole 2 in May 1991 are summarized in Table 7.3-3. All analytes except plutonium were found to be at or

TABLE 7.3-3

ANALYSIS OF STANDING WATER COLLECTED FROM CORE HOLE 2 IN MAY 1991[a]

Analysis		Result	Uncertainty	Units
Ba		28	3	µg/l
Ca		8.2	0.8	mg/l
Cl		1.1	0.1	mg/l
CN		0.01	0.01	mg/l
K		7.2	0.7	mg/l
Mg		1.0	0.1	mg/l
Na		33	3	mg/l
Nitrate		0.37	0.04	mg/l
Phosphate		0.26	0.05	mg/l
Sulfate		17	2	mg/l
Conductivity		147	7	µmhos/cm
Dissolved solids		22	2	g/l
pH		9.5	0.1	

RCRA-regulated metals were not detected above action levels (TCLP procedure). VOCs, SVOCs, and PCBs were not detected.

Radionuclides

uranium		21	2	µg/l
plutonium-239/240	(unfiltered)	0.19	0.12	pCi/l
plutonium-239/240	(filtered)	1.1	0.2	pCi/g
gross beta		6.2	0.7	pCi/l
tritium	(below 300 pCi/l LSC detection limit)			

[a]Data are from Stoker (1991, 03-0049). Detection limits are approximately those given in Table 5.1-1.

below background levels or detection limits. Plutonium concentrations were above background, but well below the levels found in standing water in Core Hole 2 in 1975.

The most unusual aspects of the Core Hole 2 water chemistry are the high pH of 9.5 (vs about 7.6 for regional surface- and groundwaters) and the elevated levels of sodium and sulfate. Based on comparison with analyses of a variety of drilling fluids recovered during a recent regional study, these data are consistent with Core Hole 2 fluid containing a minor component (probably less than 5%) of drilling fluid (Gardner 1991b, 03-0052; Meeker et al. 1990, 0147).

The tritium content of the Core Hole 2 water in the 1991 sampling was found to be near the detection limit (about 300 pCi) of the tritium analysis method used. The analytical method, therefore, was not precise enough to allow inference of the age of the water.

In the spring of 1991, subsurface moisture was measured again in the existing access holes around Area 2 by using a neutron moisture probe (Ferenbaugh 1991, 03-0005). As Figure 7.3-4 shows, these measurements indicated no significant change in general subsurface conditions when compared to similar measurements in 1981. In particular, below a depth of 10 ft, moisture levels are about 5% or less by volume and show no evidence for saturated zones. Measurements in both 1981 and 1991 indicated a possible slight increase in moisture content below a depth of 100 ft in Hole TH-1, but the significance of this observation is unclear. Similar observations have been made near transitions between tuff units, but measurements at greater depth are necessary to clarify this point for Area 2.

In November 1991, cracks in the asphalt pad were resealed with asphalt.

7.3.6.5 Origin of Water in Core Hole 2

In considering the appearance of water in Core Hole 2, it is important to note that Area 2 is unique among the MDA experimental shaft areas in several respects.

- Area 2 is the only experimental shaft area in which a significant near-surface release of contamination occurred (drilling of Hole 2-M in 1960).
- Core Hole 2 is one of few boreholes in MDA AB in which significant amounts of fluids were expended during drilling and characterization.
- Area 2 is the only area (except for the tops of some shafts) that has been capped with material other than native soil and vegetation, specifically, the asphalt pad and underlying fill. The impervious nature of this cap will significantly retard the transpiration of subsurface water to the atmosphere.

- Areas 2, 2A, and 2B are the only MDA AB experimental areas that are located in a drainage system of any appreciable size (see Appendix A).

The stability of the water level and small volumes of standing water suggest that the occasional appearance of water in Core Hole 2 is the result of minor episodic events, but this point has not been proven beyond reasonable doubt.

Various hypotheses have been considered to explain the appearance of water in Core Hole 2.

(1) An obvious explanation is that collapse of the asphalt in 1975 and asphalt cracking before May 1991 have provided pathways for infiltration of meteoric water. However, it is not intuitively apparent that the openings were large enough to capture sufficient water to cause saturation in the borehole. The apparent insensitivity of the Core Hole 2 water level to intense rainfall in the summer of 1991, when the cracks were still open, also shows that recharge from the surface by this (or any other mechanism) must be slow or insignificant.

(2) Fluids expended in Core Hole 2 could have created an artificial perched water zone, which now is recharging the borehole. However, the observed water chemistry indicates this cannot be the only source of water. The observation of several different stable water levels during the 1975 to 1980 and the 1991 to 1992 time frames also is not intuitively consistent with this idea. It is also unclear why the postulated water source should become available after long periods of unavailability, although it could be conjectured that the clay seal (formed by the use of drilling mud to isolate the borehole from the permeable zone) may have deteriorated at various times, thus allowing fluid to reenter the borehole.

(3) The surface drainage system upgradient from Area 2 could have created a recent recharge pathway that has not been detected by the network of moisture measurement holes. Because the monitoring-hole network has reasonably good lateral and vertical coverage, such a recharge pathway would have to be of a very unusual nature. Although this possibility cannot be excluded completely, it seems unlikely, given tuff's capacity for storing (and thus immobilizing) large quantities of injected water (see Chapter 2 of the IWP). The chemistry observed recently for Core Hole 2 water also is inconsistent with the hypothesis that this is the only source of water in Core Hole 2.

(4) A natural perched zone that either was not detected during the initial site characterization or is episodic in nature, could exist under Area 2. This hypothesis also seems unlikely, given the relatively extensive site characterization performed in the past and the fact that this recharge pathway must have developed recently.

(5) Fluids expended in the logging of well DT-5A could have created an artificial perched zone, which subsequently has migrated down the stratigraphic gradient to Core Hole 2. Because these fluids were lost at a depth greater than 285 ft, they would not have been detected by the moisture monitoring holes around Area 2. However, because the fluids were lost at a depth less than the top of the water observed in Core Hole 2, they are a conceivable source for Core Hole 2 water.

In conclusion, the existing data are insufficient to allow a convincing determination of the source of water in Core Hole 2. This is an important conclusion for the TA-49 RFI because confident understanding of the behavior of water under MDA AB is vital in assessing the potential migration of the large buried source term, and thus to the ultimate selection of remedial measures. Therefore, this issue is addressed early and aggressively in the RFI.

7.3.6.6 Special Studies of Soil and Vegetation

During a special study in September 1987, about 20 soil samples and 20 vegetation samples were collected around Area 2, as shown in Figure 7.3-5 (Fresquez 1991, 03-0006). Of the soil samples analyzed, one sample from the northeast corner of Area 2 showed elevated levels of gross alpha activity (80 pCi/g) and a nearby sample showed elevated plutonium-239 activity (1660 pCi/g). Replicate analyses for the first sample gave values of 41 and 1.7 pCi/g of gross alpha activity, indicating a highly discontinuous surface-contaminant distribution. A PHOSWICH survey over the same area showed readings about twice the background level. Positive readings also were measured along the drainage channel leading to the culvert under the road on the north side of Area 2. One sample collected about 50 ft from the site of the most radioactively contaminated sample indicated 44 ppm Be, well above the regional background level of about 1.7 ppm. A vegetation sample from the same location exhibited 24 pCi/g of plutonium-239/240. Elevated levels of other potential contaminants from Area 2 were not detected in the soil and vegetation samples.

During another special study in March 1991, 10 samples of pocket gopher soil diggings along the perimeter of the Area 2 pad were collected and analyzed (Ferenbaugh 1991, 03-0005; Fresquez 1991, 03-0006). Again, there was some indication that the exposed radioactive contamination had washed a short distance along the Area 2 drainage toward Water Canyon. As observed in 1987, elevated radioactivity was detected in a sample from the northeast corner of the asphalt pad: gross alpha (135 pCi/g), americium-241 (38 pCi/g), plutonium-238 (24 pCi/g), and plutonium-239/240 (43 pCi/g). Gopher diggings at the same location were resampled in April 1991. Elevated gross alpha activity (about 1200 pCi/g) was found again, but additional analysis indicated no VOC, SVOC, PCB, or TCLP metal levels above EPA guidelines.

During the A411 survey in 1987, about 40 soil and 45 vegetation samples were collected around Areas 2, 2A, and 2B. Analytical results are summarized in Table 7.3-4 and sampling locations are shown in Figure 7.3-5. The study indicated that levels of contaminants in Area 2B and in the portion of Area 2A away from the asphalt pad were at (or only slightly above) regional background levels. However, at several sampling locations immediately adjacent to the

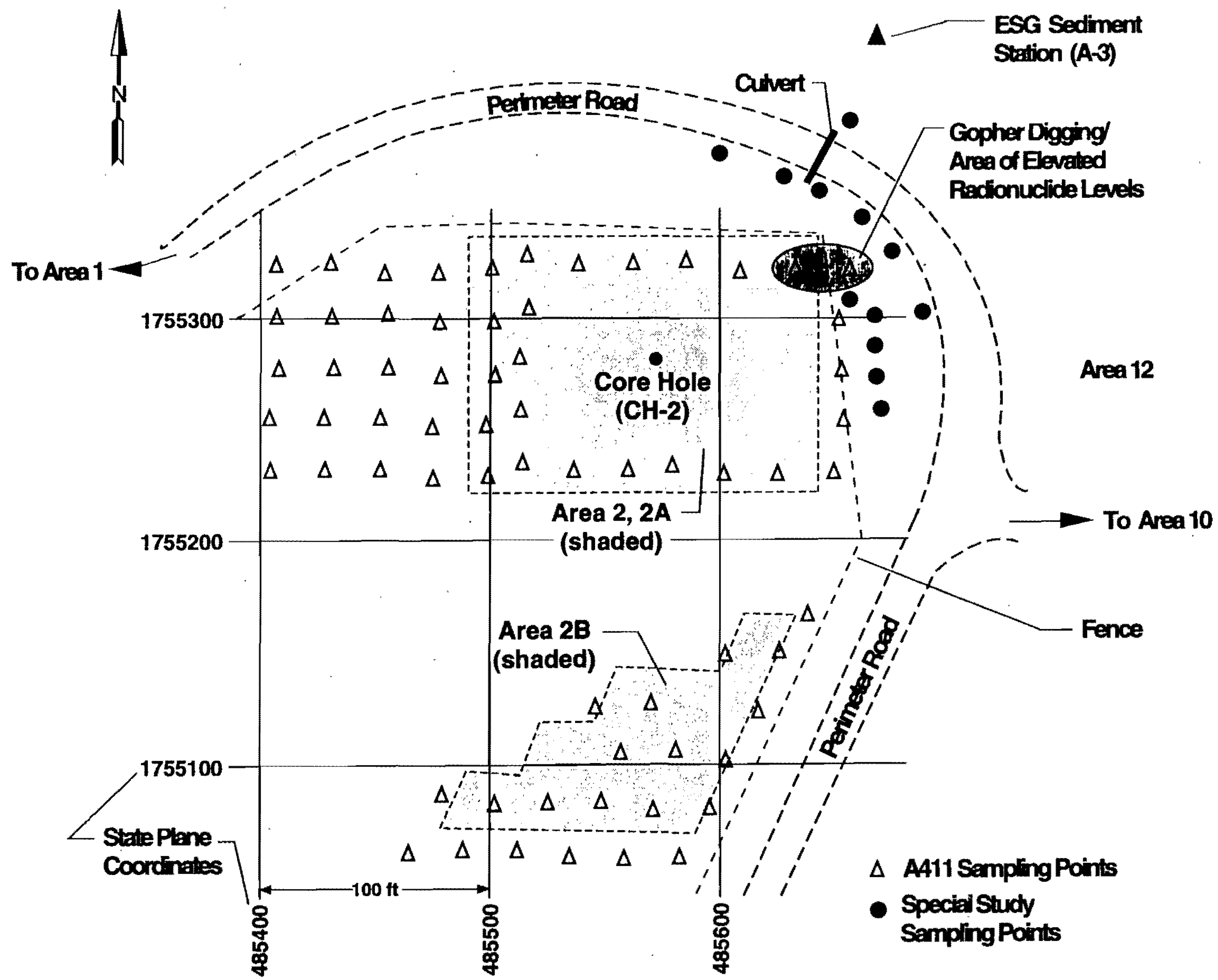


Figure 7.3-5. 1987 A411 and special study sampling locations for Areas 2, 2A, and 2B (Soholt 1990, 0698). Note how sample locations at Area 2 outline the asphalt pad.

TABLE 7.3-4

SUMMARY OF 1987 A411 SURVEY RESULTS FOR AREAS 2, 2A, AND 2B[a]

Am—241 etc.	Units	Number of samples	Maximum	Minimum	Arithmetic Mean	Background
Soils						
Am^{241}	pCi/g	65	53.98	0.002	0.931	-
Cs^{137}	pCi/g	70	3.56	0.06	0.70	0.88
Pu^{238}	pCi/g	25	0.0970	0.001	0.007	0.004
$Pu^{239/240}$	pCi/g	39	24.000	0.001	0.566	0.019
Total uranium	µg/g	65	5.0	3.1	3.1	3.8
$U^{235/238}$	Ratio	18	0.0080	0.0041	0.0068	0.0073
Gross gamma	pCi/g	67	51	0.6	5.5	10
Be	µg/g	44	43.7	1.2	4.8	1.9
Pb	µg/g	55	108	17	35	24
Vegetation (ashed sample)						
Am^{241}	pCi/g	25	1.989	0.001	0.233	-
Cs^{137}	pCi/g	45	3.48	BDL	0.62	-
Pu^{238}	pCi/g	49	0.460	BDL	0.010	-
$Pu^{239/240}$	pCi/g	48	24.000	0.001	0.504	-
Total uranium	pCi/g	45	20.0	0.1	3.9	-
Gross gamma	pCi/g	44	49.	1.0	16	-
Pb	µg/g	20	12.2	2.9	6.6	-
Be	µg/g	20	0.4	BDL	0.2	-

[a]Data are adapted from the 1987 A411 Survey data (Soholt 1990, 0698). Data quality levels are approximately Level III and detection limits are approximately the same as those given in Table 5.1-1. (See Subsection 5.3.2 of this OU work plan.) Radionuclide backgrounds are maximum values taken from Table G-32 of the 1989 ESG report (ESG 1990, 0497). Lead and beryllium backgrounds are from Ferenbaugh et al. (1990, 0099). BDL=below analytical detection limits.

asphalt pad, plutonium and americium levels well above background were observed. As was found in the later Area 2 special studies (described above), this trend was particularly notable at the extreme northeast corner of the pad, where the level of americium-241 in one sample was 53 pCi/g.

In summary, the most elevated radionuclide levels in surface soils at Areas 2, 2A, and 2B are concentrated in the northeast corner of Area 2 and appear to be associated with the exhumation of contaminated soil from beneath the asphalt pad by gophers. Based on past sampling, the highest contaminant levels in TA-49 surface soils are found in this portion of Area 2 and in a highly localized section of Area 11.

7.3.7 Area 3

Area 3 was used exclusively for development of confinement and sample recovery techniques that were subsequently used in Areas 1, 2, and 4. Figure 7.2-1(d) indicates that 7 shafts were used for experiments with radioactive tracers (usually irradiated uranium). Two other shafts were excavated but backfilled without further use, and twelve grid locations were never used. According to Laboratory records, the activated uranium tracer used in Area 3 shafts contained only about 5 g of uranium-235 and about 30 g of uranium-238. A maximum of several microcuries of neptunium-239 tracer was used in Area 3 shafts and has decayed completely to insignificant levels of plutonium-239 (Minor 1991, 03-0034). No other plutonium is believed to be present in Area 3. As at other experimental areas of MDA AB, downhole materials at Area 3 were left in place at the conclusion of experiments.

Other than the initial logging of Area 3 holes as they were drilled and the checking of Core Hole 3 for water on an approximately annual basis (none was ever detected), subsurface sampling has not been carried out at Area 3. However, the detailed historical information that is available and past surface soil sampling (discussed below) strongly indicate that significant contamination is highly unlikely in the surface or subsurface of Area 3.

In 1969, low levels of alpha contamination were found in an Area 3 structure that subsequently was burned in place (Eller 1991, 03-0002). The source of this contamination is unknown but probably derived from elsewhere at MDA AB. Area 3 also was used for burning slightly contaminated structures that were removed from other areas of TA-49 (Eller 1991, 03-0002). Slight soil contamination at Area 3 could have occurred from this activity, but the levels are unlikely to be detectable. Anecdotal information suggests the burning area may have been near the curve in the road at the southwest corner of Area 3.

Well-documented surface-soil sampling at Area 3 is essentially restricted to the 1987 A411 survey. Results of this survey are summarized in Table 7.3-5 and sampling locations are shown in Figure 7.3-6. In this study, about 40 soil samples were collected on a grid with a 25 ft spacing, approximately centered on the Area 3 shafts. Samples also were collected from the leveled area (possibly used for burning structures) to the west of the Area 3 shafts and in a short extension to the southeast of the shafts. About 45 vegetation samples also were collected for analysis. The analyte levels were found to be essentially at background or analytical detection levels. The A411 results therefore support

TABLE 7.3-5

SUMMARY OF 1987 A411 SURVEY RESULTS FOR AREA 3[a]

	Units	Number of samples	Maximum	Minimum	Arithmetic Mean	Background
Soils						
Am^{241}	pCi/g	25	0.110	0.0020	0.026	-
Cs^{137}	pCi/g	41	1.96	0.13	0.47	0.88
Pu^{238}	pCi/g	42	0.006	BDL	0.003	0.003
$Pu^{239/240}$	pCi/g	24	0.049	0.004	0.015	0.019
Total uranium	µg/g	42	6.5	2.0	3.6	3.8
$U^{235/238}$	ratio	18	0.0087	0.0048	0.0070	0.0073
Gross gamma	pCi/g	43	12	0.3	4.6	10
Be	µg/g	24	1.55	0.55	0.96	1.9
Pb	µg/g	24	16.2	6.9	9.6	24
Vegetation (ashed sample)						
Am^{241}	pCi/g	22	0.424	0.004	0.088	-
Cs^{137}	pCi/g	20	5.17	0.08	1.59	-
Pu^{238}	pCi/g	22	0.003	BDL	0.001	-
$Pu^{239/240}$	pCi/g	21	0.014	BDL	0.005	-
Total uranium	µg/g	20	2.5	0.5	1.3	-
$U^{235/238}$	ratio	19	0.0077	0.0044	0.0060	-
Be	µg/g	20	2.3	0.1	1.5	-
Pb	µg/g	11	19.0	BDL	8.6	-

[a]Data are adapted from the 1987 A411 Survey report (Soholt 1990, 0698). Data quality levels are approximately Level III and detection limits are approximately the same as those given in Table 5.4.1. (See Subsection 5.3.2 of this OU work plan.) Radionuclide backgrounds are maximum values taken from Table G-32 of the 1989 ESG report (ESG 1990, 0497). Lead and beryllium backgrounds are from Ferenbaugh et al. (1990, 0099). BDL=below analytical detection limits.

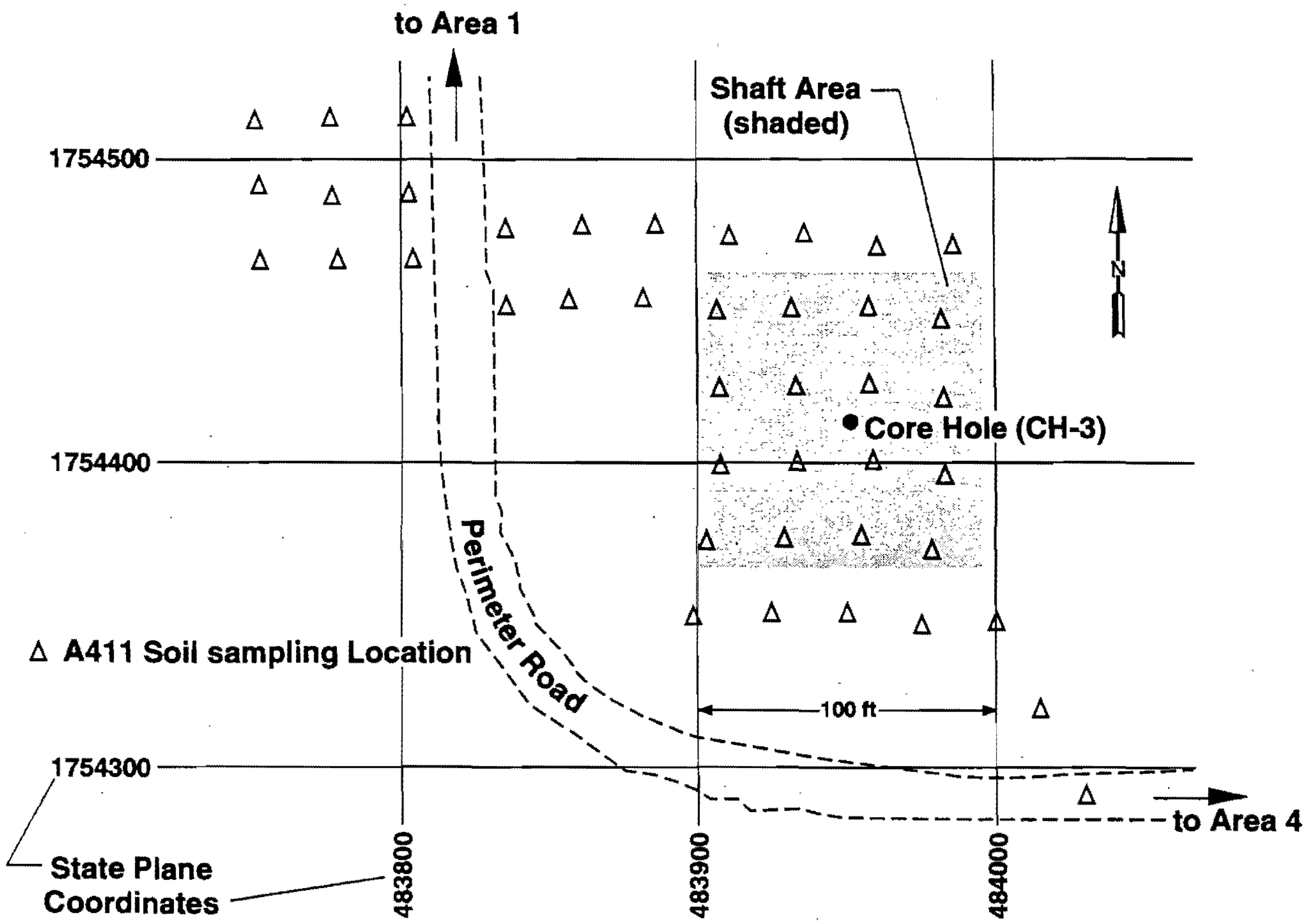


Figure 7.3-6. 1987 A411 soil sampling locations for Area 3 (Soholt 1990, 0698).

historical information, which suggests that significant surface contamination does not exist at Area 3.

7.3.8 Area 4

Area 4 was used for containment experiments and hydronuclear experiments involving radiochemical sample recovery, much as described for Area 2. As Table 7.1-1 indicates, these experiments dispersed significant amounts of uranium, plutonium, beryllium, and lead at the bottoms of the experimental shafts. Figure 7.2-1(e) indicates that eleven shafts contain plutonium, one contains uranium-238 as the only radioactive contaminant, and one contains uranium-235 and uranium-238 as the only radionuclides. The plutonium-containing shafts also contain uranium-235 and -238. One hole was used for a containment experiment and probably contains lead as the only significant contaminant. Three shafts were backfilled without use after being drilled and should contain no contaminants. Eight grid locations were never used. One gas expansion hole is evident in Area 4, and "pipe dump" holes containing contaminated debris (exact locations unknown) almost certainly are present.

In many experiments in Areas 2, 2A, 2B, and 4, liquid scintillation detectors were used downhole. These detectors used p-terphenylene fluor dissolved in about 2 gal. of toluene as phosphors. Some experiments also used detectors with a fluor consisting of polystyrene, and small amounts of p-terphenyl and zinc stearate may have been used. The organics are believed to have been consumed largely or completely in the HE detonations.

Some Area 4 experiments involved the use of a few curies of tritium, which by now have decayed through almost three half-lives.

In July 1969, a skid-mounted structure in Area 4 was found to be slightly alpha contaminated from an unknown source (Eller 1991, 03-0002). The structure was moved to Area 3 and burned.

Other than the initial logging of holes of Area 4 as they were drilled and inspections of Core Hole 4 for water on an approximately annual basis (no water was ever detected), subsurface sampling has not been carried out at Area 4.

Results of the 1987 A411 survey of Area 4 surface soils and vegetation are summarized in Table 7.3-6. A411 sampling locations are shown in Figure 7.3-7. About 36 soil samples were collected on a grid pattern with a 25-ft interval, approximately centered on the Area 4 shafts. An additional 25 soil samples were collected from the leveled area immediately southeast of Area 4. About 10 vegetation samples also were collected around the area.

The average soil levels for americium-241 and plutonium-239/240 (and most other analytes) are slightly above regional background but far below TRU action levels discussed in Section 5.1 of this OU work plan. The average values are strongly skewed because only a few points have contaminant levels significantly above background (but below action levels). At most sampling locations, the

TABLE 7.3-6

SUMMARY OF 1987 A411 SURVEY RESULTS FOR AREA 4[a]

	Units	Number of Samples	Maximum	Minimum	Arithmetic Mean	Background
Soils						
Am^{241}	pCi/g	55	1.50	BDL[a]	0.41	-
Cs^{137}	pCi/g	51	24.2	0.05	0.79	0.88
Pu^{238}	pCi/g	59	0.041	BDL	0.004	0.003
$Pu^{239/240}$	pCi/g	71	2.090	0.001	0.081	0.019
Total uranium	µg/g	56	14.2	1.40	2.7	3.8
$U^{235/238}$	ratio	56	0.0293	0.0045	0.0073	0.0073
Gross gamma	pCi/g	56	20.0	3.4	7.5	10
Be	µg/g	68	3.2	BDL	18	1.9
Pb	µg/g	62	119.0	4.0	41.1	24
Vegetation (ashed sample)						
Am^{41}	pCi/g	10	0.37	0.002	0.043	-
Cs^{137}	pCi/g	10	3.55	BDL	1.77	-
Pu^{238}	pCi/g	10	0.043	BDL	0.006	-
$Pu^{239/240}$	pCi/g	10	2.15	0.001	0.035	-

[a]Data are adapted from the 1987 A411 Survey report (Soholt 1990, 0698). Data quality levels are approximately Level III and detection limits are approximately the same as those given in Table 5.4.1. (See Subsection 5.3.2 of this OU work plan.) Radionuclide backgrounds are maximum values taken from Table G-32 of the 1989 ESG report (ESG 1990, 0497). Lead and beryllium backgrounds are from Ferenbaugh et al. (1990, 0099). BDL=below analytical detection limits.

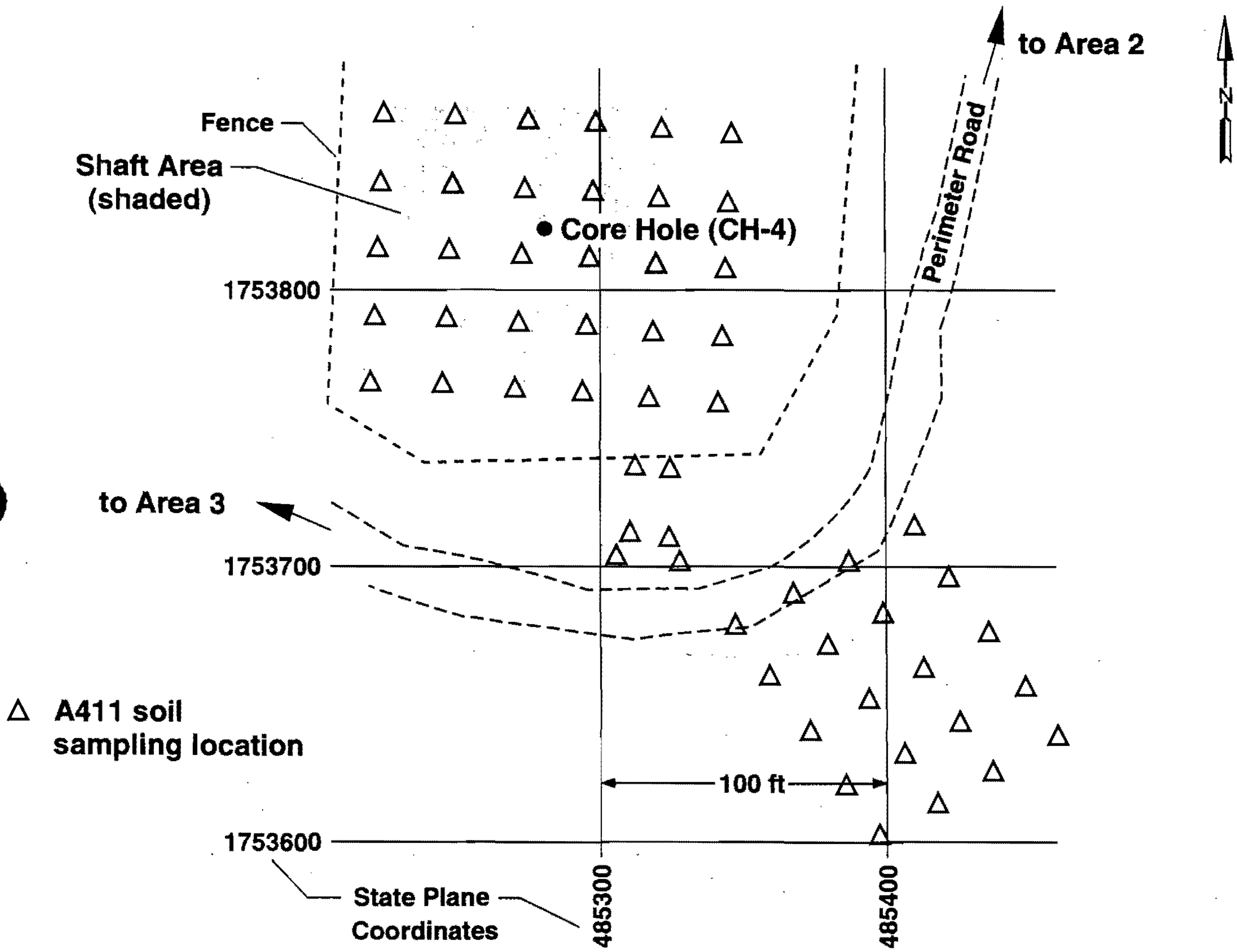


Figure 7.3-7 1987 A411 soil sampling locations for Area 4.

analyte levels were at or below regional background. The observed distribution indicates a highly discontinuous distribution of soil contaminants, as observed in the other experimental areas at MDA AB.

In June 1991, a pilot geophysical study was conducted in Area 4 to test the capability of standard geophysical techniques for detecting near-surface structures (Geophex 1991, 03-0031). Of particular interest was the capability to locate shafts and buried metallic debris. Figure 7.3-8 shows an interpretive sketch based on the geophysical survey and other field observations. Superimposed on the sketch is a grid representing the approximate locations of Area 4 experimental holes. It is evident that the geophysical techniques used (proton magnetometry and electromagnetics) are moderately successful in locating shafts when the distance from the chain link perimeter fence is greater than about 20 ft and near-surface metallic debris is not present. However, strong interferences arise when these artifacts are present. It is also clear that a substantial amount of metallic debris (probably piping) lies near the surface of Area 4 and interferes with the capability to detect the shafts. In some cases where geophysics correctly identified a shot hole location, the deduced center of the hole was in error by 5 to 10 ft, probably because of interference. The precision undoubtedly can be improved by using a finer geophysics grid interval (10 ft was used in the 1991 study) and by removing magnetic debris at or near the surface before the survey. Temporary removal of the chain link fence undoubtedly would help as well.

7.4 Data Needs and Objectives and Investigation Rationale

For the purpose of developing characterization plans, MDA AB SWMUs conceptually can be divided into two categories:

- backfilled shafts and
- surface and near-surface units.

Relatively independent sampling plans are developed in this chapter to address these two distinct categories of units.

Given the remedial actions that are likely to be recommended from the RFI/CMS process and the assumed future use scenario for MDA AB, the observational approach limits the field investigation for the backfilled shafts to that relating to the evaluation of the potential for subsurface transport of the deeply buried waste over time.

For the surface and near-surface units, the observational approach limits investigations to those necessary for determining whether contamination of concern is present in surface soils at MDA AB (except for Area 2, where surface contamination is already known) and the environmental significance of contamination sources and potential pathways.

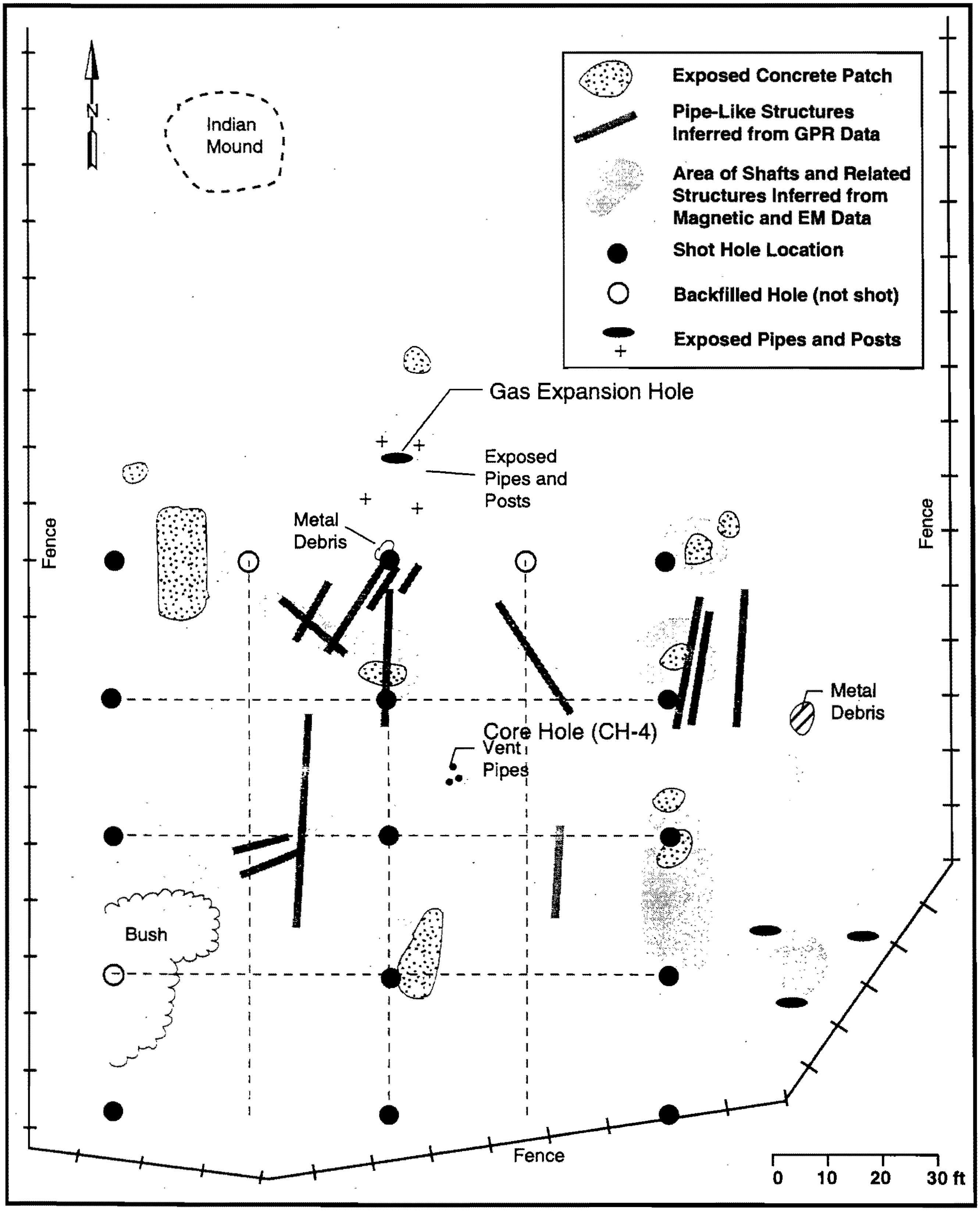


Figure 7.3-8 Interpretive sketch of Area 4, based on geophysical data (Geophex 1991, 03-0031). Hole locations are approximate.

7.4.1 Data Needs and Objectives

As discussed in Chapters 4 and 5 of this OU work plan, the principal potential contamination-migration pathways of concern at MDA AB are erosion (surface runoff and aerial resuspension), infiltration, and biological transport. With continuous surveillance, maintenance and control of MDA AB, the likelihood for significant contaminant transport is considered to be low over at least the 100-yr time frame assumed for institutional control. Despite the low likelihood for migration, the field investigation must test this hypothesis because of the size of the source term buried in the hydronuclear shafts and the existence of potential release sources near the surface.

Realistic remedial options for MDA AB, given the status of current technology, are outlined in Section 5.4 of this OU work plan. At the present time, capping and stabilization, accompanied by long-term institutional control, maintenance and monitoring, appears to be the most reasonable remedial action for the deeply buried contaminants within MDA AB. Selective removal of contaminated soils and artifacts at or near the surface also is likely. Based on existing information, the likelihood appears to be high that this approach will ensure that health and environmental impacts resulting from MDA AB contaminants will remain insignificant over at least a 100-yr period of institutional control.

General data needs for MDA AB are summarized in Section 4.12 of this OU work plan. Data are needed primarily to delineate the vertical and lateral extent of contaminants in the soils and shafts and to adequately define site hydrogeochemical factors that could influence contaminant migration. The location, nature, and inventory of the primary MDA AB contaminants already are known with an adequate degree of certainty. For this reason, and because of the risks involved in deliberate sampling of highly radioactive materials in the field, direct sampling of the source term is neither required nor desirable. The RFI for MDA AB therefore focuses on whether and how waste in the near-surface soils and buried in the shafts might migrate from its original location.

In addition to fulfilling the needs of the RFI, the field investigation of MDA AB also is intended to meet special requirements of DOE Order 5820.2A for ongoing monitoring of buried TRU waste areas (that is, a new A411-type survey, the requirements of which are discussed in Section 5.3 of this OU work plan). One of the requirements is that additional surface soil sampling be conducted over the shaft areas that were sampled in the 1987 survey.

In general, Level III analysis of discrete surface and subsurface samples is necessary because some data of this quality level is required for use in quantitative risk assessment. The Level III data will be combined with Level I and II data from area radiological surveys, geophysical surveys, and standard hydrogeological characterization methods for this purpose.

The development of a better understanding of the behavior of water under Area 2 and confirmation that contaminants have not migrated (and have little likelihood to migrate) from their original locations in the shafts are two of the most crucial aspects of the TA-49 RFI. These two issues must be addressed by additional hydrogeological characterization around and under the shafts. For this purpose, implacement and characterization of a system of vertical and lateral core holes is planned for Phase I. Additional boreholes are likely to be required in Phase II.

The borehole network will test the most important working hypotheses for MDA AB: that the contaminants in the deep shafts have not migrated from their original location and that credible mechanisms for future transport are absent.

As outlined above in Section 7.3, substantial sampling of surface soils already has been carried out at MDA AB. This sampling, coupled with detailed historical information, shows that radioactive source terms exist at the surface or near-surface in Areas 2 and 4, may be present in Area 1, but are unlikely in Area 3. However, better definition is needed of the magnitude, nature, spatial variability, and lateral/vertical extent of this contamination (especially under and adjacent to the Area 2 pad and downgradient toward Water Canyon) to allow modeling of contaminant distribution and transport pathways. The significance of near-surface piping and other debris with probable internal contamination also must be assessed in the RFI, as well as the significance of burrowing animals in mobilizing contamination near the surface.

As indicated earlier in this OU work plan, deep groundwater and surface water at TA-49 has been monitored for over 30 yr with no indication of water contamination, except in Core Hole 2. Water monitoring, as well as the ongoing air, ambient radiation, and soil monitoring around MDA AB that forms part of the Laboratory's routine environmental surveillance program, will be continued beyond the RFI by the Laboratory's Environmental Surveillance Group. In addition, the TA-49 work plan proposes investigation of isotope and water chemistry data on water from Core Hole 2 and the deep aquifer as well as recovered pore fluids. This information will provide information on the recharge rate from the surface of MDA AB, which then can be used for long-term modeling of contaminant migration.

Specific data needs for MDA AB are summarized below.

- The magnitude, nature, and lateral/vertical extent of radionuclide and metal contaminants (especially lead and beryllium) in the surface and near-surface of the MDA AB experimental areas must be defined further.
- Potential contaminant transport pathways of significance must be identified and characterized for the near-surface and the vadose zone to a depth of at least 700 ft (that is, across the potentially water-perching Tshirege-Otowi contact). This is particularly important for Area 2 because of the appearance of water in Core Hole 2.
- Further characterization is needed of hydraulic, lithologic, chemical, and mineralogic properties required for modeling long-term contaminant migration through soils and rock at MDA AB .
- Data on the erosional stability of MDA AB is needed.
- The significance of biologically induced transport pathways should be evaluated (especially for burrowing animals).

- Additional site information relevant to design of the CMS should be obtained.
- More extensive water chemistry and isotopic analysis of Core Hole 2 water is needed to check the mass balance of water constituents and to better infer the age and source of the water. Similar analyses are needed for deep groundwater and pore fluid waters that will be extracted from core sections recovered from the experimental shaft areas.
- Analyses of solids from the bottoms of Core Holes 1, 3, and 4 are needed as a direct check on whether contaminated water has ever moved through these core holes.

7.4.2 Investigation Rationale

Based on the extensive historical information already available for MDA AB, the assumptions listed below have been made in developing the RFI logic for MDA AB.

- A limited set of contaminants are present that, with high certainty, overwhelmingly will dominate any reasonable risk scenario. The probability is very high that contaminants of lesser environmental significance will be associated with one or more of the major contaminants. Thus a limited set of indicator analytes [total uranium, isotopic plutonium, gamma spectrometry (which yields americium-241, cesium-137, and gross gamma radioactivity levels), gross alpha/beta radioactivity, and RCRA metals (which notably includes lead and beryllium)] can serve as reliable indicators to define the spatial extent of contaminants (including minor contaminants).
- The extensive historical information that is available for the primary MDA AB source term (deeply buried contaminants at the bottoms of the experimental shafts) is sufficiently accurate. The value of data gained from direct sampling of the highly radioactive source term would not outweigh the non-trivial risks incurred by such sampling.
- The distribution of near-surface soil contaminants of concern at MDA-AB is highly discontinuous and point-like in nature, except those contaminants contained in piping and related debris.
- Radionuclide levels at the surface of MDA AB, above the most conservative action levels likely to be set for this area by subsequent risk assessment, will be indicated by area radiological surveys. Radiological surveys also will provide valuable data on the distribution of contamination at or near the surface. Discrete sampling of MDA AB soils will be used to confirm the survey results.
- Near-surface debris such as pipes and sampling boxes, which have contaminated interiors, are significant potential future

source terms. These artifacts will be detected with high probability by standard geophysical methods.

- Except during the drilling of Experimental Hole 2-M, contaminants placed in the bottoms of the shafts have been dispersed only by the original detonations and remain within a radius of about 10 to 15 ft from their original locations. Any migration beyond this radius will be detected with adequate probability by vertical coring through—and lateral coring under— the experimental areas.
- The importance of infiltration and subsurface features (for example faults and permeable lithologic units) that could significantly influence waste migration beneath Area 2 can be assessed by augmenting the existing borehole network with a limited number of additional boreholes in and around Area 2.

7.4.3 Coring Requirements

During the hydrogeologic characterization of MDA AB during the RFI, a number of new boreholes are proposed. As discussed in greater detail in Section 7.6, the proposed borehole locations and characterization have been designed to provide maximum information relating to the intended uses of the data. Some of the requirements for these boreholes are listed here.

- Continuous high-quality core should be obtained with high recovery rate.
- Drilling with fluids is undesirable because the determination of the presence or absence of subsurface saturation is a primary object of the investigation; drilling fluids also complicate the chemical characterization of pore water; drilling with air is problematical because of the potential for contaminant dispersal if subsurface contamination is encountered.
- A 4-in. minimum-diameter core hole is necessary to allow the use of down-hole logging instruments and the installation of well casing (when required).
- Both vertical and lateral boreholes are required; some vertical boreholes down to about 700 ft should penetrate the Tshirege-Otowi contact (Tsankawi Member) because it has potential to perch excessive moisture in the tuff beneath MDA AB (Stoker et al. 1991, 0715); lateral boreholes are intended to detect contaminant movement immediately beneath the shaft areas and to provide hydrogeologic data related to potential waste migration.
- The potential for encountering downhole contamination is significant when drilling within the experimental areas; rigorous health and safety measures, including effective contamination

control and continuous radiological monitoring of cutting materials, dust, core samples, etc., must be employed when drilling near the experimental areas of MDA AB.

- Boreholes must be implaced (and locationally verified) to an accuracy of about 2 ft in the vicinity of the contaminated shafts.

For these requirements, hollow-auger techniques are adequate for shallow (less than 200-ft) vertical holes but are not suitable for deeper core holes or for inclined holes. However, for deeper holes and (most especially) for inclined boreholes, meeting all of the above criteria may prove to be difficult. For example, for deep coring without the use of fluids, experience in the Bandelier Tuff has shown that efficient core recovery can be problematical, especially in nonwelded units. Although the air-rotary diamond-tipped coring technique may be the method of choice for recovering core from nonwelded units, it may not be compatible with other requirements mentioned above. Therefore, the specification of the drilling techniques to be used at MDA AB for the deep and lateral coreholes will be deferred until experience has been gained with auguring the 150 ft holes in Area 2. Alternative methods such as rotosonic, hammer, and ODEX drilling will be considered as possibilities.

Decisions on the details for the completion of new bore holes installed at TA-49 will be deferred until later in Phase I, when Phase II objectives can be formulated more clearly.

7.4.4 Characterization of Recovered Core

Recovered core sections will be logged as they are collected within regular intervals as determined by professional judgement (typically 5-ft intervals). Longer sections will be laid out to facilitate their description. All core sections and cuttings from the vicinity of MDA AB shafts will be field screened for radioactivity.

An important objective of the investigation of the TA-49 OU is to evaluate the importance of fractures as potential transport pathways. Therefore, core fractions containing prominent fractures will be sampled preferentially when they are encountered. For example, if a fracture is encountered over a 5-ft sampling interval, two samples may be taken over the interval to compare properties of fracture and nonfracture units. A five-sample contingency is allowed for each borehole for this purpose (except for the very shallow boreholes in the Area 2 pad).

Based on recovered core and borehole measurements, logs will be prepared that describe lithologic changes with depth, stratigraphic contacts, alteration features, welding characteristics, color, and phenocryst and lithic contents for all MDA AB boreholes. The logs also will include descriptions of fracture density, occurrence of fracture-lining minerals, and the dip of fractures. Core sections will be photographed in color immediately after recovery.

Geochemical characterization of recovered core is needed to provide input for geochemical models, as discussed in Section 2.11 of this OU work plan. Selected core samples will be used to characterize the following:

- rock and fracture lining mineralogy (clays, zeolites, rock matrix, carbonates, and iron/manganese minerals),
- total organic carbon,
- cation exchange capacity, and
- slurry pH.

Hydrogeologic characterization of recovered core will include description of the following:

- hydrostratigraphic units,
- porosity,
- density,
- redox state, and
- gravimetric moisture content.

The analyses may be performed on crushed core samples. The number and distribution of samples selected for characterization will be dependent on the number and nature of fractures encountered by the boreholes and will be determined as the cores are obtained. For planning purposes, collection of one sample for each 20-ft section of core is assumed. Some hydrologic tests (for example, initial water potential, isotopic water analysis, and unsaturated moisture characteristics) will require special handling when core is recovered from the core barrels (per approved SOPs). Analysis for contaminants will be carried out as specified in Section 7.6. of this chapter.

Additional core samples will be selected to characterize fracture-lining minerals, changes in lithology, or zones of sorptive minerals. One additional sample per 100 ft of borehole is assumed for planning purposes. Where possible, mineralogic and hydrologic testing will be done on the same suite of samples. Core samples will be selected by inspection and will include all the hydrostratigraphic units encountered.

Characterization of the vertical variation in moisture content is a critical measurement for MDA AB. Because other investigations at the Laboratory have determined that moisture content can vary significantly over a short vertical distance near the surface, core moisture content for vertical boreholes will be measured every 5 ft to a depth of 30 ft and every 20 ft thereafter. Additional samples will be collected, when deemed necessary based on professional judgement, in open and in filled joints and from host rock away from joints.

Hydrogeologic testing can be performed sequentially in a geotechnical laboratory on high-quality core that is collected for the gravimetric moisture test. Bulk density, dry density, and porosity values will be calculated for each core sample for which moisture content is measured. These results will be used to select core samples for measurement of porosity (helium gas injection), water characteristic curves, relative permeability, and saturated hydraulic conductivity.

7.4.5 Borehole Logging

Boreholes will be logged by standard techniques to extend the database assembled from previous information, surface studies, and tests performed on core samples. Table 7.4-1 lists logs to be collected in open boreholes and describes the information to be obtained from each log.

The logs will document stratigraphic correlations, identify and map orientation of fractures and joints, define the relative variation in moisture within the unsaturated zone, and define the variation in bulk density within the vertical hydrogeologic section.

An inflatable straddle packer assembly will be used to determine *in situ* permeabilities for discrete depth intervals in open vertical boreholes, using the vacuum extraction method. The testing interval will be 20 ft for the first 150 ft, which encompasses the depth of the deepest hydronuclear shaft. Thereafter, measurements will be taken near the midpoint of each major lithologic unit and adjacent to each unit contact. Additional permeability measurements may be carried out, based on an evaluation of core geology, the borehole geophysical logs, and moisture content tests on recovered core samples.

7.4.6 Contingency Plans for Borehole Drilling

If perched groundwater or unexpected contamination is encountered during drilling of any TA-49 core holes, drilling will be stopped and an evaluation will be made on whether to resume drilling. In some cases, it may be advisable to complete the hole as a monitor well in the perched zone. In other cases, it may be appropriate to continue drilling or to move away from the original hole and to install a new hole. Any perched water encountered will be sampled and analyzed as described in Subsection 6.1.6 of this OU work plan for the deep test wells at TA-49.

As discussed above in Subsection 7.4.3, this OU work plan retains flexibility in choice of drilling techniques because of uncertainties about meeting all the desired core hole criteria specified in that subsection. As discussed below in Subsection 7.6.6, flexibility also is retained in angled coring under MDA AB in case the proposed lateral core hole drilling proves problematical.

Boreholes will be sampled to at least the nominal depth or length specified in the sampling plans. If contamination is detected by field screening or laboratory measurements in either of the last two core intervals of the nominal depth or length, drilling will continue until background concentrations are detected or the limits of detection are reached in two successive sample intervals. This stopping criterion will be applied to ensure that the maximum information on contaminant depth is acquired at minimum cost.

7.5 Phase I Surface Investigations at MDA AB

The surface investigations at MDA AB are designed primarily to answer the following decision-based questions:

TABLE 7.4-1

GEOPHYSICAL LOGS TO BE COLLECTED IN MDA AB BOREHOLES

Open Hole	Parameter Measured
Thermal neutron (moisture)	percent moisture, perched water zones
Gamma gamma (density)	bulk density of rocks
Caliper	borehole dimensions
Borehole video	fracture orientation
EM induction (Geonics EM-39)	stratigraphic correlation; perched water zones
Magnetic susceptibility (Romulus)	stratigraphic correlation
Natural gamma	stratigraphic correlation; radioactive contamination
Spectral gamma (U, TH, K)	stratigraphic correlation; radioactive contamination
Prompt fission neutron	radioactive contamination by fissionable isotopes
Geochemical (Californium-252)	chemical contamination by 8 to 10 elements that undergo neutron activation and elastic scattering
Temperature gradient	temperature profile
Cased Hole	
Thermal neutron (moisture)	percent moisture; perched water zones
Gamma-gamma (density)	percent moisture; perched water zones
EM induction (PVC casing)	perched water zones

- ***Does surface soil contamination currently exist in Areas 1-4 (except Area 2) that is above the most conservative action levels likely to be set for these areas by subsequent risk assessment?***
- ***In Area 2, what is the extent of contamination in surfaces soils around and under the asphalt pad at Area 2?***
- ***What is the significance of soil excavation by burrowing animals at Area 2?***
- ***Where and how extensive are the surface and near-surface artifacts (piping, sample boxes, etc.) that represent contaminant release points in the future?***
- ***What is the potential for surface migration of contaminants from MDA AB?***

According to the observational approach and the assumed future use scenario for MDA AB (institutional control), only those data that address these questions needs to be collected. If satisfactory answers to these questions do not result from Phase I investigations, a Phase II study is likely to be triggered.

QA/QC samples for the MDA AB surface investigation will be collected and analyzed as indicated in Tables 7.1-2(a—d).

7.5.1 Radiological Surveys

The surface investigation at Areas 1, 2, 2A, 2B, 3, and 4 will begin with radiological surveys using hand-held or tripod mounted detectors (PHOSWICH, FIDLER, or related instruments) or mobile gamma spectrometry systems. These surveys primarily address decision questions 1 and 2 listed in the preceding section. The objectives of the radiological surveys are to identify areas of elevated radioactivity for judgmental sampling and to identify any surface areas with radionuclide concentrations sufficiently high to require enhanced health and safety precautions.

At least 90% of the area encompassed by the MDA AB shaft areas (approximately a 100 ft by 100-ft area extending over Areas 1, 2, 2A, 3, and 4), plus a 25-ft margin on each side of the areas, will be surveyed radiologically as indicated in Figures 7.5-1 through 7.5-4. (An irregularly-shaped area will be surveyed for Area 2B because of its shape). If hot spots are found, the radiological survey will be extended outward from these areas until elevated radioactivity levels no longer are detected.

If hot spots are detected, their locations and lateral distributions will be determined with portable instruments. Hot spots will be sampled over a depth range of 0 to 6 in. The spatial distribution of radiological contaminants will be determined by collecting and analyzing supplemental soil samples at a depth of 6 to 12 in. below the hot spots and at a lateral distance of 1 m from the hot spot to a depth of 6 in. Level III analysis will be carried out on these discrete soil samples for isotopic plutonium, total uranium, gamma spectrometry, RCRA metals, and gross alpha/beta radioactivity.

The drainage area from the northern perimeter of the Area 2 pad toward sediment Station A-3 also will be surveyed radiologically, as indicated in Figure 7.5-2. If hot spots are found, they will be characterized as described above. The survey will be extended down the Area 2 drainage until elevated radioactivity levels no longer are detected.

7.5.2 Geophysical Surveys

The radiological survey of MDA AB will be followed by a general geophysical survey over the experimental areas. This investigation primarily addresses question 4 listed in the introduction to Section 7.5 and has the following specific objectives:

- detect and locate all near-surface structures (piping, sampling boxes, etc.) that are potential sources of contamination and that may interfere with the geophysical detection of other subsurface features of interest (for example, shaft locations);
- provide confirmatory information on the location and number of underground shafts under the experimental areas; and
- detect and locate any near-surface features that are anomalous, based on currently available information.

The geophysical survey will cover approximately the same area proposed for radiological surveys. Standard proton magnetometry and electromagnetic techniques will constitute the primary geophysical methods to be used. These methods will be augmented by ground-penetrating radar, seismic, and other techniques that are being refined at the present time for application to Bandelier Tuff and that will be used as they become available.

Temporary relocation of small sections of the exclusion fence may be required to avoid metallic interference during geophysical surveys.

7.5.3 Removal of Near-Surface Debris

Field surveys and direct observation at MDA AB undoubtedly will indicate pipes, sample boxes, and other debris at or near the surface. These artifacts may interfere with the geophysical capability to find other subsurface features of interest, such as shaft locations, which ideally should be located by nonintrusive methods. Also, the location and removal of such artifacts is desirable because, as discussed earlier in this chapter, their interiors can be assumed to be highly contaminated by radionuclides and represent probable sources of contaminant release over the long term. Therefore, when feasible, such near-surface artifacts will be removed as a voluntary corrective action (VCA). Geophysical resurvey of some areas may be required after interfering debris has been removed.

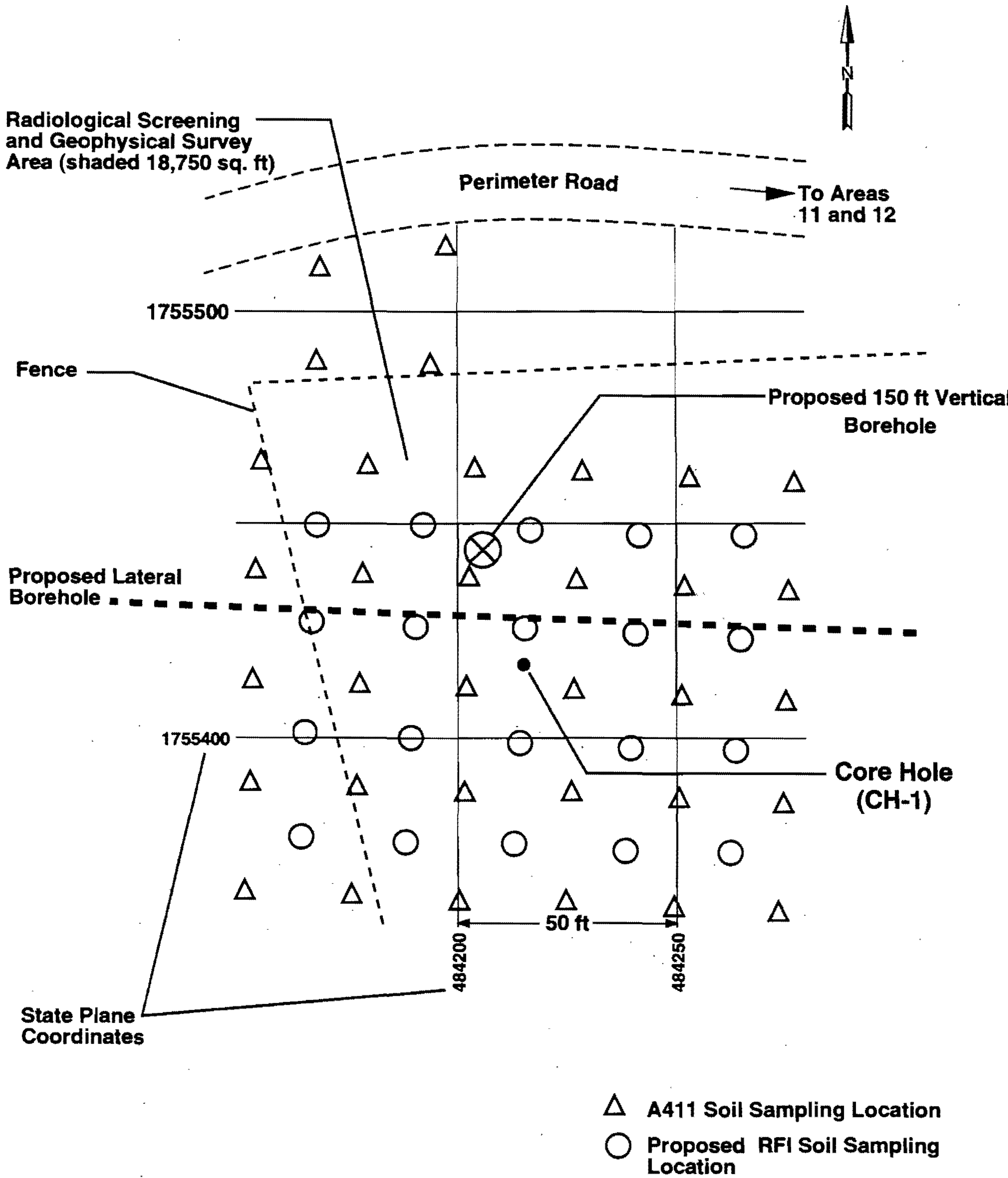


Figure 7.5-1 Phase I RFI borehole and soil sampling locations for Area 1.

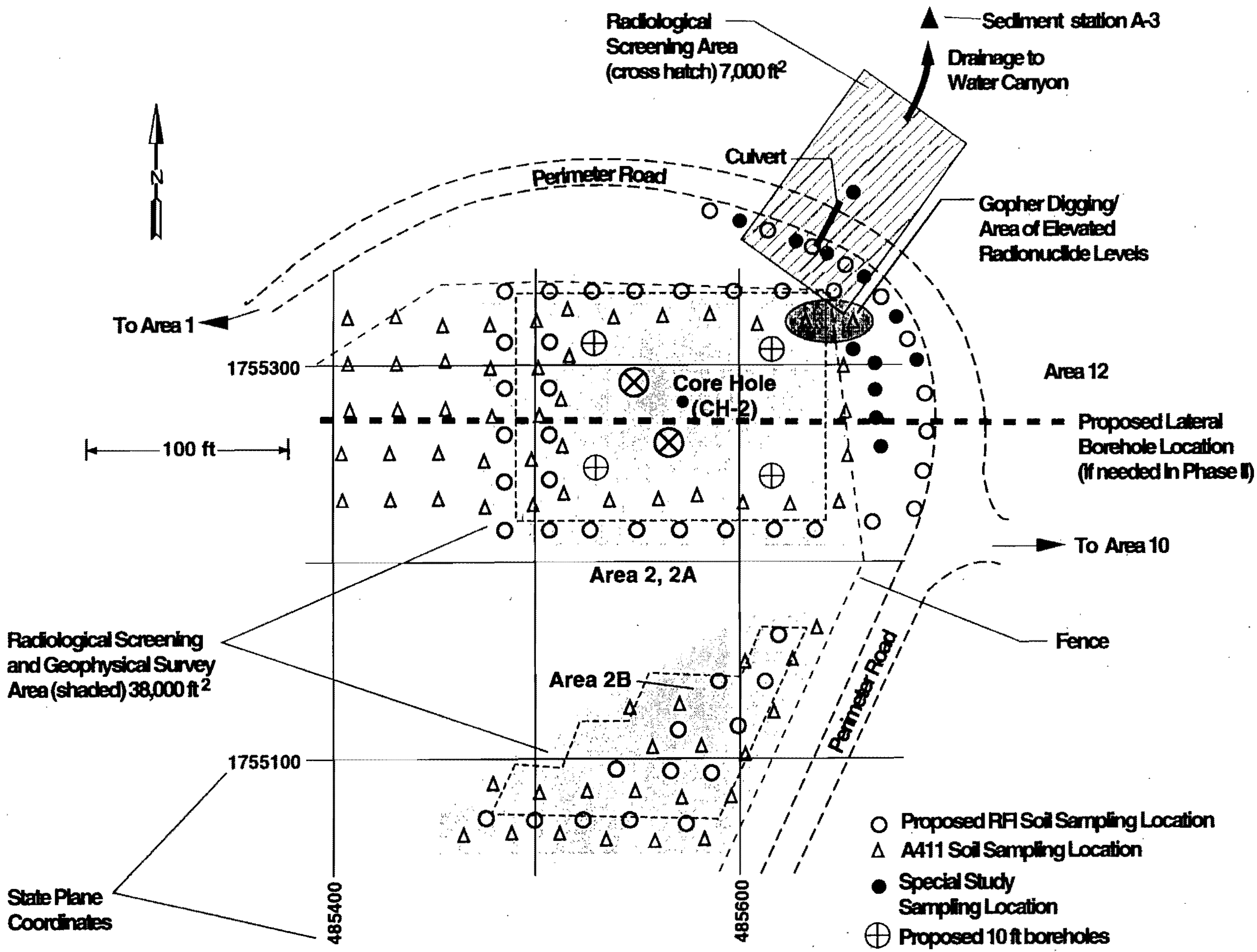


Figure 7.5-2 Phase I RFI borehole and soil sampling locations for Areas 2, 2A, and 2B.

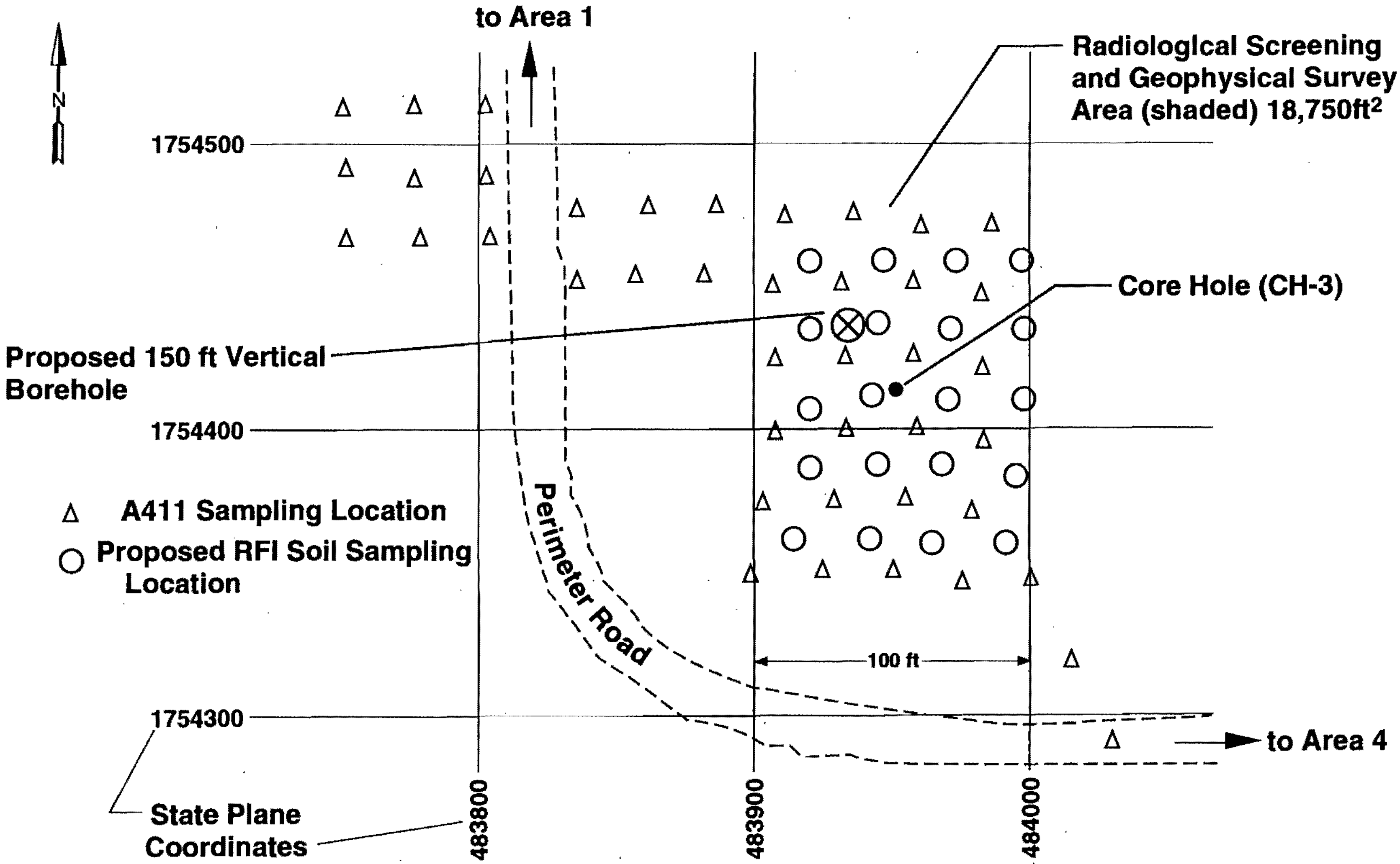


Figure 7.5-3 Phase I soil sampling and borehole locations for Area 3.

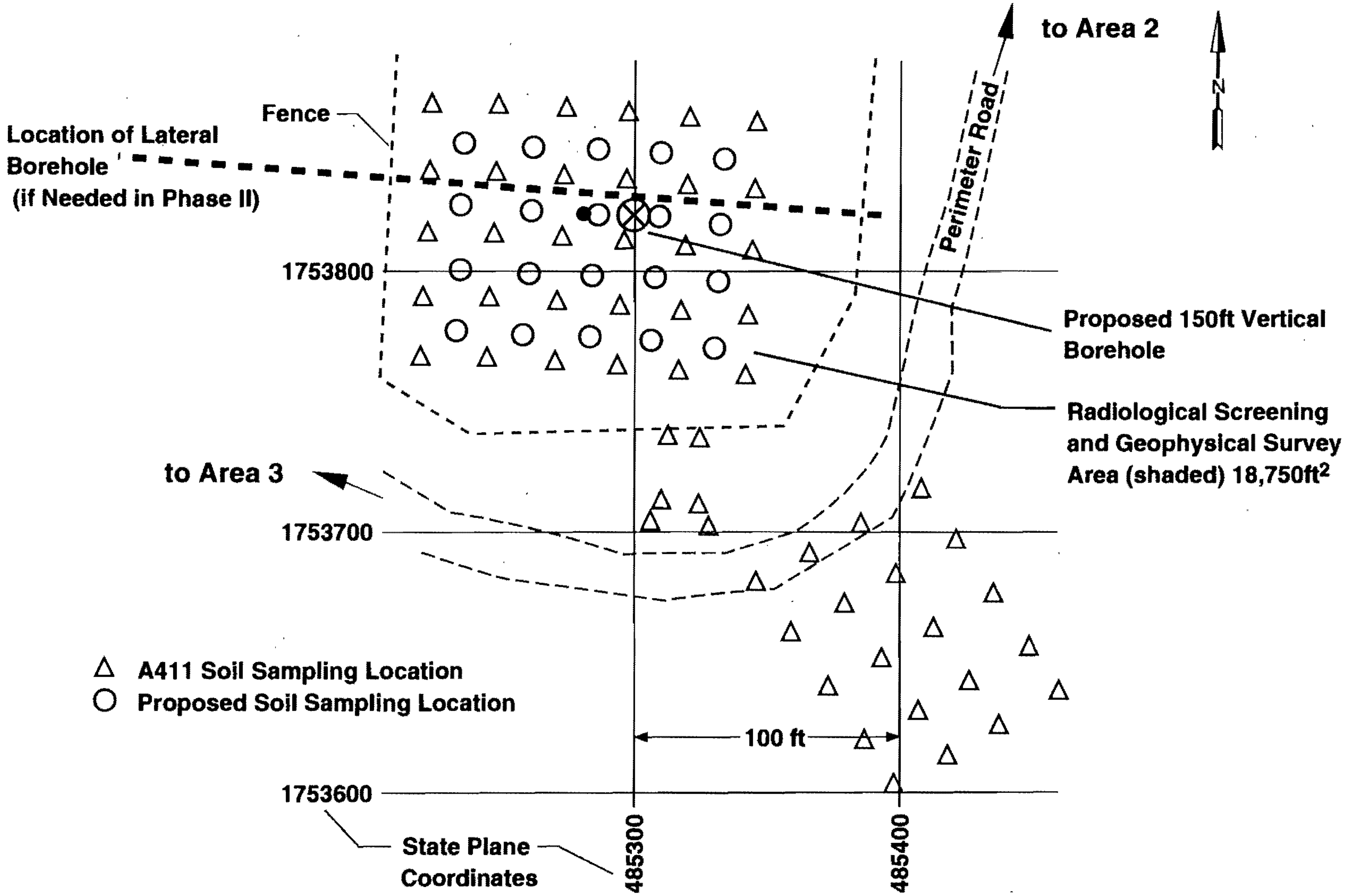


Figure 7.5-4 Phase I RFI soil sampling and borehole locations for Area 4.

Soils adjacent to near-surface artifacts in the vicinity of the hydronuclear shafts must be presumed to be contaminated unless investigations prove otherwise. Therefore, artifact removal must be accompanied by frequent field screening for elevated radioactivity levels. In addition, at least one soil sample per 10 linear ft of artifact will be collected for analysis as described above in Subsection 7.5.1 for soil hot spots. A sampling interval of 10 ft is proposed because this is probably a typical length of piping to be encountered (that is, typical distance between joints). Based on the geophysical survey of Area 4 conducted in 1991 and other available information, about 500 linear ft of such debris may be present at MDA AB. Therefore, for planning purposes, it is assumed that about 50 field samples of this type will be collected.

7.5.4 Discrete Surface Soil Sampling

Discrete sampling of soils over the MDA AB experimental areas will be conducted as indicated in Figures 7.5-1 through 7.5-4. This sampling primarily addresses questions 1 and 2 (and secondarily, questions 3 and 5) listed in the introduction to Section 7.5. The investigation has the following specific objectives:

- supplement the 1987 A411 survey and fulfill the requirements of the next A411-type survey of MDA AB;
- document changes (if any) in surface contamination levels since the 1987 A411 survey and various special studies of the surface of MDA AB; and
- detect areas of significantly elevated contaminants, thus complementing the radiological surveys proposed in Subsection 7.5.1 of this OU work plan.

It is expected that previous surface soil analyses from the 1987 A411 survey will be combined with new data collected in Phase I of the RFI. If a distribution other than isolated hot spots exists, the combined data should allow the construction of spatial prediction surfaces (for example, by kriging) for the sampled areas. These surfaces then would be used to model radionuclide distributions and migration processes. If Phase I data is not adequate for this purpose, a good foundation will have been established either for proposing no additional surface soil sampling in Phase II or for designing a statistically-based Phase II surface investigation.

Sampling of surface soils at Areas 1, 3, and 4 will be carried out on square grids with 25-ft intervals centered on the shaft areas, as shown in Figures 7.5-1 through 7.5-4. The grids were centered on the hydronuclear shaft areas because this covers the areas with maximum likelihood for contamination, based on the extensive historical information that is available for these areas. The mesh size was chosen for consistency with the previous A411 survey, which in turn was based on the grid size defining the locations of the hydronuclear shafts. The sampling locations were selected to exactly interleave the earlier A-411 grid, thus doubling the sampling resolution over the shaft areas and making subsequent analysis of the combined datasets convenient.

This strategy simultaneously satisfies requirements driven by DOE Order 5820.2A for periodic surface sampling above the shafts. Samples will be collected at each grid location indicated in Figures 7.5-1 through 7.5-4.

Characterization of discrete soil samples will be conducted as indicated in Tables 7.1-2(a, c and d). Gross alpha, gross beta, and gamma spectrometry measurements (using either the field laboratory or an off-site analytical laboratory) will be conducted for all samples collected. One-half of these samples, plus all samples for which above-background levels of these analytes are indicated, also will be analyzed in an analytical laboratory for isotopic plutonium, total uranium, and RCRA metals.

Sampling of surface soils on a regular grid at Areas 2, 2A, and 2B is not practical because of the asphalt pad and irregular shape of Area 2B. The soil sampling locations proposed in Figure 7.5-2 emphasize the need for data around and downgradient from the section of the pad where gopher activity has been most severe and the highest contamination levels historically have been recorded. The sampling interval has been maintained at about 25 ft for consistency with the rest of the MDA AB surface soil sampling scheme.

Proposed sampling locations from the northernmost edge of the Area 2 pad down the drainage toward Water Canyon are shown on Figure 7.5-2. The selection of these locations is based judgementaly on previous studies in this area, the presence of the ditch between the roadway and pad (which strongly focuses the drainage), and the presence of natural collection areas in the canyon carrying drainage from Area 2 toward Water Canyon.

Three samples will be collected from each of two transects perpendicular to the drainage downgradient from sediment Station A-3. The transects will be located approximately 100 and 200 ft from Station A-3. If levels of contamination above background are found for the transect farthest removed from Area 2, additional sampling locations will be established further downgradient until background levels are recorded.

7.5.5 Sampling of Biota

Vegetation sampling carried out in the 1987 A411 survey is considered to be adequate for the purpose of Phase I of the TA-49 RFI. The need for additional sampling of biota (such as vegetation and gophers) will be considered for Phase II investigations as Phase I proceeds and after programmatic guidance on risk assessment is developed and documented in a future IWP.

7.5.6 Soil Characteristics Around Area 2

Soil characteristics will be determined as described in Section 6.1 of this OU work plan for the uppermost core section from one of the shallow boreholes through the Area 2 pad (see Subsection 7.6.5). Soil characteristics also will be determined at two locations in the vicinity of Area 2, one location being about half-way between Area 2 and Area 11 and another location near sediment Station A-3. This investigation primarily addresses question 5 listed in the introduction to Section 7.5.

7.6 Subsurface Investigations at MDA AB

The subsurface investigations at MDA AB are designed to address the following decision-based questions:

(1) ***Have wastes migrated from the subsurface zones of contamination created in the original hydronuclear experiments?***

(2) ***Are the site geotechnical properties adequately known to allow predictions of future waste migration?***

(3) ***What is the source and significance of water in Core Hole 2?***

(4) ***What is the distribution of contaminants beneath the asphalt pad at Area 2?***

According to the observational approach and the assumed future use scenario for MDA AB (institutional control), only those data that address these questions needs to be collected. If satisfactory answers to these questions do not result from Phase I investigations, a Phase II study is likely to be triggered. Otherwise, it may be possible to proceed directly to a corrective measures study.

7.6.1 Continuous Monitoring for Water in Core Holes 1, 2, 3, and 4 and Moisture Test Holes

Investigations proposed in this subsection are intended primarily to address question 3 listed in the introduction to Section 7.6.

Continuous monitoring of the water level in Core Hole 2 will be continued through Phase I using a transducer and data logger. During the summer or fall of 1992, the existing water in Core Hole 2 will be bailed and the recovery of the level of standing water will be measured.

Although water has not been detected in Core Holes 1, 3, and 4, it cannot be stated without qualification that water has never been present in these holes because they have been checked infrequently. Therefore, Core Holes 1, 3, and 4 also will be equipped with transducers and data loggers to detect the appearance of water, if it should occur in these holes. Continuous data will be collected to quantify the response of detectable infiltration (if any) into these holes as a result of seasonal and episodic events at the surface. At the conclusion of Phase I, an assessment will be made as to whether continuous monitoring should be extended beyond this period.

The entire moisture test hole network in the vicinity of Area 2 (see Figure 7.3-3) will be monitored with a neutron moisture probe on a quarterly basis through the Phase I studies and more often if anomalous moisture content is detected.

7.6.2 Chemical and Isotopic Analysis of Water

Investigations proposed in this subsection are intended primarily to address questions 1 and 3 listed in the introduction to Section 7.6.

Water retrieved from Core Hole 2 (and Core Holes 1, 3, and 4, if water is observed in these holes) will be analyzed quarterly during the expected 2-yr duration of Phase I. Level III chemical and isotopic analysis will be carried out for TA-49 water samples for the list of analytes indicated in Table 6.1-5. Deep test wells DT-5A, DT-9, and DT-10 will be sampled annually. Stable and radioisotopic measurements (as indicated in Table 6.1-5) will be carried out to determine absolute ages of vadose water. These ages will be used to evaluate the rate of infiltration through the hydrostratigraphic column beneath MDA AB.

Analysis for the same analyte suite will be carried out on pore fluids extracted from at least two sets of core recovered from Area 2 during Phase I. Similarly, two sets of pore fluids will sampled from Area 1. Sampling depths of about 30 and 100 ft will be used to bracket most of the experimental shaft bottoms.

The stable and radiologic isotope data (for example chlorine-36, deuterium and oxygen-18) of TA-49 subsurface waters will be used to place constraints on recharge areas of these waters, based on current information on local springs, streams, and the main aquifer. If isotopes in the sampled water vary on a seasonal basis, it can only mean that the water is responding to seasonal changes in recharge and/or has a mixed source of recharge. By use of appropriate calculations, maximum and minimum ages of the water can be calculated to constrain the hydrologic models.

7.6.3 Analysis of Solids from Core Holes 1, 3, and 4

Investigations proposed in this subsection are intended primarily to address questions 1 and 3 listed in the introduction to Section 7.6.

One solid sample each will be collected from the bottoms of Core Holes 1, 3, and 4 and will be analyzed by Level III methods for total uranium, isotopic plutonium, gamma spectrometry, RCRA metals, and gross alpha/beta radioactivity.

7.6.4 Vertical Borehole Installation and Characterization

Investigations proposed in this subsection are intended primarily to address questions 1, 2, and 3 listed in the introduction to Section 7.6. These investigations also will provide some information pertaining to question 4. The vertical boreholes will be used to characterize geotechnical properties related to potential waste migration in the vadose zone beneath the MDA experimental areas. In addition, analysis of cores from these holes will test the critically important hypothesis that movement of contaminants beyond the assumed radius of about 10 to 15 ft has not occurred in the three decades since the hydronuclear experiments created the wastes.

7.6.4.1 150-ft Core Holes in Area 2

The existing moisture monitoring holes around Area 2 (see Figure 7.3-3) will be augmented by 150-ft deep holes drilled through the Area 2 pad at previously unused grid locations 2-G and 2-R [see Figures 7.2-1(b) and 7.5-2]. Locations 2-G and 2-R were selected in part because historical information indicates that they do not contain subsurface contaminants, thus simplifying drilling operations. In addition, boreholes at these locations provide a good distribution of sampling locations around Core Hole 2 and Experimental Hole 2-M, and these locations are surrounded by adjacent holes containing plutonium and uranium. The uppermost core sections also will provide information on the distribution of contaminants in the fill material under the asphalt pad and confirm the thickness and composition of the fill.

The 150-ft holes will be drilled with a split-spoon hollow-stem auger rig, thus maximizing the probability of recovering intact core sections that can be characterized for excess moisture, lithology, and other subsurface characteristics. Also with augering (compared to other drilling methods such as air coring), contamination control is less problematical in the event that contamination is unexpectedly encountered. Three-foot core sections will be collected down to the level of the intact tuff (about 8 to 10 ft below the surface) and 5-ft core sections will be collected below the tuff interface. Core geotechnical properties and borehole logging will be carried out as outlined in Section 7.4 and summarized in Table 7.4.1. Chemical and radiochemical analysis will be performed as described in Subsection 7.5.4 for discrete surface soil samples.

7.6.4.2 150-ft Boreholes in Areas 1, 3, and 4

It is proposed that one each 150-ft boreholes be installed in Areas 1, 3, and 4 during Phase I. The objectives, siting criteria, and sampling protocols are the same (except for sampling of the fill under the Area 2 pad) as those described in the preceding section for 150-ft boreholes in Area 2. Characterization of these boreholes and core sections recovered from them also will be carried out as described for the 150-ft vertical boreholes in Area 2 .

In Area 1, a 150-ft borehole will be installed at the unused grid location 1-H [(see Figures 7.2-1(a) and 7.5-1]. This drilling location was selected because it is adjacent to a number of plutonium contaminated shafts.

In Area 3, a 150-ft borehole will be installed at unused grid location 3-H, which is adjacent to several tracer and containment shot holes [see Figures 7.2-1(d) and 7.5-3].

In Area 4, a 150-ft borehole will be installed at unused grid location 4-N, which is adjacent to a number of plutonium contaminated shafts [see Figures 7.2-1(e) and 7.5-4].

7.6.4.3 700-ft Vertical Boreholes in Areas 1 and 2

During Phase I, one 700-ft vertical borehole is proposed for Area 1 and another for Area 2. These holes will allow the characterization of geotechnical properties beneath MDA AB to a depth below the Tshirege-Otowi contact and will detect perched water (if any) beneath these areas. Logging of these holes, in combination with surface geologic studies outlined in Section 6.1 of this OU work plan, will facilitate the identification of north-south fault zones that may exist within MDA AB (Subsection 4.5.2 of this OU work plan addresses this point in greater detail). The objectives are the same (except for chemical and radiochemical analysis) as those described for the 150-ft borehole proposed for Area 2 (see Subsection 7.6.5.1). Characterization of these boreholes and core sections recovered from them also will be carried out as described in Subsection 7.6.5.1.

If the 150-ft boreholes drilled in Areas 1 and 2 are found to be uncontaminated, coring probably will be continued to the 700-ft depth in one of the 150-ft holes in each area. However, the 700-ft vertical borehole also might be sited immediately adjacent to the experimental areas, depending upon assessment of the situation after the 150-ft vertical boreholes are completed.

Chemical and radiochemical analysis of recovered core samples will be discontinued below the 150-ft level when contaminants no longer are detected in two consecutive core samples, as per the borehole stopping criterion described in Subsection 7.4.6 of this chapter.

7.6.5 Shallow Boreholes Through the Area 2 Pad

The investigation described in this subsection primarily addresses question 4 in the introduction to Section 7.5. Questions 2 and 3 are addressed secondarily.

Four shallow boreholes will be implaced through the Area 2 pad to quantify the distribution of moisture in the fill and soil underlying the asphalt pad. Four holes located symmetrically with respect to the asphalt pad (see Figure 7.5-2) were judged to provide adequate and reasonably representative indication in for abnormal moisture levels beneath the pad. The proposed 150-ft vertical boreholes will provide supplemental information of this type. Besides information on moisture in the fill material, the boreholes through the Area 2 pad will provide information on the thickness, composition, and contaminant distribution.

The shallow boreholes will be drilled until intact tuff is encountered (expected at a depth of about 9 ft). Three-ft core sections will be collected for analysis as described above for recovered core samples from the 150 ft vertical holes.

Soil moisture in the boreholes will be measured with a neutron moisture probe on a quarterly basis during Phase I, and more often if anomalous conditions are detected.

7.6.6 Lateral Boreholes Under Areas 1 and 2

Investigations proposed in this subsection are intended primarily to address questions 1, 2, and 3 listed in the introduction to Section 7.6.

A lateral borehole is proposed for installation under Area 2, as indicated in Figure 7.5-5. The primary purposes of this hole are to detect downward movement (if any) of water and contaminants through the shaft areas of MDA AB and to provide data on geologic structure under the MDA. The east-west orientation was chosen to maximize the likelihood of intersecting any tectonic structure that may be present because regional tectonic features are oriented predominantly north-south (Gardner and House in preparation, 0720). The locations of the drilling platform and the inclination of the hole were selected to provide a reasonably low borehole inclination under Area 2 while limiting the borehole to a reasonable length.

The lateral borehole under Area 2 will be directed between the lines defined by two pairs of experimental holes, 2-P/2-T and 2-K/2-O [see Figures 7.2-1(b) and 7.5-2]. This alignment was selected to be reasonably close to Core Hole 2 while underlying several plutonium-contaminated shafts. A vertical clearance of 20 ft (minimum) below the deepest shaft in Area 2 and 2A (Hole 2-Y, 78 ft deep) is planned. The 20-ft clearance was selected to be outside the 10-to 15-ft radius expected for the original explosive dispersal of contaminants, but close enough to detect with reasonable confidence any contaminant transport that may have occurred thereafter. This borehole will be installed after evaluation of results from the 150-ft vertical boreholes in Area 2.

Borehole characterization will be carried out as described as described earlier in Section 7.6 for the 150-ft vertical shafts to be installed in Area 2. Beginning 50 ft from the shaft area and extending 50 ft beyond the opposite side, 5-ft core sections recovered from the lateral boreholes will be collected for chemical and radiochemical analysis. If the last two samples from the borehole do not show background levels of contaminants, core sampling and analysis will be continued until this condition is met, as per the borehole stopping criterion discussed in Subsection 7.4.6 of this chapter.

Installation and sampling of the Area 1 lateral core hole will occur after the initial evolution of results from the Area 2 lateral borehole because specific refinement of borehole alignment and depth might be suggested. It is likely that the Area 1 lateral borehole will be very similar to that in Area 2, except that it probably will be emplaced from west to east rather than from east to west (for operational convenience). The borehole will be directed to pass between the lines established by Experimental Holes 1-F/1-J and 1-K/1-O [see Figure 7.2-a(a)]. This alignment was selected because it lies near the center of the Area 1 shaft complex and underlies a high density of shafts containing plutonium.

If the proposed lateral drilling scheme is not feasible for technical reasons, alternatives will be proposed. An alternative to the proposed scheme, for example, might be implacement of two shorter, more steeply angled holes from each side of Area 1 and Area 2.

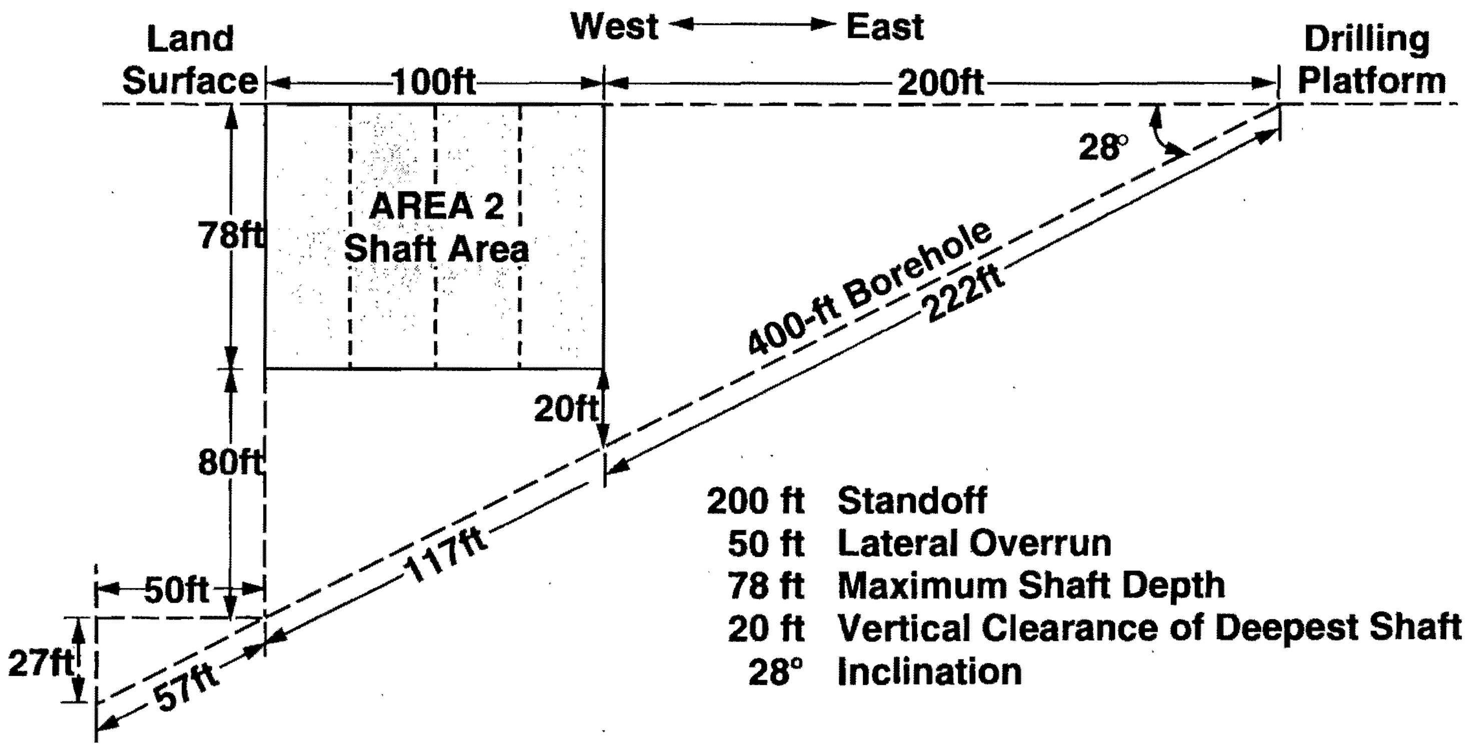


Figure 7.5-5 Placement of Area 2 lateral borehole.

7.7 Phase II Sampling Plan

Phase II of the TA-49 RFI is expected to consist of completion of investigations at MDA AB and Area 11, as well as at other TA-49 areas (if Phase II investigations are required at the other areas). In Phase II, routine borehole and groundwater monitoring at MDA AB will continue as described above. Routine monitoring of air, ambient radiation levels, and sediment stations around MDA AB also will be continued in conjunction with the Environmental Surveillance Group's activities.

The necessity for additional subsurface and surface characterization at all areas within MDA AB will be evaluated at the end of Phase I. Determination of the need for additional boreholes and collection of additional surface soil samples will be based on this evaluation.

Depending upon the assessment of Phase I results, the following additional actions might be appropriate in Phase II:

- implace lateral boreholes under Areas 3 and 4;
- install additional vertical boreholes at MDA AB experimental areas;
- collect soil/tuff samples from soil pits;
- install a geologic trench north of MDA AB to assist the mapping of fractures (particularly tectonic);
- remove localized hot spots and contaminated debris from the surface and near-surface of MDA AB;
- conduct additional surface/near-surface characterization at MDA AB; and
- install a new deep test well into the main aquifer in the vicinity of TA-49.

The details of these activities will be refined after completion of Phase I and will be described in a revised work plan covering Phase II activities. For planning purposes, the installation of four additional 150-ft vertical boreholes and the collection of 100 soil samples is assumed.

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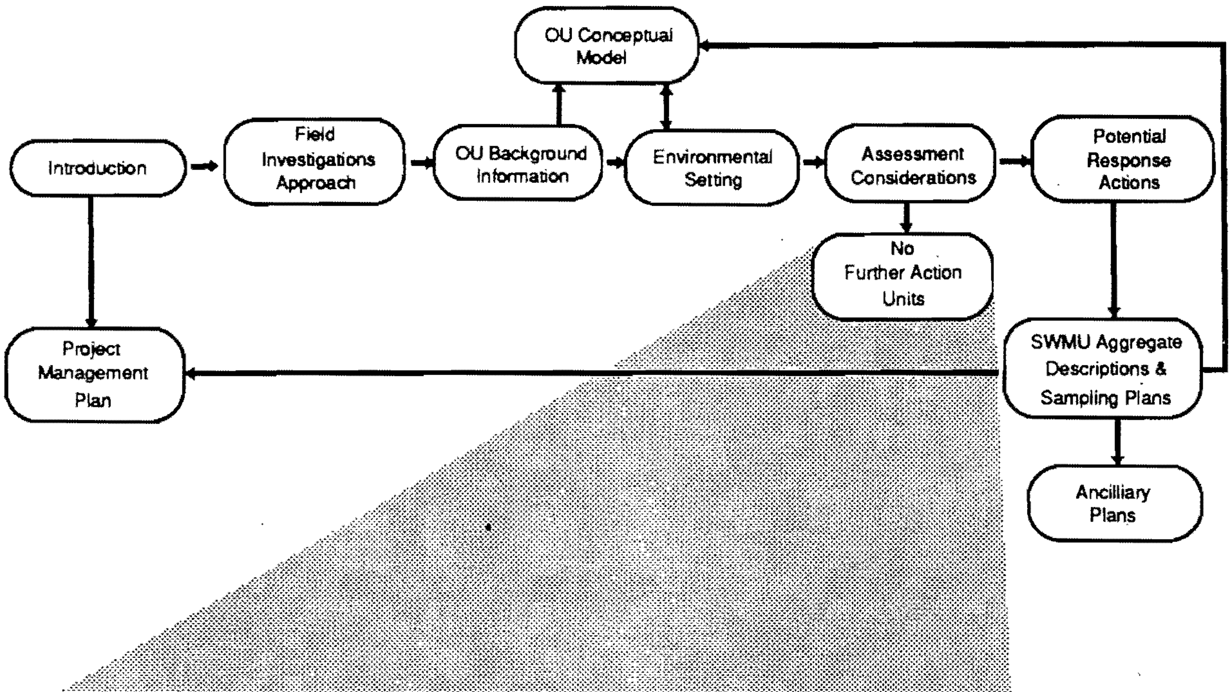
Chapter 8



No Further Action Units

- Underground Fuel Tank
- Septic Systems
- HE Storage Area
- Along State Road 4 Borrow Pits
- Other Disturbed Areas
- PCBs in Road Oil
- Firing Site Shrapnel
- HDT Firing Pit

CHAPTER 8 - NO-FURTHER ACTION UNITS

8.1 Introduction

This chapter presents information on SWMU 49-00 (underground fuel tank) and on SWMUs 49-007(a) and 49-007(b) (septic systems), which are listed in the 1990 Laboratory SWMU report (LANL 1990, 0145). In addition, this chapter discusses several unlisted potential areas of concern that were considered during the work plan development. Based on the information discussed below, no further action (NFA) is proposed for these units, and these areas should be considered suitable for unrestricted Laboratory use, subject to restrictions imposed by the ongoing use of TA-49 as a buffer zone for adjacent firing sites.

The proposed NFA units are as follows:

- underground fuel tank (nonexistent) (SWMU 49-009),
- septic systems [SWMUs 49-007(a) and 49-007(b)],
- HE storage area east of Area 4,
- borrow pits along State Road 4,
- other disturbed areas at TA-49,
- PCBs in TA-49 road oil,
- firing site shrapnel, and
- HDT firing pit.

Archival data for these TA-49 OU SWMUs and potential areas of concern indicate that it is appropriate to propose NFA under guidance proposed in Subpart S because these SWMUs pose no threat to human health or environment. Criteria used for proposing NFA for these units are listed below.

- ***NFA Criterion 1.*** The site or SWMU never has been used for the management (that is, generation, treatment, storage, or disposal) of RCRA hazardous wastes or radionuclides.
- ***NFA Criterion 2.*** Site design, conditions, or institutional controls prohibit release from the SWMUs that would pose a threat to human health or environment.
- ***NFA Criterion 3.*** The SWMU is part of a process operating under the Laboratory's current RCRA Part B permit, NPDES, or other applicable discharge permit.
- ***NFA Criterion 4.*** The SWMU has been characterized or remediated in accordance with current applicable state or federal regulations, and the available data indicate that contaminants of concem are either not present or are present in concentrations near background levels.

8.2 Underground Fuel Tank (SWMU 49-009)

On the basis of engineering drawings, the Laboratory SWMU report states that structure R-192 was an underground fuel storage tank. The SWMU report further states that the tank was relocated from TA-15 to TA-49 and renumbered as TA-49-56 some time between 1954 and 1963. The SWMU report references engineering drawing ENG-R5126 in stating that the tank was removed from TA-49 in 1971 but gives no further information regarding its size, construction, removal, or disposal.

Engineering Drawing R5110 (contained in Appendix B) documents the tank relocation noted in the SWMU report.

Further document searches and extensive interviews with former site employees have shown that this tank actually was a 1036-gal butane tank located above ground in Area 11. Laboratory records show that the tank was taken to the salvage yard in September 1971 and found to contain no significant levels of chemical or toxic contamination (Eller 1991, 03-0050).

The archival records and interviews also indicate strongly that no activities performed anywhere at TA-49 required on-site storage of fuels other than propane or butane for heating structures during the 1959 to 1961 period (Eller 1991, 03-0002; Penneman 1991a, 03-0043). Gasoline and diesel fuel were brought on-site as needed in tanker trucks to refuel vehicles and equipment.

On the basis of this additional information, no underground fuel tank is believed to have been present at any time at TA-49. By NFA Criterion 1 of Section 8.1, NFA is proposed for SWMU 49-009.

8.3 Septic Systems [SWMUs 49-007(a) and 49-007(b)]

Two septic systems, composing SWMUs 49-007(a) and (b), accommodate sanitary waste from structures in Area 6 and the HDT training area. Figures 3.1-2 and 8.3-1 show the locations of these septic systems. Engineering records and employee interviews indicate that the septic tanks were installed in 1985, and until May 1991 were used as holding tanks. During this period, contents of both septic tanks were pumped into septic truck collectors when necessary and disposed of off-site. In May 1991, evapotranspiration fields were completed and connected to the tanks. Discharge through the tanks and into the septic fields then commenced. Septic tank reports [Pan Am World Services, Inc., 1990, 0693; HSE-8 1989, 0752; Eller 1991, 03-0051] and engineering construction drawings (see Appendix B) provide siting and construction details.

SWMU 49-007(a) consists of the area immediately around the septic tank in Area 6. This tank is designated as structure TA-49-115, NMEID Registration Number LA-50. The tank has a volume of 1000 gal and is 8 ft long and 4 ft wide by 4 ft deep. The tank serves Building TA-49-115 (referred to as the Day Room, or the Antenna Test Facility), which currently is used by Laboratory Group AT-9.

SWMU 49-007(b) consists of the area immediately around the septic tank that serves building TA-49-113 and associated structures, which currently are used by the Laboratory's Hazardous Devices Team. This tank is designated as

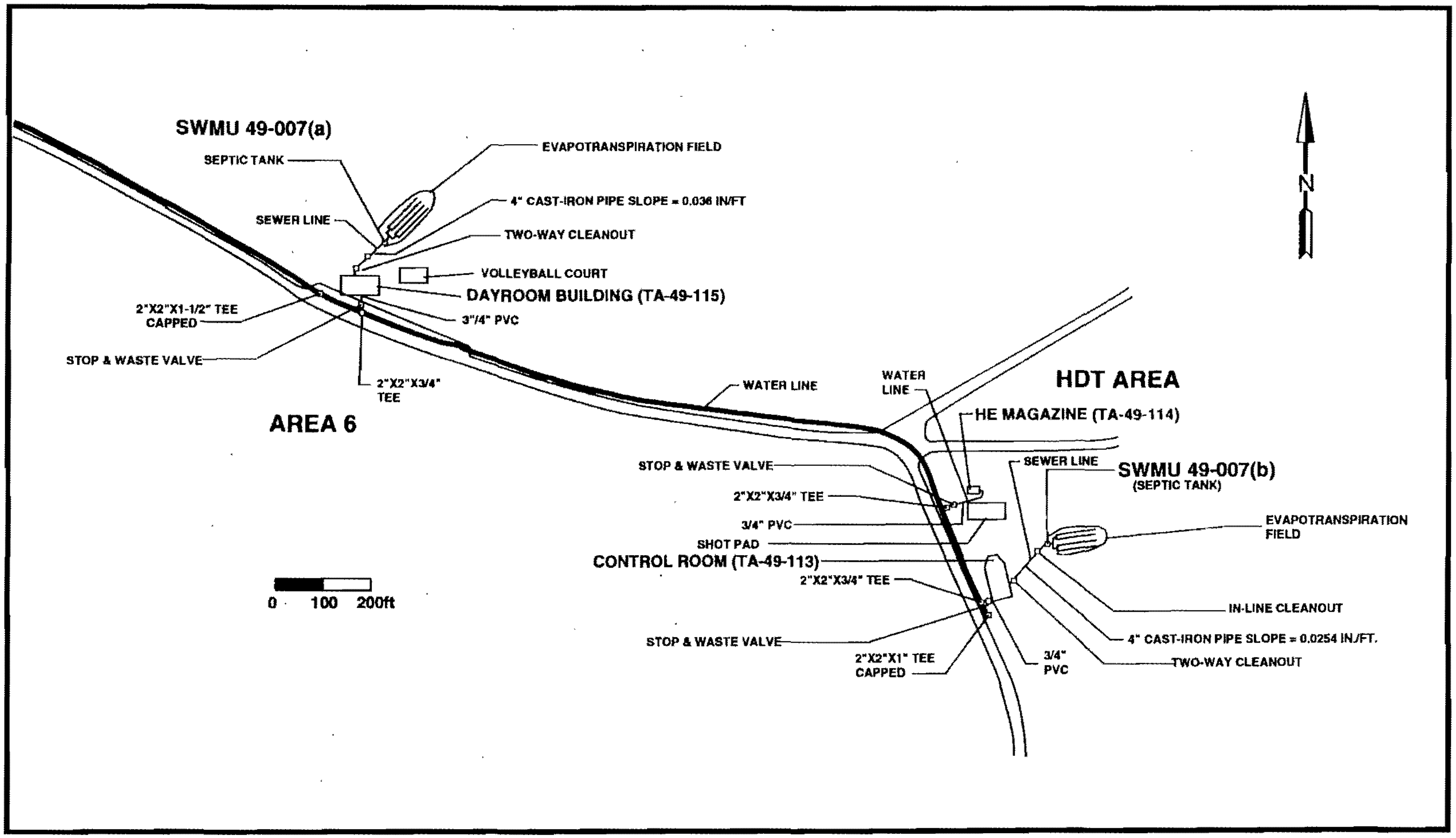


FIGURE 8.3-1 Site map showing the location of TA-49 Septic Systems [(SWMUs 49-007 (a) and (b)]. Additional details are contained in engineering drawing ENG-C 44775 .

structure TA-49-119, NMEID Registration Number LA-49. The tank has a capacity of 1500 gal and is 9.5 ft long by 4.5 ft wide by 4.5 ft deep.

The Laboratory SWMU report (LANL 1990, 0145) states that both septic tanks serve a single building. Based on field inspection and analysis of engineering drawings, this report is in error. Two (and only two) physically unconnected and geographically well separated septic systems exist (or ever have existed) at TA-49.

Environmental monitoring apparently has not been performed in the immediate vicinities of the TA-49 septic tanks. However, the possibility is very low that contaminants of concern are associated with these recently installed units. With the exception of small quantities of explosives that are detonated occasionally for training purposes at the HDT facility and the detonation of small quantities of shock-sensitive chemicals on a limited basis in adjacent areas (see Section 8.9 of this chapter) there is no evidence that hazardous or radioactive materials were ever associated with these septic systems. More specifically, there is no evidence that such materials were ever discharged into the TA-49 septic tanks nor that tank overflow or leakage has occurred. Consequently, it is very unlikely that the septic systems are release sites. Therefore, by Criteria 1–3 listed in Section 8.1, NFA is proposed.

8.4 HE Storage Area

Aerial photographs of TA-49 taken in 1965 and 1977 show two leveled and devegetated areas of approximately 100 by 100 ft located on the north side of the road opposite test well DT-10 about 2000 ft east of MDA AB (see Figures 3.1-1 and 8.4-1). A small structure appears in the photographs. The cleared areas do not appear in 1954 aerial photographs and are not mentioned in any available documents. Because of the unusual and isolated location and lack of previous documentation, the origin and use of the cleared areas were investigated further.

The site engineer responsible for this area during the 1959 to 1961 hydronuclear program has stated that the aforementioned areas were used for storage of dynamite and blasting caps solely during this time period (Eller 1991, 03-0004). He further stated that radioactive or hazardous materials (other than HEs) were never used in this area, that all unused material was removed, and that no spills occurred. The two storage structures were identical and consisted of 8- by 8-ft sheds covering 8-ft-diameter holes dug 4 ft deep in the soil. The structure that appears in the 1965 and 1977 photographs probably was removed during the TA-49 cleanup campaign in 1984.

Field inspection in 1991 showed no evidence of artificial surface debris at the cleared areas (Eller 1991, 03-0004).

Field sampling apparently has never been conducted at the site of the former HE storage area, but historical information indicates that the likelihood is very low that contamination above action levels presently exists at this site. HE residuals at a depth of about 4 ft are the only credible contaminants, and these should have degraded substantially by natural processes in the three

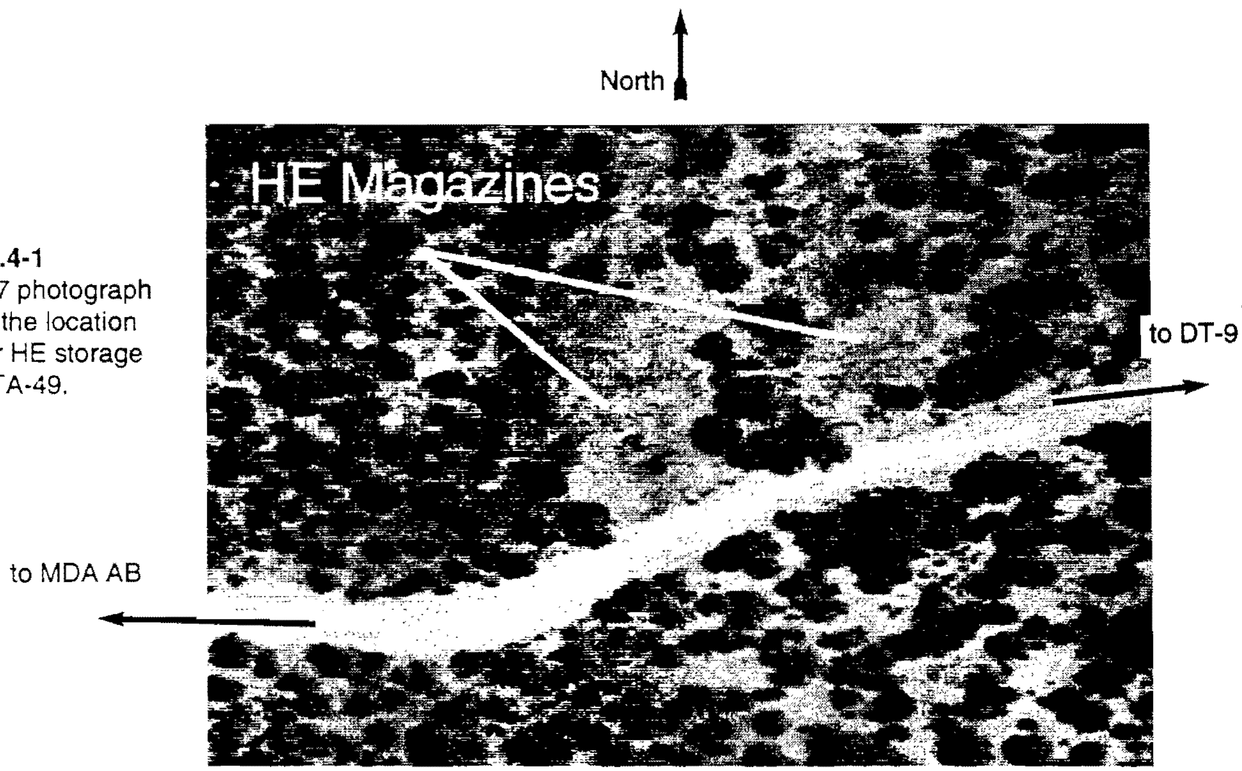


Figure 8.4-1
July 1977 photograph showing the location of former HE storage units at TA-49.

decades since the area was used (Dubois and Baytos 1991, 0718). Therefore, by criteria 2 and 4 listed in Section 8.1, NFA is proposed for the former HE storage area.

8.5 Borrow Pits Along State Road 4

Aerial photographs that cover the period 1954 to 1991 show disturbed areas distributed along both sides of State Road 4 along the southern boundary of TA-49 (Figures 3.1-1 and 8.5-1). These features are not present in 1935 aerial photographs, and photographs for the intervening period are not available.

Field inspection during the summer of 1991 showed these features to be open pits. Several of the pits have exposed bedrock marked by tracks from the heavy vehicles apparently used for the excavation (Eller 1991, 03-0004). Several of the pits contain small amounts of common trash, but evidence of hazardous or radioactive waste or significant burial of debris is not apparent.

The pits appear to be borrow pits of the type used regionally for road construction in the 1950s and earlier. The pits appear relatively fresh in the 1954 photographs, which is the proper timing for their creation and use during the realignment and paving of this portion of State Road 4 during the early 1950s. However, search of Laboratory, Los Alamos County, and State of New Mexico Engineering Records has not produced documentation of this supposition (Eller 1991, 03-0004). Interviews of many former Laboratory employees has given no evidence that the area south of the State Road 4 boundary of the Laboratory ever was used for Laboratory operations.

The likelihood is high that the pits are borrow pits associated with road construction and that hazardous or radioactive materials are not present. Thus, by criterion 1 listed in Section 8.1, NFA is proposed.

8.6 Other Disturbed Areas At TA-49

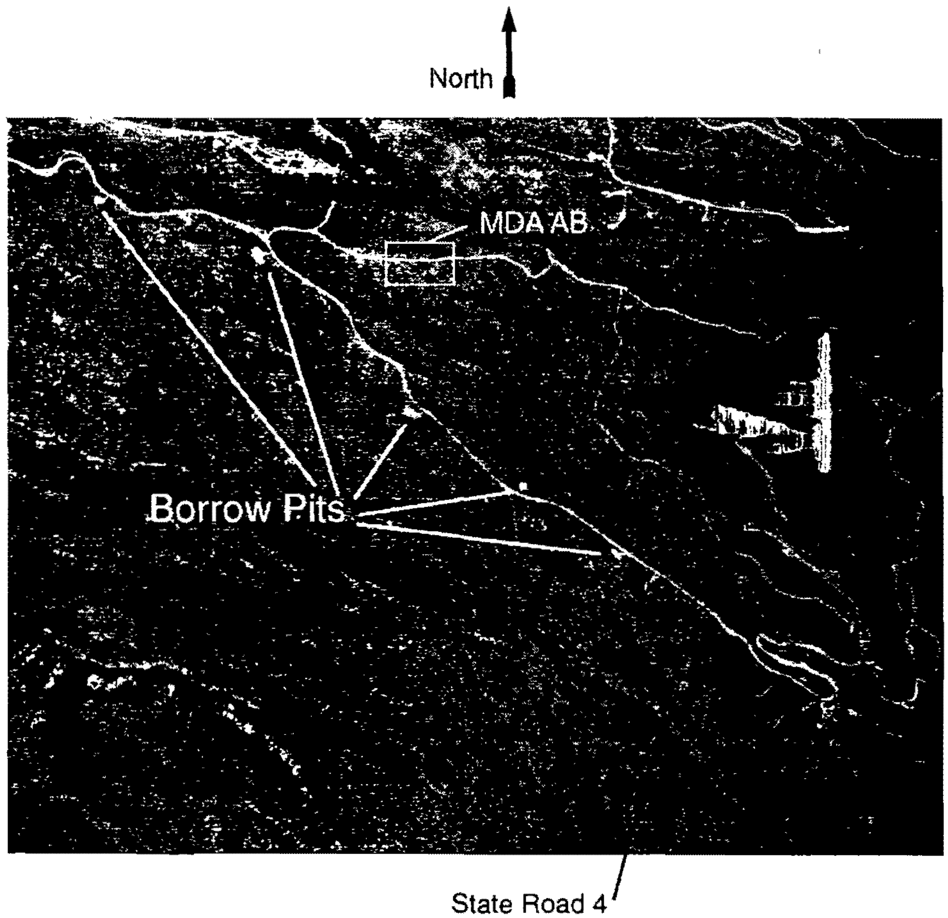
Aerial photographs taken after 1954 and a field inspection during the summer of 1991 indicate a number of areas at TA-49 that show obvious soil disturbance. Extensive site-employee interviews, archival search, and examination of aerial and ground-level photographs from the period 1959 to 1965 have shown that essentially all of this soil disturbance occurred during the hydronuclear experiments from late 1959 to mid-1961. Apparently, the soil disturbance was associated with routine site construction activities that did not involve radioactive or hazardous materials or any type of disposal (except as noted elsewhere in this work plan). The location and probable use of these areas, as reconstructed from the information discussed above, are shown in Figure 8.6-1.

The likelihood is high that the disturbed areas are of no environmental concern and therefore, by Criterion 1 listed in Section 8.1, NFA is proposed.

8.7 PCBs In Road Oil

Former TA-49 employees were asked whether PCB-contaminated road oil could have been used at TA-49 for dust control. The Zia Site Engineer for

Figure 8.5-1
May 1954 aerial photo showing the locations of possible borrow pits along State Road 4.



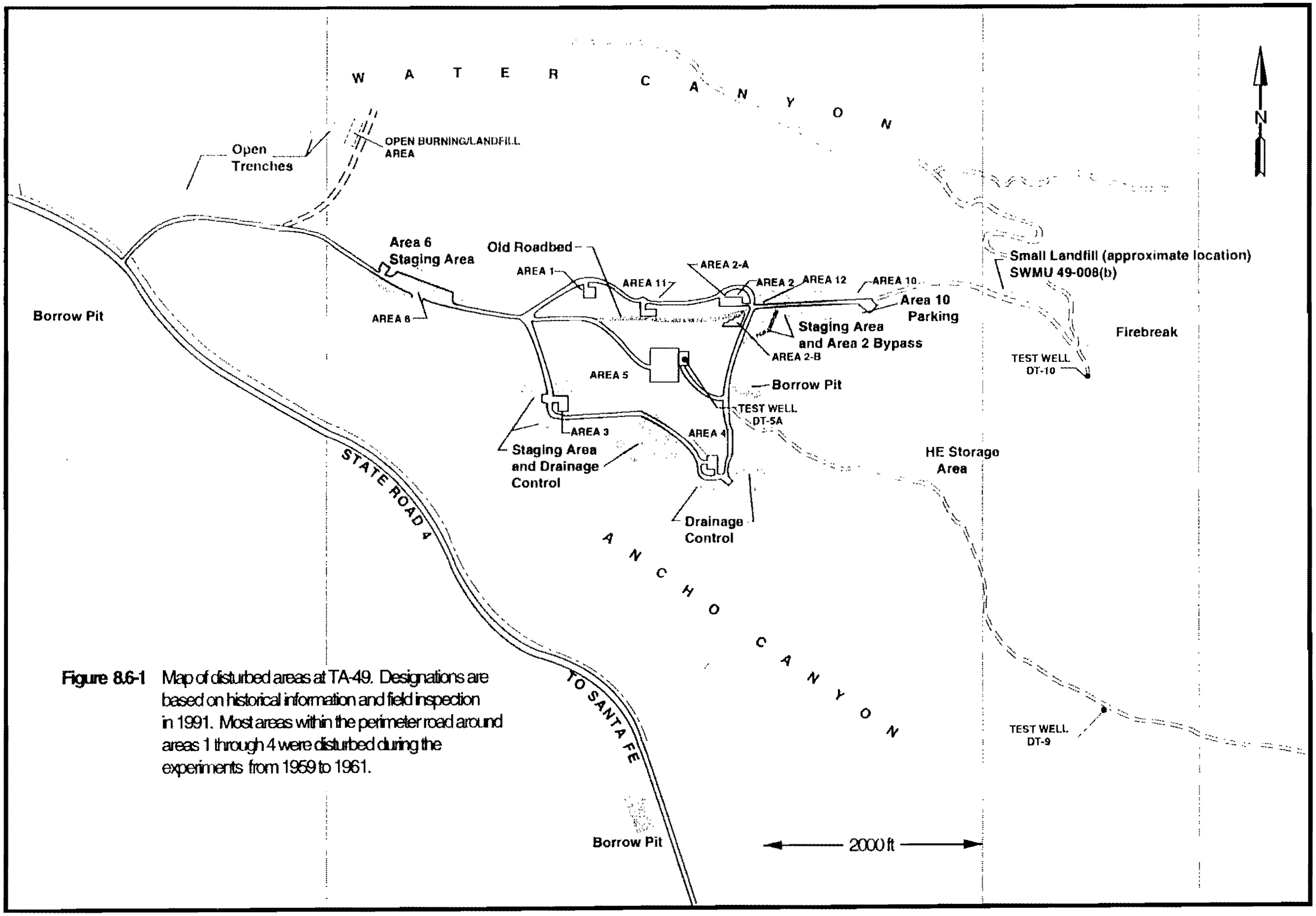


Figure 8.6-1 Map of disturbed areas at TA-49. Designations are based on historical information and field inspection in 1991. Most areas within the perimeter road around areas 1 through 4 were disturbed during the experiments from 1959 to 1961.

TA-49 during the hydronuclear and related experiments stated that such use would have been permitted only on a limited basis around MDA AB and that unused (uncontaminated) road oil would have been used for this purpose (Eller 1991, 03-0004). This statement is supported by the fact that PCBs were not detected in the 1989 sampling of the 12 run-off stations around MDA AB (ESG 1990, 0497). The likelihood of PCB contamination from road oil is therefore insignificant and by Criterion 1 of Section 8.1, NFA is proposed.

8.8 Firing Site Shrapnel

MDA AB and essentially all of the northernmost portion of TA-49 currently lie within the hazard circle (theoretical shrapnel-impact zone) of the TA-15 Phermex firing site (see the hazard radius diagram in Appendix B). In the past, portions of TA-49 also lay within the impact zones of other firing sites at TAs 15 and 39. Field inspection and extensive site-employee interviews have provided no documented evidence that shrapnel has ever impacted Frijoles Mesa. The group leader currently responsible for TA-15 firing sites has stated that during the past 20 yr, no HE shots capable of projecting debris onto TA-49 have been conducted and that the likelihood is very small that fragments of metal were projected onto TA-49 even during larger shots in the 1950s and 1960s (Penneman 1991b, 03-0048).

The possibility that small amounts of uranium-238 shrapnel have impacted TA-49 from adjacent firing sites is very small but cannot be excluded categorically. If impact has occurred, the shrapnel would be exceedingly difficult to locate and the likelihood is very small that levels of uranium exceeding action levels currently exist over significant areas. Therefore, by Criteria 1 and 2 of Section 8.1, NFA is proposed.

8.9 HDT Firing Pit

The Hazardous Devices Team (HDT) occasionally uses a firing pit in the HDT area for training with common high explosives (see Figure EXEC-3). Figure 3.1-2 (b) shows a recent view over this area.

In 1989, the firing pit was used on a limited emergency basis for the detonation of small quantities (less than 1 kg) of unstable, reactive chemicals collected elsewhere at the Laboratory (McInroy 1991, 03-0009). This emergency activity, as well as the use of common explosives, is allowable under RCRA regulations.

Gross alpha and gross gamma analysis of 15 soil samples collected in 1990 from locations distributed around the HDT area showed only background radionuclide levels.

The HE training activities and the one-time small-scale chemical detonations are not is expected to have generated contamination above action levels, and no other hazardous or radioactive materials are believed to have been used in this area at any time. By NFA Criterion 1 listed in Section 8.1, NFA is proposed

Chapter 8 References

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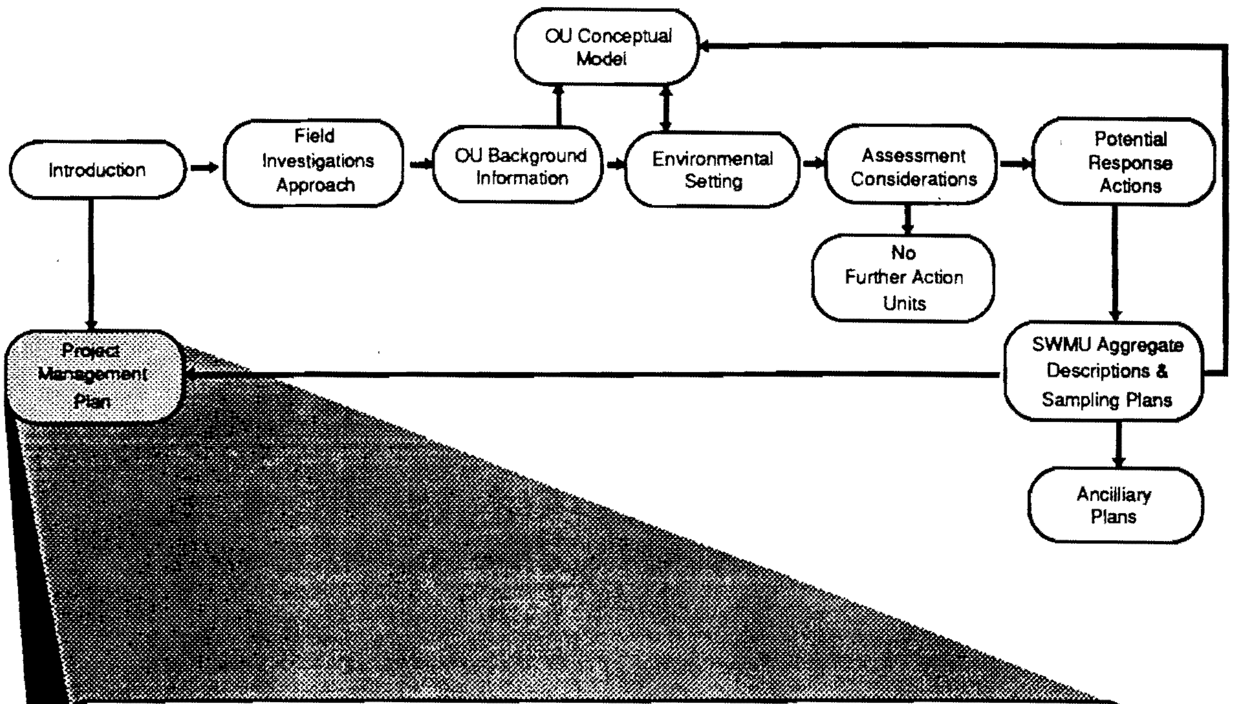
Annex I



Project Management Plan

- •Technical Approach
- •Schedule
- •Reporting
- •Budget
- •TA-49 OU Organization & Responsibilty

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PROJECT MANAGEMENT PLAN

This annex addresses the project management plan requirements of the HSWA Module (Task II, E., p. 39) of the Laboratory's RCRA Part B Permit (EPA 1990, 0306) and presents the technical approach, management structure, schedule, budget, and reporting milestones for implementation of the TA-49 OU RFI as set forth in this work plan. The project management plan for the TA-49 OU RFI is an extension of the ER Program project management plan given in Annex I of the Installation Work Plan (IWP) (LANL 1991, 0553) and contains no significant departures from the IWP guidelines.

Figure EXEC-3 of the Executive Summary and Appendix A contain site diagrams and SWMU lists for the TA-49 OU. Attachment A contains a list of LANL ER Standard Operating Procedures referenced in this OU work plan.

I.1 Technical Approach

The approach used for the TA-49 OU is based on the ER Program's overall technical approach to the RFI/CMS process as described in Chapter 3 of the IWP (LANL 1991, 0553). The following key features characterize the ER Program approach:

- use of action levels as criteria to trigger a corrective measures study (CMS);
- phased sampling approach to site characterization;
- decision and cost effectiveness analysis to support the selection of remedial alternatives; and
- the application of the "observational" or "streamlined" approach to the RCRA Facility Investigation (RFI)/CMS process as a general philosophical framework.

The technical approach employed for the TA-49 OU RFI is described in Chapters 2 and 5 of this OU work plan. Figure I.1-1 contains a logic diagram for the TA-49 RFI. The general philosophy is to develop and iteratively refine the TA-49 OU conceptual model through carefully planned stages of investigation and data interpretation. The data gathered and subsequent interpretation will be used to define the nature and extent of contamination, and the likelihood for waste migration, at the TA-49 OU. An objective is to support decisions on interim corrective measures or a corrective measures study using the minimum data necessary.

The technical objectives of the TA-49 OU RFI, as presented in Chapters 5-7 of this OU work plan, are as follows:

- identify contaminants present at each SWMU;
- determine the vertical and lateral extent of the contamination at each SWMU;

- identify contaminant migration pathways;
- acquire sufficient information to allow quantitative migration pathway modeling and risk assessment;
- provide data necessary for the assessment of potential remedial alternatives; and
- provide the basis for detailed planning of corrective measures studies (CMS)

I.1.1 Technical Implementation Rationale

As summarized in this section, several relatively independent investigation paths comprise the schedule logic and the investigation rationale for the TA-49 OU RFI, listed as follows:

- SWMUs in areas other than Materials Disposal Area AB (MDA AB) or Area 11
- Area 11
- MDA AB
- Baseline characterization (away from SWMU areas)
- Borehole monitoring

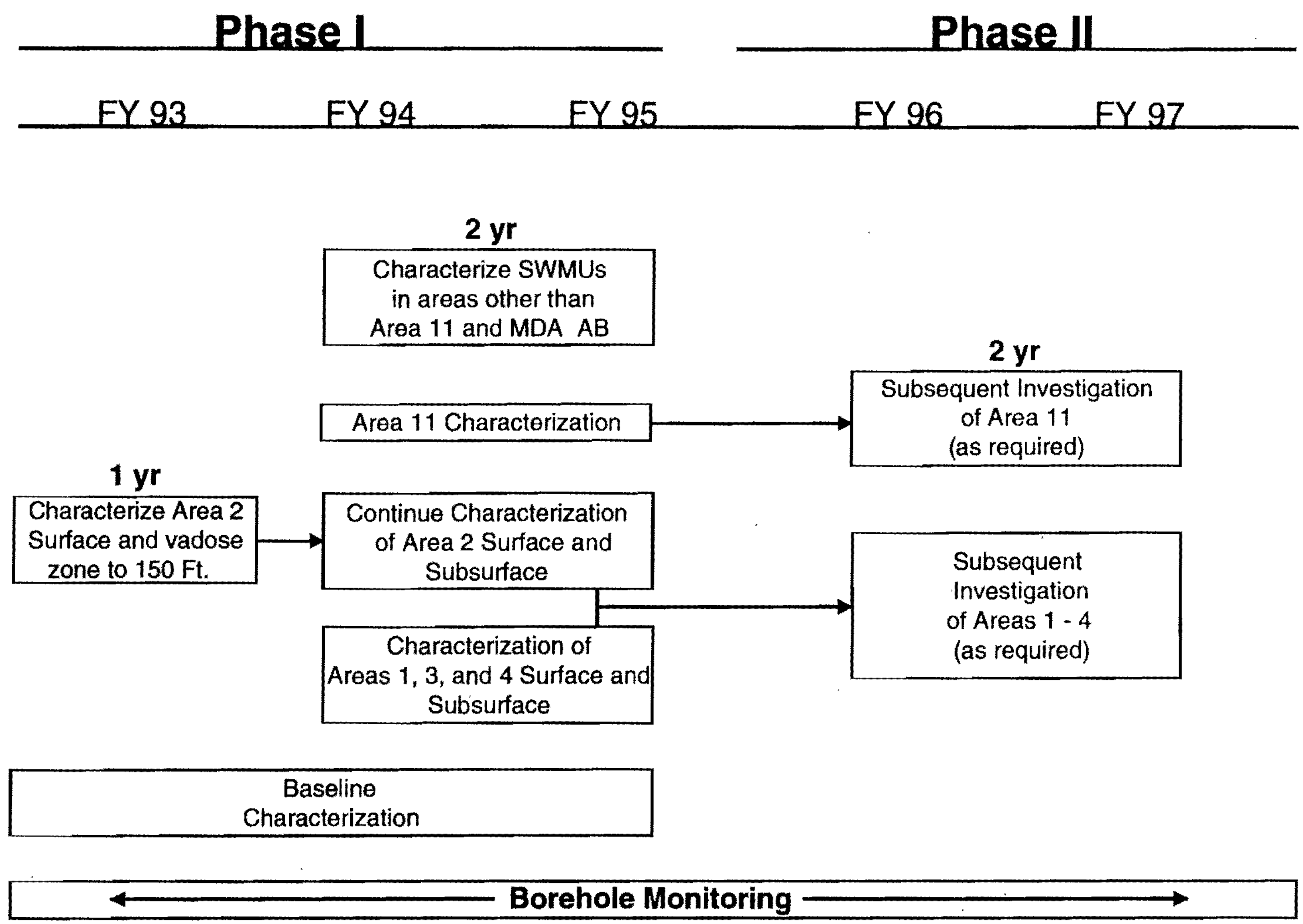
Investigations of SWMUs in areas other than MDA AB and Area 11

Investigations of SWMUs located in areas other than MDA AB and Area 11 are described in Sections 6.3-6.6 of this OU work plan. The characterization studies are designed primarily to determine whether contaminants exist above levels of concern in these areas. Only a single phase of investigation requiring about one year of field work to complete (within the three-year window of Phase I) is expected to be required for these areas. The RFI is expected to lead to recommendations of minimal remedial action or *no further action* (NFA) for these SWMUs, because the lack of significant contamination at these SWMUs is likely to have been demonstrated.

Area 11 Investigations

Phase I and II investigations of Area 11 are described in Section 6.2 of this OU work plan. These investigations primarily are designed to delimit the contaminated surface area and subsurface volume known to exist in Area 11. Limited characterization of transport-related properties of Area 11 soils also is proposed. Approximately one year of field work (within the three-year window) is expected to be required for Phase I investigations of Area 11. Contingent upon the results of Phase I, Phase II investigation could be required which may or may or not suggest a subsequent CMS.

Figure I.1-1 Logic flow of the TA-49 RFI.



MDA AB Investigations

Phase I and II investigations of MDA AB are described in Chapter 7 of this OU work plan and primarily involve the following elements:

- characterization of the nature and extent of surface and near-surface contamination;
- characterization of subsurface structure, hydrology, and other site geotechnical;
- characteristics which relate to modeling of the transport of deeply buried contaminants in the hydronuclear shafts; and
- specific studies to clarify the origin and significance of water in Core Hole 2.

Phase I investigations of MDA AB will require the full three-year period planned for the initial investigative phase. It is probable that Phase II investigations will be required for MDA AB, which could indicate the necessity for a CMS.

Baseline Characterization (away from SWMU areas)

In Section 6.1 of this OU work plan, limited Phase I baseline characterization is proposed which consists of the following elements:

- analysis of a small number of soil and sediment samples well away from known TA-49 SWMUs to define site background levels and to confirm that contaminants have not migrated to the perimeter of the operable unit.
- surface geologic characterization of site stratigraphy, structure, drainage, and erosional characteristics
- development of a hydrogeologic base map addressing stratigraphic sections, geomorphology, hydrology, and joint/fracture information.

This work will be conducted at various levels of intensity over the three-year period of Phase I investigations. It is not anticipated that additional baseline investigations will be required in Phase II.

Borehole Monitoring

The annual sampling of the existing deep test wells DT-5A, DT-9, and DT-10 will be continued indefinitely. Neutron moisture measurements will be carried out on a quarterly basis Phase I in boreholes as specified in Chapter 7 of this OU work plan. Water levels in Core Holes 1-2 of MDA AB will be measured continuously during Phase I.

I.1.2 Priorities

The management priorities for the TA-49 RFI are as follows:

- MDA AB contains by far the largest inventory of contaminants at TA-49 and is the most likely area to require a second phase of investigation, and possibly a CMS. Long-term surveillance is virtually certain to be required. Therefore, the primary focus of the TA-49 RFI/CMS is on MDA AB and work at this area should receive preferential scheduling and funding.
- Characterization of the source of water in Core Hole 2 should receive the highest priority in the investigation of MDA AB.
- Area 11 is the only other area of TA-49 which is likely to contain contaminants above levels of concern. Therefore, the investigation of Area 11 is second in priority only to that of MDA AB.
- SWMUs other than MDA AB and Area 11 are of lower priority because it is expected that the RFI will confirm that significant levels of contamination do not exist in these areas.
- Except for groundwater monitoring as mentioned above, the proposed baseline characterization can be carried out at any time during Phase I.

I.2 Schedule

General schedule requirements for the Laboratory's ER program are described in Annex I (Program Management Plan) of the IWP. Appendix S of the IWP contains a projected RFI/CMS schedule for the RFI/CMS process for the TA-49 OU, through the completion of the final CMS report. A revised version of this schedule was completed recently as Activity Data Sheet (ADS) 1144 and was submitted on February 22, 1992 for incorporation in the DOE Environmental Restoration and Waste Management Five-Year Plan. This plan is a key budget planning document for the DOE-wide ER program. The projected RFI/CMS schedule, milestone schedule, and baseline (unconstrained) budget summary submitted recently to DOE for the TA-49 RFI (ADS 1144) are provided in Tables EXEC-5 and I.1-1 and in Figures EXEC-3 and I.1-1 of this OU work plan. Attachment B of this annex contains a detailed projected schedule for the TA-49 RFI/CMS, based on the unconstrained Five-Year Plan budget/schedule.

Implementation of RFI activities is contingent upon regulatory review and approval of the TA-49 OU Work Plan and upon the availability of funding. If the detailed costing of this OU work plan exceeds the planned budget, budgetary resolution will have to be accomplished either by a petition to DOE for additional funding through a change-control procedure or by extension of the RFI schedule. Schedules and costs will be updated through the DOE change control process as appropriate, with revisions submitted to EPA for approval.

The assumptions used to generate this schedule include the following.

- Review and approval of the TA-49 OU RFI work plan and supporting project plans by regulatory agencies will be completed by August, 1992.
- Certain tasks (e.g., baseline and Area 2 characterization) may be initiated before regulatory agencies grant final approval of the work plan.
- The schedule assumes that an adequate number of support personnel (e.g., health and safety technicians and trained drilling contractors) will be available.
- EPA approval of technical memoranda/work plan modifications (including EPA comments, Laboratory revision, and final EPA approval) is assumed to take two months, of which one month is allowed for EPA review and comment, and one month for revisions.
- Phase II investigations are expected to be required only at MDA AB and Area 11.
- The Phase I work scheduled in the first investigation year (1993) is constrained by the current planned DOE budget.
- Where possible, extensive field work will not be scheduled between November 15 and March 15 each year, to allow for inclement weather.

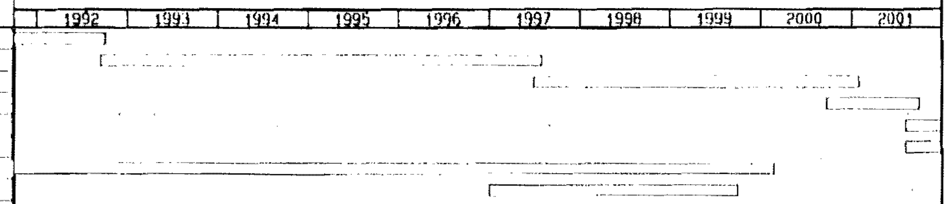
I.3 Reporting

Results of RFI field work will be presented in three principal documents: quarterly technical progress reports, technical memoranda/work plan modifications, and the RFI Report. The purpose of these reports is detailed in the following discussion. A schedule of future documents, associated with implementation of this OU work plan, which are deliverable to EPA and DOE, is summarized in the following list.

Document	EPA	DOE	Date Due
Monthly	X	X	25th of the following month
Quarterly	X		Feb. 15, May 15, & Aug. 15
Annual	X	X	Nov. 15
Phase Reports	X	X	as in baseline; DOE milestones

TABLE I.1-1

WBS4	LANL WBS 4	ORIG DUR	EARLY START	EARLY FINISH
1	ASSESSMENT - RFI WORK PLAN	250	1OCT91	30SEP92
2	ASSESSMENT - RFI	1213	14SEP92	29JUL97
3	ASSESSMENT - RFI REPORT	889	1JUL97	29JAN01
4	ASSESSMENT - CMS PLAN	254	22SEP00	28SEP01
5	ASSESSMENT - CMS	245	7AUG01	31JUL02
6	ASSESSMENT - CMS REPORT	383	7AUG01	24FEB03
7	ASSESSMENT - ADS MANAGEMENT	2087	1OCT91	23FEB00
8	ASSESSMENT - VCA	687	2JAN97	30SEP99



	1992	1993	1994	1995	1996	1997	1998
FIVE YEAR PLAN BASELINE BUDGET	600	998	834	868	1,238	1,202	422

Scheduling and budgeting summary of the RFI/CMS for the TA-49 OU (ADS 1144). Data are based on the budget/schedule information submitted on 22 February 1992 for the DOE ER/WM Five Year Plan baseline.

Plot Date	7MAY92
Data Date	1OCT91
Project Start	1OCT91
Project Finish	24FEB03

(c) Primavera Systems, Inc.

Summary Bar/Early Dates
Critical Designator
Progress Bar
Milestone/Flag Activity

Sheet 1 of 1

LANL EM-8 ELLER
ADS 1144: TA-49 BASELINE
BAR CHART - SUMMARY

ENVIRONMENTAL RESTORATION

Date	Revision	Checked	Approved

I.3.1 Quarterly Technical Progress Reports

As the TA-49 OU RFI is implemented, technical progress will be summarized in quarterly technical progress reports, as required by the HSWA module of the Laboratory's RCRA Part B operating permit (Task V, C, page 46). Detailed technical assessments will be provided in technical memoranda/work plan modifications.

I.3.2 Technical Memoranda/Work Plan Modifications

Technical memoranda/work plan modifications will be submitted for work conducted on TA-49 SWMUs. These documents will function as interim reports on portions of the RFI effort because of the multi-year time frame which will be required for completion of RFI field work. In other words, these technical memoranda will serve as partial RFI Phase I reports summarizing the results of initial site characterization activities and as partial RFI Phase II work plans describing the follow-on activities being planned (including any modifications to field sampling plans suggested by initial findings).

I.3.3 RFI Report

The RFI report for the TA-49 OU will summarize all field work conducted during the RFI. As required by the HSWA module of the Laboratory's RCRA Part B operating permit, the Laboratory will submit an RFI report within 60 days of completion of the RFI. As stated in Chapter 3 of the IWP (LANL 1991, 0553), the RFI Report will describe the procedures, methods, and results of field investigations and will include information on the type and extent of contamination, sources and migration pathways, and actual and potential receptors. The report also will contain adequate information to support delisting of sites that require no further corrective action.

I.4 Budget

The schedule presented above is based on a constrained budget for the first years of the RFI and preliminary cost analysis which is subject to significant uncertainties. The projected budget in fiscal year 1993 (FY 93) is based on expected DOE funding levels and is subject to change depending upon funding allocations actually made. A change control petition to DOE is required to augment these funding levels. Because DOE funding requests are set two years in advance, the first year in which the TA-49 OU RFI is not constrained by previous budget estimates will be FY 94. Funding requests for FY 94 and beyond will reflect the cost and schedule that most efficiently complete the RFI plans.

As pointed out above, the RFI costing is being refined and is subject to considerable uncertainties at the present time. In particular, uncertainties regarding the cost of drilling through potentially contaminated areas could impact RFI costs substantially (and thus potentially affect the RFI schedule).

I.5 TA-49 OU Organization and Responsibility

The organizational structure for the ER Program is presented in Chapter 2 of the generic LANL ER Program Quality Program Plan and Quality Assurance Project Plan (QPP/QAPjP). ER Program lines of authority and responsibilities are identified in that document and in Figures I.5-1 and I.5-2 of this annex.

Records of qualifications and training of all field personnel working on the RFI for the TA-49 OU will be kept as ER Records [see Annex IV of the IWP, Records Management Plan]. Technical Contributors to the TA-49 work plan are listed in Appendix H of this OU work plan.

The responsibilities of the positions identified in Figures I.5-1 and I.5-2 are summarized in the following subsections.

I.5.1 OU Project Leader

Responsibilities of the TA-49 OU Project Leader are as follows:

- oversees day-to-day RFI operations, including planning, scheduling, and reporting of technical and administrative activities;
- ensures preparation of scientific investigation planning documents and procedures;
- prepares monthly and quarterly reports for the Project Manager (PM);
- oversees subcontractors, as appropriate;
- coordinates with technical team leaders
- conducts technical reviews of the milestones and final reports;
- interfaces with the ER Quality Program Project Leader (QPPL) to resolve quality concerns and to coordinate with the QA staff for audits;
- complies with the LANL ER Program Health and Safety (H&S), records management, and community relations requirements;
- oversees RFI field work and manages the field teams manager; and
- complies with the Laboratory's technical and QA requirements for the LANL ER Program.

I.5-2 Technical Team Members

Technical team members are responsible for providing technical input for their discipline throughout the RFI/CMS process. Technical team members have participated in the development of the TA-49 OU work plan and the individual field sampling plans and will continue to participate in the field work, data analysis, report preparation, work plan modifications, and planning of subsequent investigations as necessary.

The primary disciplines currently represented on the TA-49 OU technical team are chemistry, geology hydrology, geochemistry, statistics, biology, archeology, and health physics. The composition of the technical team may change with time as the technical expertise needed to implement the TA-49 OU RFI changes.

I.5-3 Field Teams Manager

Responsibilities of the TA-49 OU Field Teams Manager include the following:

- conducts detailed planning and scheduling for the implementation of the RFI field activities outlined in Chapters 6 and 7;
- oversees day-to-day field operations; and
- manages field team activities.

1.5-4 Field Team Leader(s)

The Field Teams Manager will assign field work to Field Team Leaders for implementation in the field. Each Field Team Leader will direct the execution of field sampling activities, using crews of field team members as appropriate for the activity. Field Team Leaders may be Laboratory or contractor personnel.

1.5-5 Field Team Member(s)

Field Team Members may include the following, as appropriate:

- sampling personnel,
- site safety officer,
- geologists,
- hydrologists,
- health physicists, and
- other applicable disciplines.

All teams will have, at a minimum, a site safety officer and a qualified field sampler. They are responsible for conducting the work detailed in field sampling plans, under the direction of the field team leader. Field team members may be Laboratory or contractor personnel.

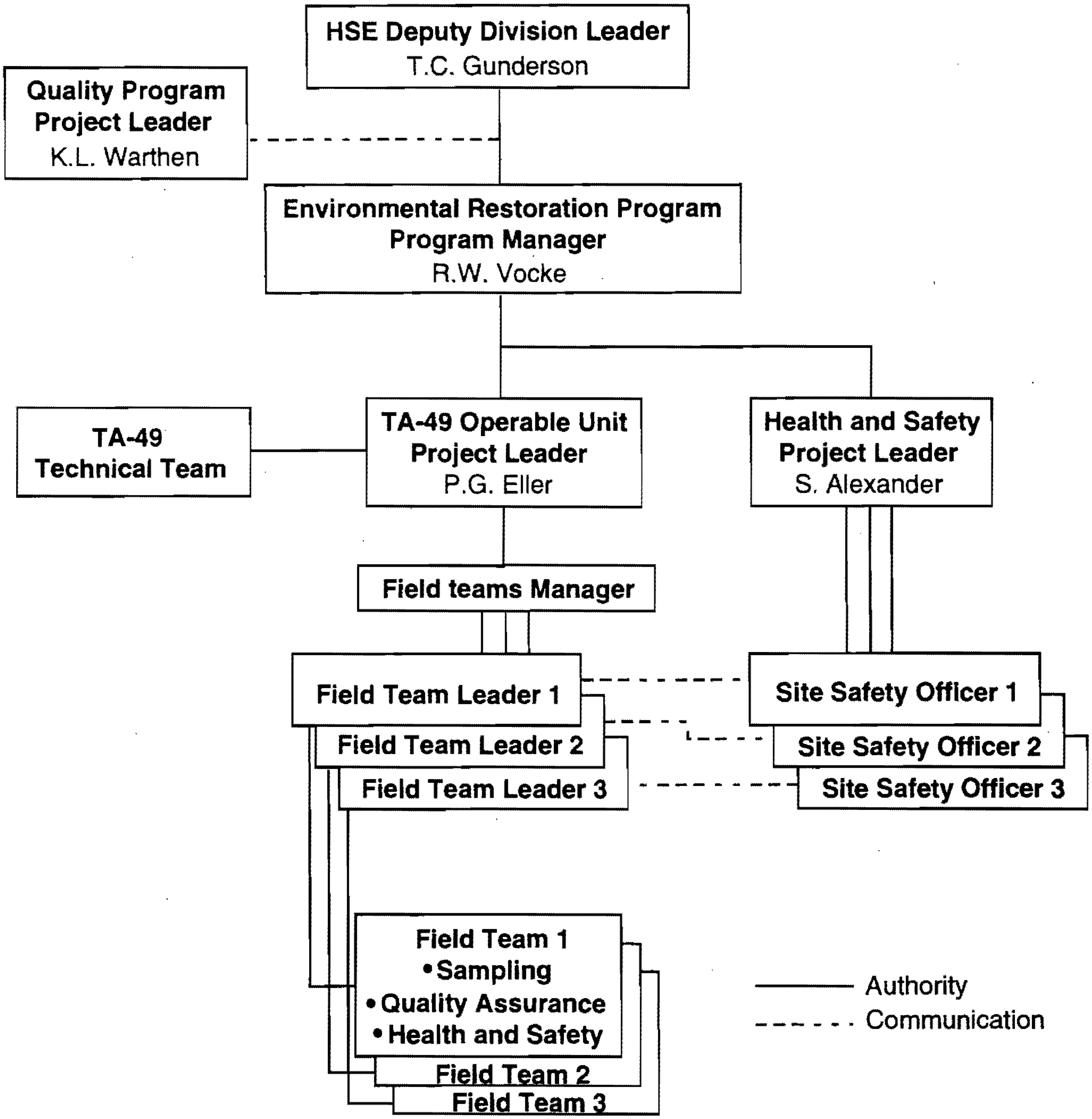
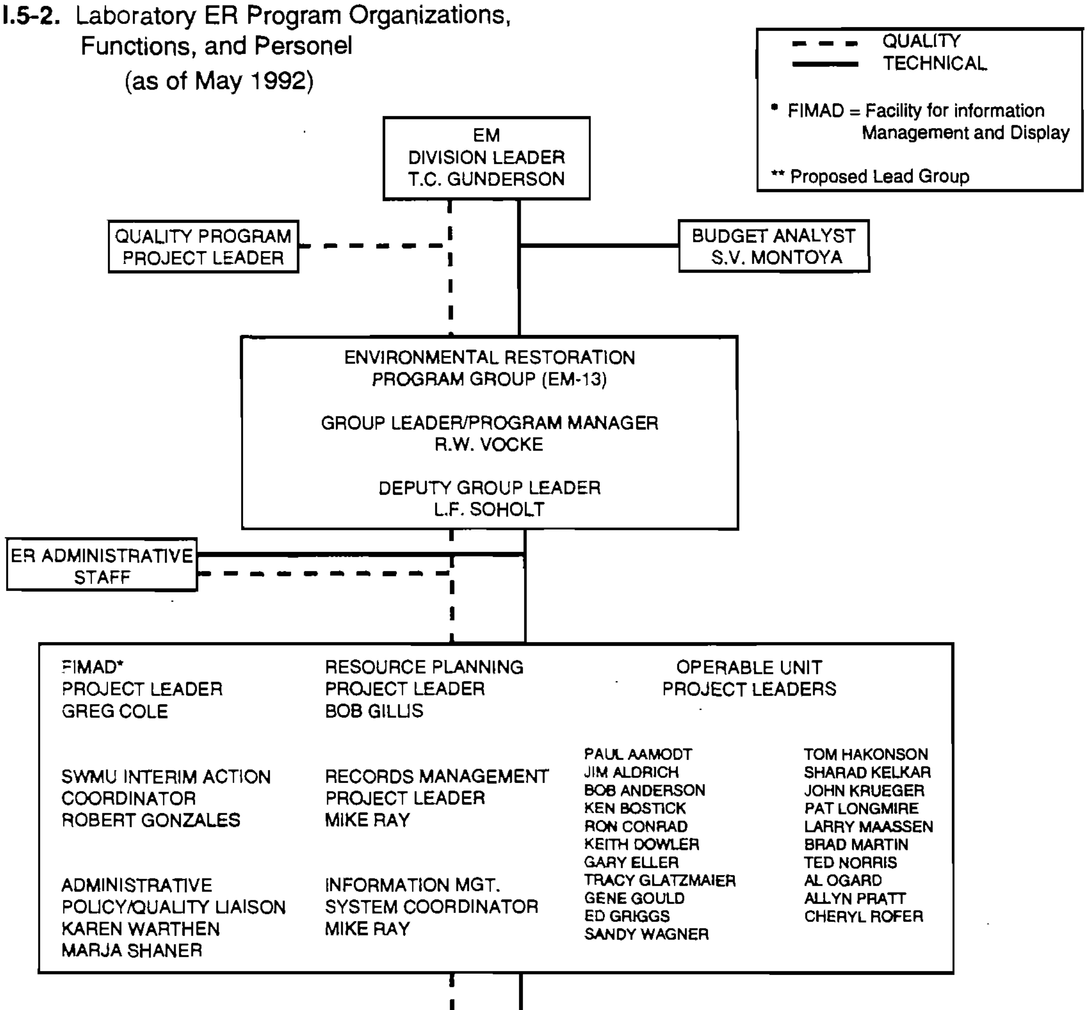


Figure I. 5-1 TA-49 Operable Unit field work organization chart showing lines of authority and responsibility

Figure I.5-2. Laboratory ER Program Organizations, Functions, and Personel (as of May 1992)



TECHNICAL TEAMS	GROUPS/DIVISIONS	TECHNICAL TEAM LEADER	QA REPRESENTATIVE	ER PROGRAM OFFICE TECHNICAL TEAM COORDINATOR
Air Quality	EM-8**, EES-5	Craig Eberhart	Soholt	Soholt
Analytical Chemistry/Sample Coordination	EM-9**, CLS, INC	John Miglio	Miglio (actg.)	Wagner
Analytical Chemistry Instrumentation Dev.	EM-9**, A, CLS, EES, ENG, INC, M, N, NMT, AET	Harry Ettinger	Ettinger	Wagner
Community Relations	PA-3**, PA-1	*To be determined*	*To be determined*	To be determined
Corrective Action Imp. (Remediation)	ENG**, EM-7	Bill Foley	Soholt	Soholt
Decision Anaysis/Cost Benefit	EM-13**, A-1, -4	Elizabeth Kelly	Campbell	To be determined
Document Preparation	IS-11, -9, -12	Betsy Barnett	Barnett	Soholt
Drilling, Logging, and Curation	EES**, EM	Sue Goff	Aamodt	Aamodt
Engineering	ENG**, MEE	Larry Byars	Aamodt	Aamodt
Environmental Assessment	EM-8**, EES-2	Doris Garvey	Garvey	Aamodt
*FIMAD**	EES	Greg Cole	Cole	Ray
Framework Studies	EES**, EM, INC	Jamie Gardner	Gardner	To be determined
Geochemistry	INC**, CLS, EES	Clarence Duffy	Morgan	Wagner
Geology	EES	Bill Laughlin	Laughlin	Maassen
Health & Safety	EM-13**, HS-1, -2, -3, -5, EM-8	Susan Alexander	Alexander	Alexander
Hydrology	EM-8, EES	Bruce Gallaher	Gallaher	To be determined
Interim Remedial Measures	EM-8, EM-13	Philip Fresquez	Fresquez	To be determined
Mixed Waste/Stroage Disposable Facility	MEE**, ENG, EM-7	Dean Nelson	Nelson	Aamodt
Planning/Cost Estimating/Scheduling/Rptg.	EM-13**, MEE, contract support	Bob Gillis	Nelson	Aamodt
Quality Assurance	EM-13, QOO, LAAO	Karen Foster	Foster	Foster
Records Management	EM-13	Mike Ray	Ray	Ray
Regulatory Compliance	EM-8	Dave McInroy	McInroy	Krueger
Risk Assessment	EM, EES, A, UCLA	Ted Norris	Norris	Norris
Site Assessment and Remediation Technologies Development	EM, A, CLS, EES, ENG, INC, M, N, NMT, AET	Harry Ettinger	Ettinger	Aamodt
SWMU Review	EM-13**, HS-3	Robert Gonzales	Gonzales	To be determined
Statistics and DOOs	A-1	Kathy Campbell	Campbell	To be determined

Annex I References

EPA (US Environmental Protection Agency), April 10, 1990. RCRA Permit No. NM0890010515, EPA Region VI, issued to Los Alamos National Laboratory, Los Alamos, New Mexico, effective May 23, 1990, EPA Region VI, Hazardous Waste Management Division, Dallas, Texas (EPA 1990, 0306)

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

LANL March 16, 1992. "Los Alamos National Laboratory Environmental Restoration Program Standard Operating Procedures, Volume I and II", Los Alamos National Laboratory, Los Alamos, New Mexico. (LANL 1992, 0688)

ATTACHMENT A (4 pages)

Los Alamos National Laboratory
Environmental Restoration Program

Standard Operating Procedures
(from Volumes I and II
of the LANL ER SOP manual)

CONTENTS

VOLUME I

Procedure Numbers	Title
1.0	GENERAL INSTRUCTIONS
LANL-ER-SOP-01.01,R0	General Instructions for Field Investigations
LANL-ER-SOP-01.02,R0	Sample Containers and Preservation
LANL-ER-SOP-01.03,R0	Handling, Packaging, and Shipping of Samples
LANL-ER-SOP-01.04,R0	Sample Control and Field Documentation
LANL-ER-SOP-01.05,R0	Field Quality Control Samples
LANL-ER-SOP-01.06,R0	Management of RFI-Generated Waste
3.0	RECONNAISSANCE/FIELD SURVEYS
LANL-ER-SOP-03.04,R0	Petrography
LANL-ER-SOP-03.05,R0	Determination of Volume Constituents in Thin Sections of Rocks
LANL-ER-SOP-03.06,R0	Fracture Characterization
LANL-ER-SOP-03.07,R0	Characterization of Lithologic Variation Within the Rock Outcrop of a Volcanic Field
LANL-ER-SOP-03.09,R0	Geologic Mapping of Bedrock Units
4.0	DRILLING, EXCAVATING, SAMPLING AND LOGGING
LANL-ER-SOP-04.01,R0	Drilling Methods and Drill Site Management

Procedure Numbers	Title
6.0	**SAMPLING TECHNIQUES**
LANL-ER-SOP-06.01,R0	Purging of Wells for Representative Sampling of Groundwater
LANL-ER-SOP-06.02,R0	Field Analytical Measurements of Groundwater Samples
LANL-ER-SOP-06.03,R0	Sampling for Volatile Organics
LANL-ER-SOP-06.04,R0	Sampling Commercial/Municipal/Domestic Wells
LANL-ER-SOP-06.05,R0	Soil Water Samples
LANL-ER-SOP-06.06,R0	Tensiometer (Soil Suction Monitor) Installation and Measurement
LANL-ER-SOP-06.09,R0	Spade and Scoop Method for Collection of Soil Samples
LANL-ER-SOP-06.10,R0	Hand Auger and Thin-Wall Tube Sampler
LANL-ER-SOP-06.11,R0	Stainless Steel Surface Soil Sampler
LANL-ER-SOP-06.13,R0	Surface Water Sampling
LANL-ER-SOP-06.14,R0	Sediment Material Collection
LANL-ER-SOP-06.15,R0	Coliwasa Samples for Liquids and Slurries
LANL-ER-SOP-06.16,R0	Thief Sampler for Dry Powders or Granules
LANL-ER-SOP-06.17,R0	Trier Samples for Sludges and Moist Powders or Granules
LANL-ER-SOP-06.18,R0	Collection of Sand, Packed Powder, or Granule Samples Using the Hand Auger
LANL-ER-SOP-06.19,R0	Weighted Bottle Sampler for Liquids and Slurries in Tanks
LANL-ER-SOP-06.21,R0	Volatile Organic Sampling Train
LANL-ER-SOP-06.22,R0	Canister Sampling for Organics EPA Method T0-14

Los Alamos National Laboratory
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Standard Operating Procedures

CONTENTS

VOLUME II

Procedure Numbers	Title
10.0	**FIELD SCREENING TECHNIQUES**
LANL-ER-SOP-10.01.R0	Screening of PCB'S in Soil
11.0	**GEOTECHNICAL ANALYSIS**
LANL-ER-SOP-11.01,R0	Measurement of Bulk Density, Dry Density, Water Content and Porosity in Soil
LANL-ER-SOP-11.02,R0	Particle Size Distribution of Soil/Rock Samples
LANL-ER-SOP-11.03,R0	Permeability of Granular Soils
LANL-ER-SOP-11.04,R0	Soil and Core pH
LANL-ER-SOP-11.05,R0	Total Organic Carbon
LANL-ER-SOP-11.06,R0	Cation-Exchange Capacity

ATTACHMENT B (11 pages)

Detailed Projected RFI/CMS Schedule for the TA-49 OU

ACTIVITY ID	ORIG DUR	REM DUR	%	ACTIVITY DESCRIPTION	BUDGET	EARNED	SCHEDULED START	SCHEDULED FINISH
260001	0	0	0	1144:START RFI WORK PLAN	.00	.00	1OCT91	
260005	250	250	0	1144:Conduct Voluntary C. Actions for RFI WP LOE	.00	.00	1OCT91	30SEP92
260008	20	20	0	1144:Write Community Relations Plan	.00	.00	1OCT91	29OCT91
260009	20	20	0	1144:Write Management Plan for RFI WP	.00	.00	1OCT91	29OCT91
260010	20	20	0	1144:Write Health and Safety Plan for RFI WP	.00	.00	1OCT91	29OCT91
260015	250	250	0	1144: Manage ADS During FY-92 (LOE)	206314.00	.00	1OCT91	30SEP92
260025	250	250	0	1144: Develop NEPA Documentation for RFI WP(LOE)	30240.00	.00	1OCT91	30SEP92
260065	40	40	0	1144: Develop Sampling Plan for RFI WP	51680.00	.00	1OCT91	27NOV91
260070	249	249	0	1144: Manage ADS During FY-93 (LOE)	179081.00	.00	1OCT92	30SEP93
260090	80	80	0	1144: Develop LANL Internal Draft of RFI WP	169338.00	.00	1OCT91	30JAN92
260095	10	10	0	1144: LANL/VE Review Internal Draft RFI WP	52120.00	.00	31JAN92	13FEB92

ACTIVITY ID	ORIG DUR	REM DUR	%	ACTIVITY DESCRIPTION / BUDGET	EARNED	SCHEDULED START	SCHEDULED FINISH
260100	10	10	0	1144: Incorp.LANL Rev Comments Intern Dft RFI WP		14FEB92	28FEB92
				17520.00	.00		
260105	9	9	0	1144: Issue DOE Draft of RFI WP		2MAR92	12MAR92
				994.00	.00		
260110	11	11	0	1144: Cond DOE Review of DOE Dft of RFI WP		13MAR92	27MAR92
				1082.00	.00		
260115	10	10	0	1144:Incorp DOE Rev.Comments into DOE Dft RFI WP		30MAR92	10APR92
				17520.00	.00		
260120	30	30	0	1144: Issue EPA/NMED Draft of RFI Work Plan		13APR92	22MAY92
				994.00	.00		
260125	44	44	0	1144: Conduct NMED Review of RFI Work Plan		26MAY92	27JUL92
				1082.00	.00		
260130	44	44	0	1144: Conduct EPA Review of RFI Work Plan		26MAY92	27JUL92
				.00	.00		
260135	46	46	0	1144: Write Ph1 Contracts for RFI;Mobilize		14SEP92	18NOV92
				38280.00	.00		
260140	20	20	0	1144: Incorporate EPA/NMED Comments for RFI WP		28JUL92	24AUG92
				17520.00	.00		
260145	10	10	0	1144: Issue Final RFI Work Plan		25AUG92	8SEP92
				994.00	.00		
260155	249	249	0	1144: Assmt - Conduct VCA (LOE)		1OCT98	30SEP99
				.00	.00		

ACTIVITY ID	ORIG DUR	REM DUR	%	ACTIVITY DESCRIPTION	BUDGET	EARNED	SCHEDULED START	SCHEDULED FINISH
260160	250	250	0	1144: Manage ADS During FY-94 (LOE)	52576.00	.00	1OCT93	30SEP94
260165	491	491	0	1144: Conduct RFI PH1 Field Work	146820.00	.00	2FEB93	23JAN95
260170	530	530	0	1144: Conduct RFI PH1 Sample Analysis	1439757.00	.00	2FEB93	20MAR95
260175	530	530	0	1144: Conduct RFI PH1 Data Assessment	58693.00	.00	2FEB93	20MAR95
260180	491	491	0	1144: Develop NEPA Documentation for RFI Report	44741.00	.00	30JUL97	20JUL99
260185	247	247	0	1144: Manage ADS During FY-95 (LOE)	203846.00	.00	3OCT94	29SEP95
260190	60	60	0	1144: Write RFI PH1 Report/WP Modification	39448.00	.00	21MAR95	13JUN95
260195	20	20	0	1144: Demobilize RFI PH1 Field Work	7276.00	.00	24JAN95	21FEB95
260200	22	22	0	1144: EPA/NMED Rev PH1 Report/WP Modification	4879.00	.00	14JUN95	14JUL95
260205	22	22	0	1144: DOE Review PH1 Report/WP Modification	4879.00	.00	14JUN95	14JUL95
260210	20	20	0	1144: Write PH2 Contract; Mobilize for RFI	42301.00	.00	14JUN95	12JUL95

ACTIVITY ID	ORIG DUR	REM DUR	%	ACTIVITY DESCRIPTION / BUDGET	EARNED	SCHEDULED START	SCHEDULED FINISH
260215	490	490	0	1144: Conduct RFI PH2 Field Work		13JUL95	30JUN97
				184662.00	.00		
260220	490	490	0	1144: Conduct RFI PH2 Sample Analysis		13JUL95	30JUN97
				1731279.00	.00		
260225	490	490	0	1144: Conduct RFI PH2 Data Assessment		13JUL95	30JUN97
				97525.00	.00		
260230	249	249	0	1144: Manage ADS During FY-96 (LOE)		2OCT95	30SEP96
				215056.00	.00		
260235	100	100	0	1144: Conduct RFI Report Facility Investigation		1JUL97	25NOV97
				62332.00	.00		
260240	110	110	0	1144: Conduct RFI Report Investigation Analysis		1JUL97	9DEC97
				251069.00	.00		
260245	20	20	0	1144: Demobilize RFI PH2 Field Work		1JUL97	29JUL97
				7276.00	.00		
260250	132	132	0	1144: Prepare Internal Draft of RFI Report		21JUL99	2FEB00
				336876.00	.00		
260255	249	249	0	1144: Manage ADS During FY-97 (LOE)		1OCT96	30SEP97
				226880.00	.00		
260260	20	20	0	1144: LANL/VE Review Internal Draft of RFI Rpt		3FEB00	2MAR00
				10644.00	.00		
260265	40	40	0	1144:Incorp.LANL Rev.Comments Intern Dft RFI Rpt		3MAR00	27APR00
				10224.00	.00		

ACTIVITY ID	ORIG DUR	REM DUR	%	ACTIVITY DESCRIPTION	BUDGET	EARNED	SCHEDULED START	SCHEDULED FINISH
260270	20	20	0	1144: Issue DOE Draft of RFI Report	1299.00	.00	28APR00	25MAY00
260275	22	22	0	1144: Conduct DOE Review of DOE Draft of RFI Rpt	4690.00	.00	26MAY00	27JUN00
260280	40	40	0	1144: Incorp. DOE Rev. Comments DOE Drft RFI Rpt	4690.00	.00	28JUN00	23AUG00
260285	20	20	0	1144: Issue EPA/NMED Draft of RFI Report	1299.00	.00	24AUG00	21SEP00
260290	249	249	0	1144: Manage ADS During FY-98 (LOE)	226880.00	.00	1OCT97	30SEP98
260295	44	44	0	1144: Conduct EPA Review of RFI Report	4713.00	.00	22SEP00	28NOV00
260300	44	44	0	1144: Conduct NMED Review of RFI Report	4713.00	.00	22SEP00	28NOV00
260305	245	245	0	1144:Conduct Bench/Pilot Studies for CMS Pl(LOE)	.00	.00	22SEP00	17SEP01
260310	35	35	0	1144: Establish Current Situation for CMS Plan	2052.00	.00	22SEP00	13NOV00
260315	35	35	0	1144: Establish CA Objectives for CMS Plan	3250.00	.00	22SEP00	13NOV00
260320	35	35	0	1144: Develop Screening Technologies for CMS Pl	2979.00	.00	22SEP00	13NOV00

ACTIVITY ID	ORIG DUR	REM DUR	%	ACTIVITY DESCRIPTION	BUDGET	EARNED	SCHEDULED START	SCHEDULED FINISH
260325	248	248	0	1144: Develop NEPA Documentation for CMS Plan	1966.00	.00	2OCT00*	28SEP01
260330	15	15	0	1144: Develop Alternatives for CMS Plan	2979.00	.00	14NOV00	6DEC00
260335	20	20	0	1144: Incorporate EPA/NMED Comments on RFI Rpt	.00	.00	29NOV00	28DEC00
260340	10	10	0	1144: Develop Internal Draft of CMS Plan	7798.00	.00	7DEC00	20DEC00
260345	10	10	0	1144: LANL/VE Review Internal Draft of CMS Plan	.00	.00	21DEC00	8JAN01
260350	20	20	0	1144: Issue Final RFI Report	1299.00	.00	29DEC00	29JAN01
260355	10	10	0	1144:Incorp. LANL REV Comments Intern Dft CMS Pl	.00	.00	9JAN01	23JAN01
260360	5	5	0	1144: Issue DOE Draft of CMS Plan	1299.00	.00	24JAN01	30JAN01
260365	22	22	0	1144: Conduct DOE Review of Draft of CMS Plan	.00	.00	31JAN01	2MAR01
260370	20	20	0	1144:Incorp DOE Rev Comments DOE Dft of CMS Pl	.00	.00	5MAR01	30MAR01
260375	10	10	0	1144: Issue EPA/NMED Draft of CMS Plan	1299.00	.00	2APR01	13APR01

ACTIVITY ID	ORIG DUR	REM DUR	%	ACTIVITY DESCRIPTION	BUDGET	EARNED	SCHEDULED START	SCHEDULED FINISH
260380	44	44	0	1144: Conduct EPA Review of CMS Plan	.00	.00	16APR01	15JUN01
260385	44	44	0	1144: Conduct NMED Review of CMS Plan	.00	.00	16APR01	15JUN01
260390	20	20	0	1144: Incorporate EPA/NMED Comments on CMS Plan	229.00	.00	18JUN01	16JUL01
260395	10	10	0	1144: Issue Final CMS Plan	1299.00	.00	17JUL01	30JUL01
260400	5	5	0	1144: EPA Approves CMS Plan	631.00	.00	31JUL01	6AUG01
260405	245	245	0	1144: Conduct CMS Bench/Pilot Studies (LOE)	478710.00	.00	7AUG01	31JUL02
260410	249	249	0	1144: Manage ADS During FY-99 (LOE)	226880.00	.00	1OCT98	30SEP99
260412	95	95	0	1144: Manage ADS During FY 2000	.00	.00	1OCT99	23FEB00
260415	30	30	0	1144: Conduct Technical Evaluation for CMS Rpt	16468.00	.00	7AUG01	18SEP01
260420	30	30	0	1144: Cond Environmental Evaluation for CMS Rpt	16236.00	.00	7AUG01	18SEP01
260425	30	30	0	1144: Cond Human Health Evaluation for CMS Rpt	15107.00	.00	7AUG01	18SEP01

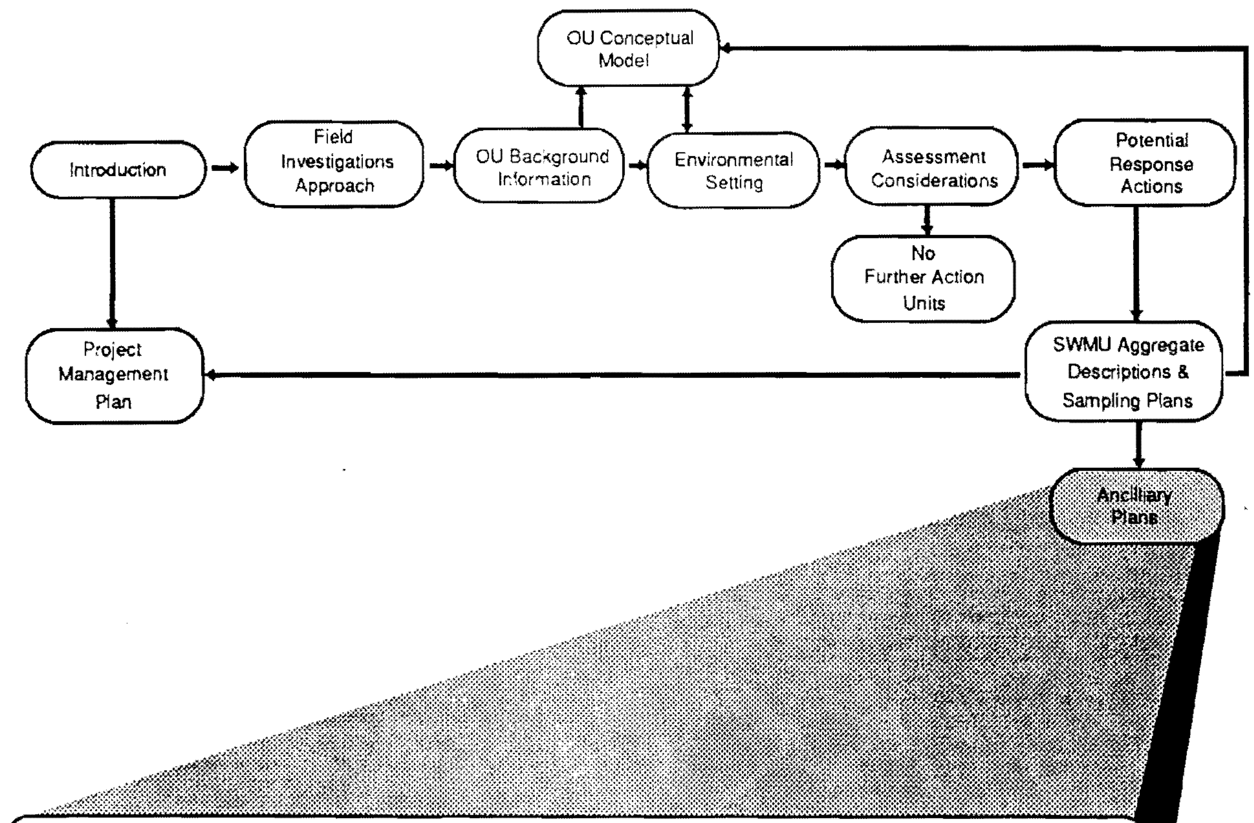
ACTIVITY ID	ORIG DUR	REM DUR	%	ACTIVITY DESCRIPTION	BUDGET	EARNED	SCHEDULED START	SCHEDULED FINISH
260430	30	30	0	1144: Cond Community Relations Eval.for CMS Rpt	14153.00	.00	7AUG01	18SEP01
260435	30	30	0	1144: Conduct Cost Evaluation for CMS Report	15000.00	.00	7AUG01	18SEP01
260440	30	30	0	1144: Develop NEPA Documentation for CMS Report	29223.00	.00	7AUG01	18SEP01
260450	10	10	0	1144: Prepare Internal Draft of CMS Report	11816.00	.00	19SEP01	2OCT01
260455	10	10	0	1144: LANL/VE Rev Internal Draft of CMS Report	631.00	.00	3OCT01	17OCT01
260460	35	35	0	1144:Incorp LANL Rev Comments Intern.Dft CMS Rpt	631.00	.00	12JUN02	31JUL02
260465	10	10	0	1144: Issue DOE Draft of CMS Report	1299.00	.00	1AUG02	14AUG02
260470	22	22	0	1144: Conduct Review of DOE Draft of CMS Report	229.00	.00	15AUG02	16SEP02
260475	22	22	0	1144: Incorp. DOE Rev Comments DOE Dft CMS Rpt	229.00	.00	17SEP02	17OCT02
260480	10	10	0	1144: Issue EPA/NMED Draft of CMS Report	1299.00	.00	18OCT02	31OCT02
260485	44	44	0	1144: Conduct EPA Review of CMS Report	229.00	.00	1NOV02	9JAN03

ACTIVITY ID	ORIG DUR	REM DUR	%	ACTIVITY DESCRIPTION	BUDGET	EARNED	SCHEDULED START	SCHEDULED FINISH
260490	44	44	0	1144: Conduct NMED Review of CMS Report	229.00	.00	1NOV02	9JAN03
260495	20	20	0	1144: Incorporate EPA/NMED Comments on CMS Rpt	.00	.00	10JAN03	7FEB03
260505	10	10	0	1144: Issue Final CMS Report	1299.00	.00	10FEB03	24FEB03
260510	169	169	0	1144: Conduct MDA AB Pilot/Study FY-92 (LOE)	284764.00	.00	14SEP92	19MAY93
690000	189	189	0	1144: Conduct VCA (LOE)	32672.00	.00	2JAN97*	30SEP97
690005	249	249	0	1144: Conduct VCA (LOE)	43563.00	.00	1OCT97	30SEP98
26M005	0	0	0	1144: DOE DRAFT RFI WORK PLAN COMPLETED	.00	.00		12MAR92
26M010	0	0	0	1144: EPA/NMED DRAFT OF RFI WORK PLAN COMPLETED	.00	.00		22MAY92
26M015	0	0	0	1144: RFI WORK PLAN COMPLETED	.00	.00		8SEP92
26M020	0	0	0	1144: START RFI	.00	.00	19NOV92	
26M025	0	0	0	1144: START DEVELOPING RFI REPORT	.00	.00	30JUL97	

ACTIVITY ID	ORIG DUR	REM DUR	%	ACTIVITY DESCRIPTION	BUDGET	EARNED	SCHEDULED START	SCHEDULED FINISH
26M030	0	0	0	1144: EPA/NMED DRAFT OF PH1 REPORT COMPLETED	.00	.00		13JUN95
26M035	0	0	0	1144: RFI FIELD WORK COMPLETED	.00	.00		29JUL97
26M040	0	0	0	1144: EPA/NMED DRAFT OF RFI REPORT COMPLETED	.00	.00		21SEP00
26M045	0	0	0	1144: START DEVELOPMENT OF CMS PLAN	.00	.00	22SEP00	
26M050	0	0	0	1144: RFI COMPLETED	.00	.00		29JAN01
26M055	0	0	0	1144: EPA NOTIFICATION OF CMS REQUIREMENTS	.00	.00		29JAN01
26M060	0	0	0	1144: EPA/NMED DRAFT OF CMS PLAN COMPLETED	.00	.00		13APR01
26M065	0	0	0	1144: EPA APPROVED CMS PLAN	.00	.00		6AUG01
26M070	0	0	0	1144: START CMS WORK	.00	.00	7AUG01	
26M075	0	0	0	1144: START DEVELOPMENT OF CMS REPORT	.00	.00	7AUG01	
26M080	0	0	0	1144: CMS WORK COMPLETED	.00	.00		31JUL02

ACTIVITY ID	ORIG DUR	REM DUR	%	ACTIVITY DESCRIPTION	BUDGET	EARNED	SCHEDULED START	SCHEDULED FINISH
26M085	0	0	0	1144: EPA/NMED DRAFT OF CMS REPORT COMPLETED				31OCT02
					.00	:00		
26M090	0	0	0	1144: ASSESSMENT COMPLETED				24FEB03
					.00	.00		
REPORT TOTAL					7429829.00	.00		

Annex II



Quality Assurance Project Plan

ANNEX II

TECHNICAL AREA 49 OPERABLE UNIT 1144
QUALITY ASSURANCE PROJECT PLAN

for the

LOS ALAMOS NATIONAL LABORATORY
ENVIRONMENTAL RESTORATION PROGRAM

I. APPROVAL FOR IMPLEMENTATION

1. **NAME**: Robert Vocke
   TITLE: ER Program Manager, Los Alamos National Laboratory

   SIGNATURE: ____________________
   DATE:__________

2. **NAME**: Karen Warthen
   TITLE: Quality Assurance Project Leader, ER Program, Los Alamos National Laboratory

   SIGNATURE: ____________________
   DATE:__________

3. **NAME**: Craig Leasure
   TITLE: Group Leader, Health and Environmental Chemistry Group (HS-9)

   SIGNATURE: ____________________
   DATE:__________

4. **NAME:** Margaret Gautier
   TITLE: Quality Assurance Officer, Health and Environmental Chemistry Group (HS - 9)

   SIGNATURE:____________________
   DATE:__________

5. **NAME:** Rich Mayer
   TITLE: Environmental Engineer, Region VI, Environmental Protection Agency

   Signature________________________________
   Date:____________

6. **NAME:** Alva L. Smith
   TITLE: Chief of Office of Quality Assurance, Region VI, Environmental Protection Agency

   Signature: ________________________________
   Date: __________

7. **NAME:** P. Gary Eller
   TITLE: Project Leader, ER Program, Los Alamos National Laboratory

   Signature ________________________________
   Date __________

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Distribution of Official Copies:

A list of the recipients of the official copies of this plan, and any subsequent revisions, will be developed and maintained as a document control activity.

2.0 LIST OF ACRONYMS

A complete list of acronyms used in this QAPjP is given at the beginning of this OU Work Plan.

3.0 Project Description

3.1 Introduction

This Technical Area (TA)-49 Operable Unit (OU) RFI [Resource Conservation and Recovery Act (RCRA) Facility Investigation] Quality Assurance Project Plan (QAPjP) is tiered to the Los Alamos National Laboratory (LANL) Environmental Restoration (ER) Program Generic QAPjP issued as a controlled document by the LANL ER Program. Information that is specific to the TA-49 OU RFI QAPjP is presented in detail in this document. Information that is covered by the LANL ER Program Generic QAPjP, or is presented elsewhere, has been referenced to a specific document chapter. The section titles and numbers in this OU QAPjP correspond directly to those contained in the Generic QAPjP for the LANL ER Program.

This TA-49 OU QAPjP integrates the U.S. Environmental Protection Agency (EPA) 16-point QAMS-005/80 guidance (EPA 1980), as well as the ASME NQA-1-1989 edition of "Quality Assurance Program Requirements for Nuclear Facilities (ASME 1989) (as specified in DOE Order 5700.6C). The integration is described in Section 3, Quality Assurance Program, of the LANL ER Quality Program Plan (QPP), which was issued as a controlled document by the ER Program.

A list of LANL ER SOPs referenced in this annex is given in Attachment I of Annex I of this OU workplan.

A list of LANL ER SOPs referenced in this annex is given in Attachment I of Annex I of thisd OU work plan.

3.2 Facility Description

A facility description of Los Alamos National Laboratory is presented in Subsection 2.0 of the IWP (LANL 1991, 0553). Historical information directly relevant to the TA-49 OU is presented in Chapters 1-8 of this OU Work Plan.

3.3 Environmental Restoration Program

A description of the ER Program is presented in Section 3.0 of the IWP.

3.4 Project Description

3.4.1 Project Objectives

Project objectives are outlined in Chapter 1 of this OU Work Plan.

3.4.2 Project Schedule

Project activity dates are presented in the Executive Summary and Annex I (Project Management Plan) of this OU Work Plan.

3.4.3 Project Scope

The scope of this project is presented in Chapter 1 of this OU Work Plan.

3.4.4 Background Information

OU background information is presented in Chapter 3 of this OU Work Plan.

3.4.5 Data Management

Information regarding data usage and data users is presented in Annex IV of this OU Work Plan. Data collected during the RFI at the TA-49 OU will be used to determine whether a source of contamination is present and, if present, to determine the extent of contamination at SWMUs or SWMU aggregates, as detailed in the field sampling plans in Chapters 6 and 7. The investigation should provide sufficient data for a baseline risk assessment and corrective measures study. Appendix C provides an overview of important aspects of data analysis for the TA-49 OU. Data collected during the RFI will be input into the Facility for Information Management, Analysis and Display (FIMAD) following the ER Records Management Procedure AP-02.1 and analyzed, as appropriate, using statistical techniques, kriging, 2- and 3-dimensional modeling, or other appropriate methods (see IWP Annex IV and IWP updates for additional details of FIMAD developments).

4.0 Project Organization and Responsibility

The overall organizational structure of the ER Program is presented in Section 2.0 of the LANL ER Program QPP. Therein, ER program personnel are identified down to the technical team leader and operable unit project leader level, and personnel responsibilities and line authority are detailed. In addition, the Quality Assurance (QA) organizational structure is presented.

Detailed information pertinent to the management organization for the TA-49 OU RFI is provided in Annex I of this OU Work Plan. Records of qualifications and training of all personnel working on the TA-49 OU RFI field work will be kept as ER Records (see Annex IV of this OU Work Plan). Additional information on general responsibilities of personnel also is contained in Annex I of this OU Work Plan.

5.0 Quality Assurance Objectives for Measurement Data in terms of Precision, Accuracy, Representativeness, Completeness, and Comparability

5.1 Level of Quality Control

The appropriate analytical levels for intended data uses for the TA-49 OU are indicated in Table 5.8-1 of this OU Work Plan. Chapter 5 also outlines specific QA objectives for environmental media and parameters to be measured.

5.1.1 Field Sampling

Quality Assurance/Quality Control definitions presented in Appendix B of the LANL ER Program Generic QAPjP are applicable to activities described in this OU QAPjP.

A discussion of quality control samples for the ER Program is presented in Subsection 6.1 of the LANL ER Program Generic QAPjP. The frequency and type of field quality control samples specified in the LANL ER Program Generic QAPjP will be used for chemical analysis of samples during the TA-49 OU RFI.

Soil samples for geotechnical analysis will be collected during the TA-49 OU RFI as described in Chapter 6 of this OU Work Plan. These analysis will use either conventional laboratory procedures [e.g., American Society for Testing and Materials (ASTM)] or SOPs. In contrast to samples submitted for chemical analysis, field quality control samples are not routinely associated with geotechnical samples.

5.1.2 Field Measurements

The quality control level for field measurements performed during the TA-49 OU RFI will follow the recommendations presented in Subsection 5.1.2 of the LANL ER Program Generic QAPjP.

5.1.3 Analytical Laboratory

The quality control level of effort for laboratory analysis for the TA-49 OU RFI will follow the recommendations specified in EPA methods or the frequency presented in Table V.2 of Subsection 5.1.3 of the LANL ER Program Generic QAPjP.

5.2 Precision, Accuracy, and Sensitivity of Analysis

The quality control acceptance criteria for laboratory analysis for precision, accuracy, and sensitivity of analysis for the TA-49 OU RFI will use the methods and detection limits specified for the EPA and DOE methods presented in Subsection 5.2 of the LANL ER Program Generic QAPjP. Specifically, the following will be used at the TA-49 OU:

- Table V.3 for volatile organic compounds

- Table V.4 for semivolatiles
- Tables V.5 and V.6 for polychlorinated biphenyls (PCBs)
- Table V.7 for inorganics
- Table V.8 for radionuclides
- Table V.9 for miscellaneous analytes
- Table V.10 for high explosives

Specific analytes identified in the tables listed above may be included in the RFI investigations at the TA-49 OU. A broad category not included for work at the TA-49 OU are pesticides (included in Tables V.5 and V.6).

5.3 Quality Assurance Objectives for Precision

The quality assurance objectives for precision of laboratory analysis for the TA-49 OU RFI samples will follow the EPA guidance specified in Subsection 5.3 and Table V.11 of the LANL ER Program Generic QAPjP.

5.4 Quality Assurance Objectives for Accuracy

The quality assurance objectives for accuracy of laboratory analysis for TA-49 OU RFI samples will follow the U.S. EPA guidance specified in Subsection 5.4 and Tables V.11 and V.12 of the LANL ER Program Generic QAPjP.

5.5 Representativeness, Completeness, and Comparability

The field sampling plans in Chapters 6 and 7 of this OU Work Plan were developed to meet the sample representativeness criteria described in Subsection 14.3 of the ER Program Generic QAPjP.

Completeness of analytical data from the TA-49 OU RFI will be calculated according to the formula presented in Subsection 14.4 of the ER Program Generic QAPjP. The quality assurance objective for analytical data completeness for the LANL ER Program is 90%, which also is the objective for the TA-49 OU RFI.

Data comparability for the TA-49 OU RFI will be achieved through the use of standard sampling and analytical techniques. Sampling will be performed according to LANL ER Program Standard Operating Procedures (SOPs) listed in Appendix L of the IWP. Sample analysis will be performed according to analytical methods referenced in the LANL ER Program Generic QAPjP or this TA-49 QAPjP. Data results will be reported in appropriate units consistent with existing site data and applicable regulatory levels.

5.6 Field Measurements

Field laboratory measurements for the TA-49 OU RFI will be performed according to the Field Screening Techniques procedures (Section 10.0) described in the LANL ER Program SOPs. Adherence to the LANL ER Program SOPs will ensure the accuracy, precision, and completeness of the field measurement data.

5.7 Data Quality Objectives

Appendix A of the Generic QA Project Plan contains a scenario illustrating a data quality objective.

TA-49 OU Data Quality Objective (DQO) elements are covered in Chapters 5, 6, and 7 of this OU Work Plan and in the LANL ER Program Generic QAPjP.

DQOs and the development process for the TA-49 OU RFI are described generally in Sections 2.2 and 5.8 of this OU Work Plan. Specific objectives for each investigation unit are described in Chapters 6 and 7, including lists of data needs, location figures, and sampling and analytical requirement tables that are specific to each SWMU.

Data analysis, interpretation, statistical representativeness, and applicability to the conceptual model are discussed in Chapters 5 through 7.

TA-49 OU RFI budget and schedule information relative to anticipated field and laboratory activities are summarized in the Executive Summary and described in greater detail in Annex I of this OU Work Plan.

6.0 Sampling Procedures

Procedures for collecting soil and aqueous samples will be selected, as appropriate to the field investigation from the LANL ER Program SOPs listed in Appendix L of the IWP.

Information on required sample containers, volume, preservation, and holding times is presented in LANL ER Program SOP-01.02, "Containers, Sampling and Preservation".

The collection, management, and handling of ER Program environmental media samples is covered by LANL ER Program SOP-01.04, "Sample Control and Documentation," and SOP-01.03, "Handling, Packaging, and Shipping of Samples". Also refer to Section 6.0 and Subsection 7.5 of the LANL ER Program Generic QAPjP for additional information on proper sample management and coordination.

6.1 Quality Control Samples

A discussion of quality control samples for the ER Program is presented in Subsection 6.1 of the LANL ER Program Generic QAPjP and the LANL ER

Program SOP-01.05, "Field Quality Assurance/Quality Control Blank Samples". The frequency and type of field quality control samples identified in the LANL ER Program Generic QAPjP will be followed for chemical analysis of samples during the TA-49 OU RFI.

Soil samples for geotechnical analysis will be collected during the TA-49 OU RFI. In contrast to samples submitted for chemical analysis, field quality control samples are not routinely associated with geotechnical samples. Quality control for geotechnical sample analysis results is prescribed in the specific laboratory procedure. An additional measure of quality control for geotechnical samples is achieved by the collection and submittal to the laboratory of a sufficient volume of sample. A large sample volume may provide for reanalysis of an individual sample in the event results from the initial aliquot did not meet specific method requirements.

6.2 Sample Preservation During Shipment

Information on sample preservation during shipment is presented in LANL ER Program SOP, "Containers, Sampling and Preservation" and in Subsection 6.2 of the LANL ER Program Generic QAPjP.

6.3 Equipment Decontamination

Equipment decontamination is described in LANL ER Program SOP-02.01, "General Equipment Decontamination" LANL ER Program SOP-01.06, "Management of RFI Generated Waste", provides information for proper handling and disposition of wash water and other materials generated during equipment decontamination and other RFI field activities.

6.4 Sample Designation

Samples will be assigned a unique alphanumeric identifier to provide chain-of-custody control during the transfer of samples from the time of collection through analysis and reporting. This information is detailed in LANL ER Program SOP-01.04, "Sample Control and Documentation".

7.0 Sample Custody

7.1 Overview

Field and laboratory sample chain-of-custody procedures are described in Subsection 7 of the LANL ER Program Generic QAPjP. These procedures will be followed for sampling activities conducted during the TA-49 OU RFI. The LANL ER Program SOP-01.04, "Sample Control and Documentation", also provides guidance for chain-of-custody procedures, including example chain-of-custody records and tags.

7.2 Field Documentation

A sample numbering system developed for the LANL ER Program uniquely identifies each boring location, monitor well, and sample collected. The LANL ER Program numbering system, including standard sample identifiers, identifiers for quality control samples, and the code system to be used is detailed in LANL ER Program SOP-01.04, "Sample Control and Documentation".

Section 7.2 of the LANL ER Program Generic QAPjP provides sample documentation guidance for field personnel involved with sample collection activities. The LANL ER program numbering system will be followed for all sampling activities conducted during the TA-49 OU RFI. All field data collection forms will be reviewed by the TA-49 Field Teams Manager, or a technical reviewer designee, before being submitted to the LANL ER Records Processing Facility. Incorrect entries will be crossed out with a single line and signed and dated by the person originating the entry and the TA-49 field teams manager or a technical reviewer designee.

7.3 Sample Management Facility

Section 7.3 of the LANL ER Program Generic QAPjP provides a discussion of the ER Program activities coordinated by the LANL ER Program Sample Control Facility [also known as the Sample Management Facility (SMF)]. The activities described will be accomplished for the TA-49 OU RFI effort.

7.4 Laboratory Documentation

Laboratory custody procedures associated with sample receipt, storage, preparation, analysis, and general security are described in Subsection 7.4 of the LANL ER Program Generic QAPjP. These procedures will be followed by all laboratories participating in chemical analysis of samples generated during the TA-49 OU RFI.

Laboratories providing radiological and geotechnical analysis of TA-49 OU RFI samples also will follow chain-of-custody and record-keeping procedures as described in Subsection 7.4 of the LANL ER Program Generic QAPjP. Sample storage for these samples will be according to requirements described in the analysis procedure or in the QA Plan of the laboratory. Tracking of these samples will be according to requirements described in the QA Plan of the laboratory.

Acquisition of appropriate QA manuals for all TA-49 OU RFI participating laboratories, including LANL EM-9, is the responsibility of the LANL SMF.

7.5 Sample Handling, Packaging, and Shipping

Sample handling, packaging, and shipping procedures are referenced in Subsection 7.5 of the LANL ER Program Generic QAPjP and in LANL ER Program SOP-01.03, "Guide to Handling, Packaging and Shipping of Samples".

7.6 Final Evidence File Documentation

Final evidence file documentation is described in Subsection 7.6 of the LANL ER Program Generic QAPjP and in Annex IV (Records Management Program Plan) of the IWP. TA-49 OU RFI activities will follow these ER Program-wide procedures. SOPs will be developed, reviewed, and approved if needed.

8.0 Calibration Procedures and Frequency

8.1 Overview

Section 8.0 of the ER Program Generic QAPjP contains information on the calibration procedures and frequency of calibration for both field and laboratory equipment. As appropriate, additional information also is referenced to the ER Program SOPs and the manufacturer's equipment manual.

8.2 Field Equipment

A list of analytical and health and safety screening procedures that may be used in the field during environmental investigations is presented in Appendix M of the Laboratory IWP.

Field instruments will be calibrated according to manufacturer's specifications before and after each field use, or as otherwise described in the Laboratory ER Program SOPs. Where necessary, instruments will be calibrated each day during field use.

Maintain and calibration records will be maintained for each field instrument used as part of environmental investigations at the Laboratory. Tracking of instrument records will be accomplished by assigning a unique number to each instrument that will correspond to its record file.

8.3 Laboratory Equipment

Subsection 8.3 of the Laboratory ER Program Generic QAPjP contains general information on the calibration procedures and frequency of calibration for laboratory equipment. The Laboratory SMF is responsible for acquiring appropriate QA manuals that describe specific calibration procedures for various analytical instruments for all TA-49 OU participating laboratories, including EM-9.

The laboratory ER Program SOPs have been provided to EPA Region VI under separate submittal and are not attached to this OU QAPjP.

9.0 Analytical Procedures

9.1 Overview

Subsection 9.1 of the ER Program Generic QAPjP provides an overview of analytical procedures. Appropriate SOPs, as listed in Appendix L of the IWP, will be followed.

9.2 Field Testing and Screening

Subsection 9.2 of the LANL ER Program Generic QAPjP describes field testing and screening. Appropriate SOPs, listed in Appendix L of the IWP, will be followed.

9.3 Laboratory Methods

The analytical methods to be used for the TA-49 OU RFI for aqueous and soil/sediment samples are those presented in Subsection 9.3 of the ER Program Generic QAPjP. All of the analytical methods presented there are applicable to the TA-49 OU RFI with the exceptions noted in Subsection 5.2 above; pesticides will not be analytes in this investigation. Where those analytes appear in Tables IX.1 and IX.2 of Section 9 of the LANL ER Program Generic QAPjP, they do not apply to the TA-49 OU RFI.

10.0 Data Reduction, Validation, and Reporting

10.1 Data Reduction

Field and laboratory data reduction for the TA-49 OU RFI will follow the protocols described in Subsection 10.1 of the LANL ER Program Generic QAPjP.

10.2 Data Validation

Field and laboratory data validation for the TA-49 OU RFI will follow the protocols described in Subsection 10.2 of the LANL ER Program Generic QAPjP, except that no reagent blanks are planned.

10.3 Data Reporting

Field and laboratory data reporting for the TA-49 OU RFI will be as described in Subsection 10.3 of the LANL ER Program Generic QAPjP.

11.0 Internal Quality Control Checks

11.1 Field Sampling Quality Control Checks

A discussion of field quality control samples for the ER Program is presented in Subsection 11.1 of the LANL ER Program Generic QAPjP. The frequency and type of field quality control samples identified in the LANL ER Program Generic QAPjP will be followed, in general, for chemical analysis of samples during the TA-49 OU RFI.

11.2 Laboratory Quality Control

The types and frequency of internal quality control samples that apply to TA-49 OU RFI laboratory activities will follow those presented in Subsection 11.2 of the ER Program Generic QAPjP.

12.0 Performance and System Audits

Performance and system audits for field and laboratory operations will be conducted during the TA-49 OU RFI. These audits will be performed as identified and referenced in Subsection 12 of the LANL ER Program Generic QAPjP.

13.0 Preventive Maintenance

13.1 Field Equipment

Preventive maintenance requirements for field equipment used in the TA-49 OU RFI will follow specifications described in Subsection 13.1 of the Laboratory ER Program Generic QAPjP (LANL 1991b). The checks required for each type of field equipment are detailed in the Section 10.0 ER Program SOPs (LANL 1991a) and in the owner's manual for the equipment. The Laboratory's ER Program SOPs have been provided to EPA Region VI under separate submittal and are not attached to this OU QAPjP.

13.2 Laboratory Equipment

Preventive maintenance requirements for laboratory equipment used in the TA-49 OU RFI will follow the specifications described in Subsection 13.2 of the Laboratory ER Program Generic QAPjP (LANL 1991b). The elements of the Laboratory EM-9 preventive-maintenance program are discussed in Section 12.0 and 14.0 of the Health and Environmental Chemistry Laboratory Quality Assurance Program Plan (Gladney and Gautier 1991).

14.0 Specific Routine Procedures used to Assess Data Precision, Accuracy, Representativeness, and Completeness

14.1 Precision

Analytical precision for TA-49 OU RFI data will be calculated according to the formula presented in Section 14.1 of the ER Program Generic QAPjP.

14.2 Accuracy

Analytical accuracy of TA-49 OU RFI data will be calculated according to the formula presented in Section 14.2 of the ER Program Generic QAPjP.

14.3 Representativeness

The field sampling plans in Chapters 5 through 7 of this OU Work Plan were developed to meet the sample representativeness criteria described in Subsection 14.3 of the ER Program Generic QAPjP.

14.4 Completeness

Completeness of analytical data from the TA-49 OU RFI will be calculated according to the formula presented in Subsection 14.4 of the ER Program Generic QAPjP.

The quality assurance objective for analytical data completeness for the LANL ER Program is 90%, which also will be the objective for the TA-49 OU RFI.

15.0 Corrective Action

15.1 Overview

The procedures, reporting requirements, and authority for initiating corrective action during the TA-49 OU RFI will follow those defined in Section 15 of the ER Program Generic QAPjP and in LANL-ER-QP-01.3Q, "Deficiency Reporting."

15.2 Field Corrective Action

Field corrective actions required during the TA-49 OU RFI will follow the process defined in Subsection 15.2 of the ER Program Generic QAPjP.

15.3 Laboratory Corrective Action

Laboratory corrective actions required during the TA-49 OU RFI will follow the process defined in Section 15.3 of the ER Program Generic QAPjP.

16.0 Quality Assurance Reports to Management

16.1 Field Quality Assurance Reports to Management

The TA-49 Field Teams Manager or a designee will provide a monthly field progress status report to the LANL ER Program Manager. This report will consist of the information identified in Subsection 16.1 of the ER Program Generic QAPjP.

16.2 Laboratory Quality Assurance Reports to Management

The laboratory QA reports identified in Subsection 16.2 of the ER Program Generic QAPjP will be prepared during the TA-49 OU RFI.

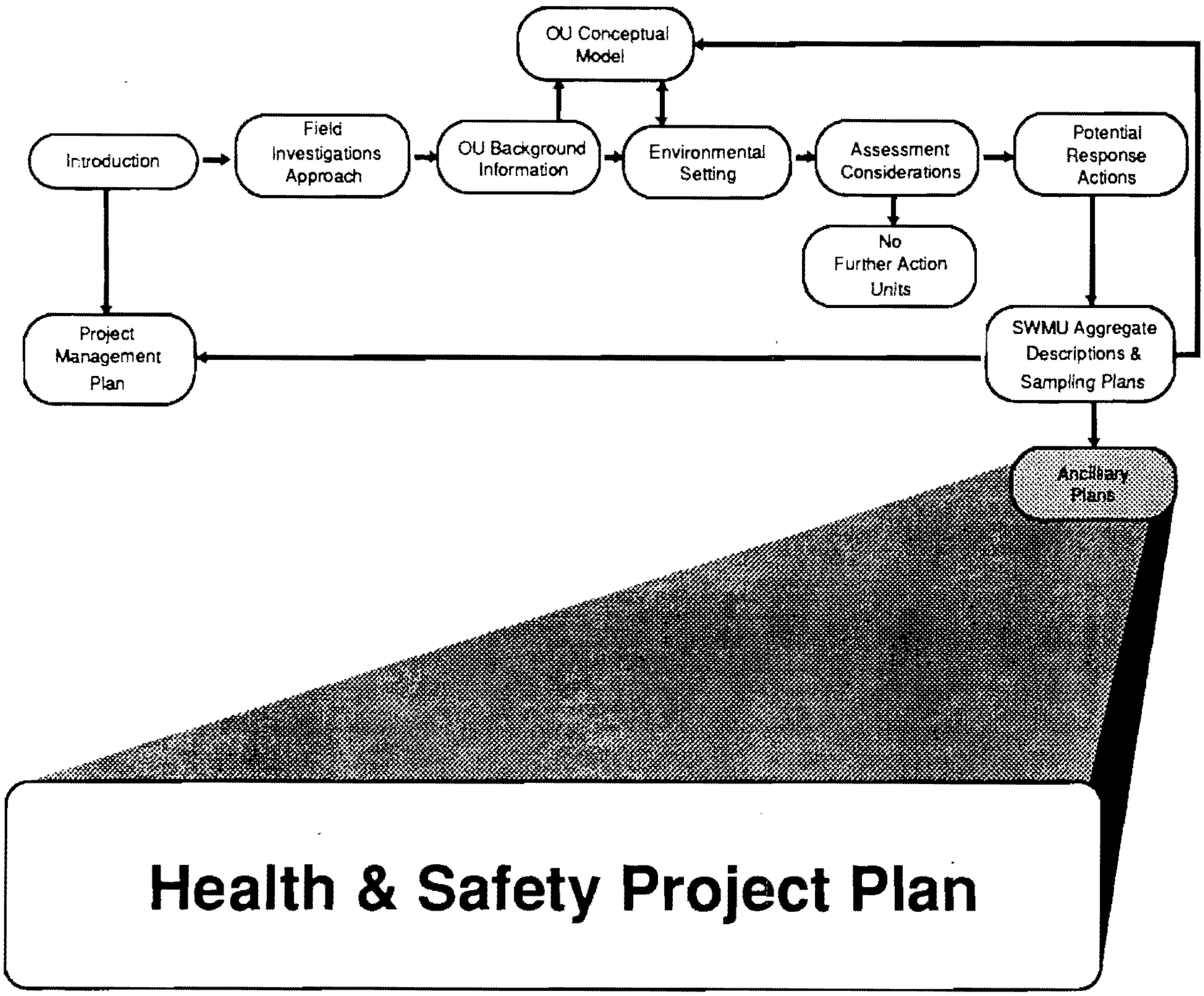
16.3 Internal Management Quality Assurance Reports

The internal management QA reports identified in Subsection 16.3 of the ER Program Generic QAPjP will be prepared during the TA-49 OU RFI

List of References

LANL ER Program Generic QAPjP	issued as a controlled document by the LANL ER Program
(EPA 1980);	US EPA QAMS-005/80
(ASME 1989);	NQA-1-1989
(LANL 1991, 0553);	LANL Installation Work Plan
LANL ER Program SOPs;	issued as controlled documents by the LANL Program
(Gladney and Gautier 1991);	HSE Chemistry Lab QAPP

Annex III


OU Conceptual Model
Introduction
Field Investigations Approach
OU Background Information
Environmental Setting
Assessment Considerations
Potential Response Actions
No Further Action Units
Project Management Plan
SWMU Aggregate Descriptions & Sampling Plans
Ancillary Plans
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ANNEX III PROJECT HEALTH AND SAFETY PLAN

1.0 Introduction

This Annex contains the OU-specific Project Health and Safety (H&S) Plan which has been developed for the RCRA Facility Investigation (RFI) at the TA-49 Operable Unit (OU), which also is referred to as OU 1144. This plan provides the framework within which personnel protection will be provided during the implementation of the RFI at TA-49. Task-specific health and safety plans will be prepared prior to the initiation of any field task. Task-specific plans also will describe the specific measures to be taken for personnel protection during implementation of the task and will define individual responsibilities which are outlined in the TA-49 OU Project Health and Safety Plan. Overall health and safety policy for the program is provided in Annex III (Health and Safety Plan) of the Installation Work Plan (IWP) (LANL 1991, 0553).

As field investigation progresses, measures for personnel protection may be identified which are more effective than those identified in this annex. Deviations from the TA-49 OU Project Health and Safety Plan will be documented in the pertinent task-specific plan along with the reasons fro that deviation. As changes are required, the TA-49 OU Health and Safety Project Plan will be updated. A list of LANL ER standard operating procedures referenced in this OU work plan is provided as Attachment III-1 to this OU work plan.

The TA-49 OU Project Health and Safety Plan includes an assessment of potential hazards, justification for personnel protection requirements, and site specific emergency response procedures. A copy of this plan will be kept on site at all times.

The specific purpose of this annex is to establish guidelines for field personnel involved in OU-wide and SWMU-specific investigations at the TA-49 OU. This plan applies only to the field investigations associated with the TA-49 OU. A new plan must be initiated for any corrective actions. In addition to following the general guidance in the IWP, the following regulations and standards were used to develop the procedures set forth in this plan: Laboratory policies and H&S Manual, DOE Orders, Occupational Safety and Health Administration (OSHA) regulations, National Institute for Occupational Health (NIOSH) standards, American Conference of Governmental Industrial Hygienists (ACGIH) recommendations, Nuclear Regulatory Commission (NRC) regulations, and Environmental Protection Agency (EPA) guidance. Applicable state and local regulations also will be followed. These standards and regulations have been established for the protection of workers on hazardous and radioactive waste sites of the type which exist at the TA-49 OU. Therefore, adherence to this plan is essential to the health and safety of site workers as well as the general public.

The responsibilities of personnel with regard to the TA-49 OU health and safety as detailed herein do not distinguish whether Laboratory or contractor personnel are implementing this plan. If it is necessary to modify this plan for implementation, EPA will be notified of any such modifications.

Detailed background information, including descriptions of specific site hazards, for the TA-49 OU is contained in Chapters 3, 6, and 7 of this OU work plan. Detailed maps of TA-49 showing the locations of SWMUs, access roads, topography, and other health and safety related features are contained in Figures EXEC-2 and EXEC-3 and in Appendix A.

2.0 OU Field WOrk Organization

The following information describes policies and standards set forth in this plan, including specific lines of responsibility, standards and regulations, and requirements for audits and variances of health and safety policies.

2.1 General Responsibilities

General RFI responsibilities are outlined in Section 5.0 of Annex III (H&S Plan) of the IWP. Listed below are specific responsibilities for personnel involved in the RFI for the TA-49 OU.

2.2 Individual Responsibilities

Within line management of the ER Program activities, there are certain employees and contractors with specific health and safety responsibilities. Figure III-1 shows a field work organization chart showing line organization responsibilities. Other organizational charts pertinent to the TA-49 RFI are presented in Annex I (Project Management Plan) of this OU work plan.

Los Alamos EM and HS Deputy Division Leaders

The Deputy Division Leaders of EM and HS Divisions are responsible for ensuring that programmatic health and safety concerns are addressed. They also are responsible for promoting a comprehensive health and safety program that covers special fields such as radiation protection, occupational medicine, industrial safety, industrial hygiene, criticality safety, waste management, and environmental protection and preservation.

ER Program Manager

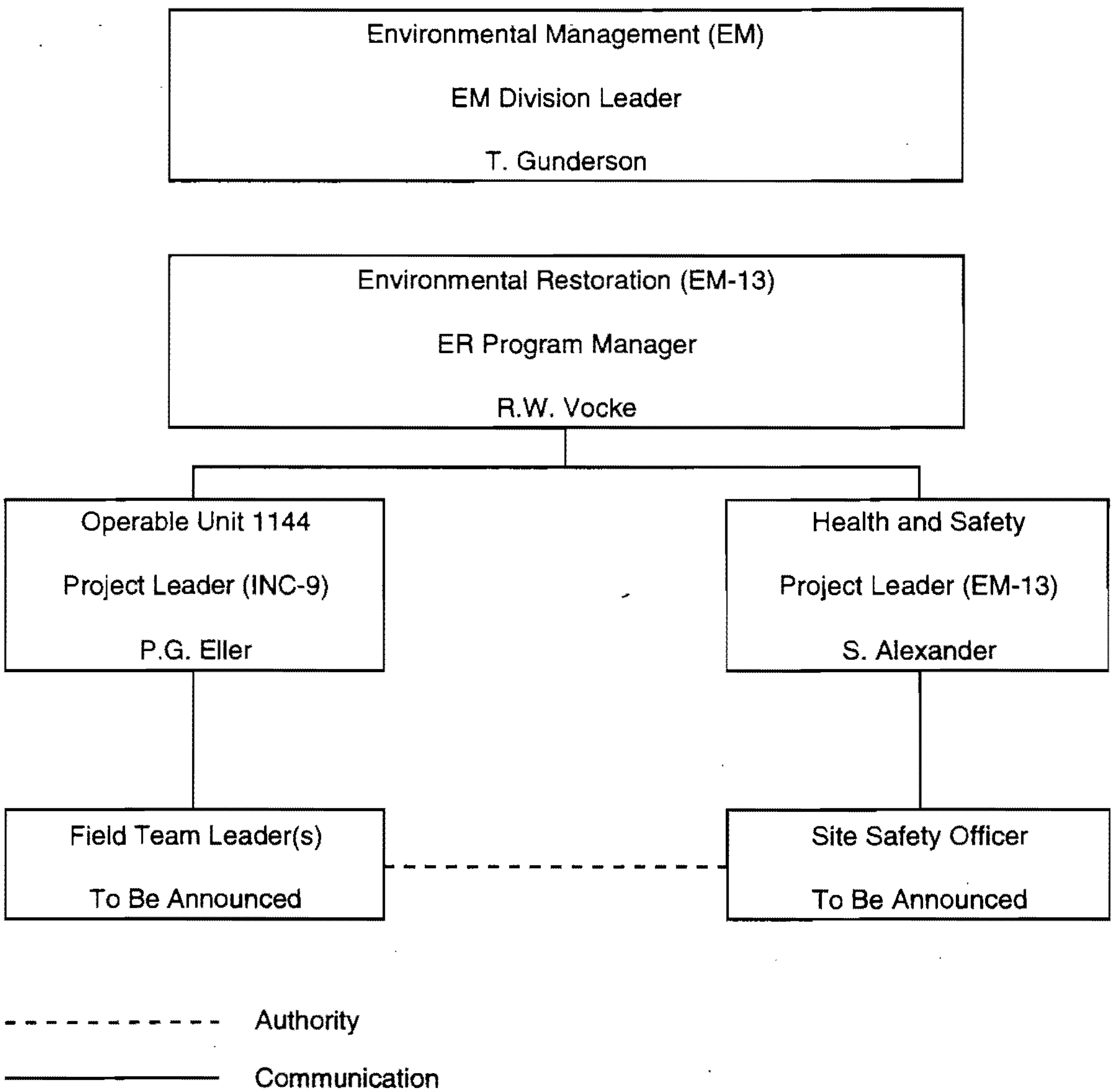
The ER Program Manager is responsible for the overall health and safety program for ER Program activities. The program manager ensures that the health and safety programs are established, implemented, and supported.

Health and Safety Project Leader

The Health and Safety Project Leader (H&S PL) is responsible for updating and implementing the ER Program H&S Plan (Annex III of the IWP) and for reviewing operable unit H&S Plans. The H&S PL also is responsible for interfacing and coordinating with Laboratory personnel to use resources appropriate for the ER H&S program, and to ensure ER Program compliance with all applicable H&S policies and regulations. In conjunction with the Field

Figure III-1

TA-49 OU Work Organization Chart Showing Health and Safety Responsibilities



Teams Manager, the H&S PL oversees day-to-day health and safety activities in the field.

Operable Unit Project Leader

The Operable Unit Project Leader (OUPL) is responsible for the RCRA investigations concerning the assigned OU. Specific health and safety responsibilities include

- preparation, review, implementation, and revision of OU health and safety documents; and
- interface with the H&S PL to resolve health and safety concerns.

Field Team Leader

The Field Teams Leader is responsible for implementing the SAP, this H&S Project Plan, and the project-specific quality assurance project plan (QAPjP). Other health and safety responsibilities include

- ensuring the health and safety of the field team members;
- assignment of a Site Safety Officer to ensure compliance with this site OU health and safety plan;
- familiarity with emergency response procedures and notification requirements and their implementation;
- acting as a backup to the site safety officer in the event of an emergency;
- coordination of field activities with Laboratory personnel and contractors, as needed;
- reading and complying with this OU health and safety plan; and
- ensuring day to day compliance of the health and safety procedures set forth in this plan.

TA-49 Site Safety Officer

In addition to the responsibilities outlined in Section 5.0 of Annex III of the IWP, the following responsibilities specific to TA-49 also will apply to the Site Safety Officer:

- reading and enforcing this OU health and safety plan;
- evaluating the potential hazards at the site;
- coordinating with AT-9, OS-4, M-Division, and the Hazardous Devices Team (HDT) about activities and experiments affecting TA-49;

- being informed about the results of sample analysis pertaining to health and safety as the ER site investigation and remediation work progresses;
- concurring with the Field Team Leader about the location of exclusion area boundaries;
- presenting safety briefings to workers;
- determining protective clothing requirements for workers;
- determining personal dosimetry requirements for workers;
- maintaining a current list of telephone numbers for emergency situations;
- having an operating radio transmitter/receiver in case telephone service is not available;
- maintaining an up-to-date copy of the H&S plan for work at the site;
- maintaining an up-to-date copy of the emergency plan and procedures for the site;
- establishing the safety requirements to be followed by visitors;
- providing visitors with a safety briefing;
- maintaining a logbook of workers and visitors within the exclusion area at a site;
- determining whether workers can perform their jobs safely under prevailing weather conditions;
- taking control of an emergency situation;
- ensuring that all personnel have been trained in the appropriate safety procedures and have read and understood this OU H&S Plan, and that all requirements are followed during OU activities;
- conducting daily health and safety briefings for the Field Team Leader and field team members;
- conducting daily health and safety audits of the work activities; and
- having authority and requiring that field be terminated if unsafe conditions develop or an imminent hazard is perceived.

Field Team Members

Field Team Members are responsible for conducting the assigned work in a manner that ensures that data collected are technically valid and legally defensible. They also are responsible for observing applicable health, safety, and environmental procedures; for using prescribed personal protective equipment; for promptly reporting accidents, injuries, and unsafe conditions; and for participating in required medical and biological monitoring programs.

2.3 Health and Safety Audits

Health and safety audits (including daily safety checks) will be performed during activities associated with this plan to ensure compliance with SOP-02.05, Safety Meetings and Inspections. The frequency of these audits will be at least quarterly with a minimum of one audit during the TA-49 remedial investigation. Audits will be conducted by the Site Safety Officer or a competent designee. Results will be documented in the Health and Safety Checklist (Attachment 1). The use of the checklist is outlined in ER Program SOP-01.01.02, Training and Medical Surveillance. The Laboratory HS and EM Deputy Division Leaders, ER Program Manager, ER H&S PL, and OU PL will receive copies of this report, which also will be retained at the work site. The Site Safety Officer will coordinate with the Field Team Leader to correct any deficiencies. OU readiness check lists must be completed before starting work.

The Laboratory HS and EM Divisions also may conduct health and safety audits separately or concurrently with the internal ER audits to ensure compliance with the Los Alamos Environmental Safety and Health Manual.

2.4 Variances from Health and Safety Requirements

Where special conditions exist, a written request for a variance from a specific health and safety requirement may be submitted by the Site Safety Officer to the Field Team Leader and H&S PL. If the Field Team Leader and H&S PL agree with the request, the request will be reviewed by the OU PL or a designee. As appropriate, higher levels of management may be consulted. The condition of the request will be evaluated and, if appropriate, a variance specifying the conditions under which the requirement may be modified will be granted in writing. The variance will become part of this H&S Plan.

3.0 Hazard Assessment and Personnel Protection Requirements

The following section is designed to identify potential hazards associated with the field activities at the TA-49 OU. Tables III-1 and III-2 (discussed later in this section) summarize the levels of personal protection at individual SWMUs and exposure limits for potential wastes at the TA-49 OU. Tables III-3 and III-4 summarize properties and suspected locations of contaminants at the TA-49 OU. Specific hazard information of this type will be reviewed again before work is performed at that particular location. Training in the use of all required personal protection equipment will be provided and only trained an/or certified personnel will be allowed to use such equipment.

TABLE III-1

SUMMARY REQUIRED INITIAL LEVELS OF PROTECTION FOR TA-49 SWMUs

Potential Waste Materials		Required Levels of Protection		
		Field Surveys	Surface Sampling	Subsurface Sampling
• SWMU 49-001 (a-g)	MDA AB	D	D	B or C
• SWMU 49-002	Areas 10 & 12	D	D	C
• SWMU 49-003	Area 11	D	D	B or C
• SWMU 49-004	Area 6	D	D	C or D
• SWMU 49-005 (a-b)	Areas 5 & 10	D	D	C or D
• SWMU 49-006	Area 6	D	D	C or D
• SWMU 49-008 (a-d)	Areas 5, 6, 11, & 12	D	D	D

TABLE III-2

Exposure Limits for Significant Contaminants at the TA-49 OU.

LOCATION	CONTAMINANTS	OSHA CEILING ppm	OSHA CEILING mg/m^3	OSHA PEL ppm	OSHA PEL mg/m^3	OSHA STEL ppm	OSHA STEL mg/m^3	ACGIH TWA ppm	ACGIH TWA mg/m^3	ACGIH STEL ppm	ACGIH STEL mg/m^3
MDA AB And Areas 5, 6, 10, 11, 12											
	Lead	--	--	--	0.05	--	--	--	0.15	--	--
	Beryllium	--	0.005	--	0.002	--	--	--	0.002	--	--
	Uranium	--	--	--	0.02	--	0.02	--	0.2	--	0.6
Areas 5, 10, 11, 12 - as above plus the following											
	PCBs	--	--	--	1.0	--	--	--	1.0	--	--
	HEs	--	--	--	--	--	--	--	--	--	--
	SVOCs	--	--	--	--	--	--	--	--	--	--

TABLE III-3

RADIOLOGICAL PROPERTIES OF ENVIRONMENTALLY SIGNIFICANT RADIONUCLIDES AT THE TA-49 OU

Radionuclide	Major/Mode of Decay (energy,MEV)	Daughter	DAC (<Ci/mL)	Critical Organ	Radioactive Half-Life	Biological Half-Life (yr)	Monitoring Instrument
Plutonium-238	Alpha, (5.50; 5.46)	U-234	$3x10^{-12}$	Bone	86.4	200	Alpha scintillometer FIDLER
Plutonium-239	Alpha, (5.16; 5.11)	U-235	$2x10^{-12}$	Bone	$2.44x10^{4}$	200	Alpha scintillometer FIDLER
Plutonium-240	Alpha, (5.17; 5.12)	U-236	$2x10^{-12}$	Bone	6580	200	Alpha scintillometer FIDLER
Plutonium-241	Beta (0.021)	Am-241	—	Bone	13.2	200	GM
Plutonium-242	Alpha (4.90;4.86)	U-238	—	Bone	$3.79x10^{5}$	200	Alpha scintillometer
Americium-241	Alpha (5.49; 5.44)	Np-237	$2x10^{-12}$	Bone	458	200	Alpha scintillometer
Uranium-235	Alpha (4.40; 4.37)	Th-231	—	Kidney	$7.1x10^{8}$	0.041	Alpha scintillometer
Uranium-238	Alpha (4.15; 4.20)	Th-234	—	Kidney	$4.51x10^{9}$	0.041	Alpha scintillometer
Tritium	Beta	He-3	$3x10^{-5}$	Total body tissue	12.3	0.033	Liquid scintillometer
Cesium-137	Beta (0.512)	Ba-137	—	Total body	30.0	0.19	GM
Strontium-90	Beta (0.546)	Y-90	$8x10^{-9}$	Bone	27.7	49	GM

DAC - derived air concentration (DOE draft Order 5480.11)
Critical organ - that part of the body that is most susceptible to radiation damage under the specific conditions being considered.
GM - Geiger-Muller detector
Half lives are from the Los Alamos Handbook of Radiation Monitoring (1970).

TABLE III--4

SUSPECTED CHEMICAL AND RADIOLOGICAL CONTAMINANTS AT INDIVIDUAL TA-49 SWMUS

SWMU Number	Location	Suspected Contaminants	Activity	Initial Level of Personal Protection
49-001	MDA AB	Pu, Am, U, Pb, Be	Surface sampling; drilling	Level D Level B or C
49-002	Areas 10 and 12	Pu, Am, U, Pb, Be	Surface sampling	Level D
49-003	Area 11	Pu, Am, U, Pb, Be	Surface sampling; drilling	Level D Level B or C
49-004	Area 6	Pu, Am, U, Pb, Be	Surface sampling; drilling	Level D Level D
49-005	Areas 5 and 10	Pu, Am, U, Pb, Be	Surface sampling; drilling	Level D Level D
49-006	Area 5	Pu, Am, U, Pb, Be	Surface sampling; drilling	Level D
49-008	Areas 5, 6, 11 and 12	Pu, Am, U, Pb, Be	Surface sampling	Level D

3.1 Identification of Hazards and Risk Analysis

The Site Safety Officer will monitor field conditions and personnel exposure to physical, chemical, biological, and radiological hazards. If a previously unidentified hazard is discovered, the Site Safety Officer will contact the Field Teams Manager and the H&S PL and address the hazard. A safety analysis will be performed on the hazard to identify the potential harm, the likelihood of occurrence, and measures to reduce the risk. The analysis will then be written and added to this plan in the form of an amendment. The amendment must be reviewed and approved by the H&S PL and OU PL and signed by appropriate field team leaders and field team members, showing that they have knowledge of the newly identified hazard.

3.1.1 Physical Hazards

Injuries occur most often from exposure to physical hazards. These injuries range from minor cuts and bruises to fatalities caused by serious unexpected events. The severity of these events may be controlled using sound inspection and monitoring practices. Therefore, this section is dedicated to outlining the potential physical hazards, as well as some preventive measures, for this RFI.

Noise

Constant exposure to noise may have an adverse affect on the ability of personnel to hear and understand normal speech. Prior to 1979, the medical profession had defined hearing impairment as an average hearing threshold level in excess of 25 decibels (dB) at 500, 1,000, 2,000, and 3,000 hertz (Hz). Therefore, limits have been established to prevent hearing loss in excess of this level. Some activities during the TA-49 RFI have the potential to exceed these levels (e.g., operation of drill rigs and and other heavy machinery).

The following are standards established by ACGIH for noise exposure:

Duration/day in hours	Sound level in dBA
16	80
8	85
4	90
2	95
1	100
.5	105
.25	110
.125	115

Because decibels are logarithmic units, they cannot be added or subtracted. In fact, if the intensity of a noise is doubled, there will only be a corresponding increase of three decibels. The following are examples of some common noises and the associated levels: an average residence is approximately 50 dB, conversational speech is 60 dB, a very noisy restaurant is 80 dB, a subway is 90 db, and a jet plane is 120 dB.

If a sound level meter is not available for monitoring noise, a simple test will identify levels above 85 db. If at an arms length (3 ft) normal conversation is not possible, engineering controls, administrative controls, or personnel protective equipment should be implemented.

Pinch Points

Pinch points are generally associated with activities utilizing tools or equipment with turning or moving parts such as a drill rig, backhoe, or even small hand tools. The moving parts may even be equipped with guards. If this is the case, periodic inspections must be performed to assure the guards have not been removed. The guards are generally removed by field personnel when it slows the progress of the operator or makes it difficult to use. When inspections show that guards have been removed, the tool or equipment should be tagged and not used until such time as the guard has been replaced.

In larger equipment, hydraulics mechanisms and tools are encountered more often. Guarding of these hazardous areas is more difficult. Additionally, the severity of injury is much greater with hydraulics due to amount of force created with hydraulically driven machinery. Initial inspections become more important, identifying areas of concern and informing field team members of the potential hazards. The most efficient and comprehensive procedure for inspections is that they be performed by a competent person who has experience with that particular piece of machinery. Most equipment can be inspected in less than 30 minutes using a check lis (see Attachment III-1 of this Annex). The Site Safety Officer will obtain a check list before the start of field activities.

OSHA requires that most equipment be inspected on a yearly basis. This inspection is generally conducted by the manufacturer, representative, or dealer. These inspections are to be documented and kept with the piece of equipment. This ensures that the equipment is properly maintained and free of any parts which could potentially become hazardous to the operator or bystanders.

Slip, Trip, and Fall

Injuries from slip, trip, and fall hazards are the most common around drill rigs, backhoe operations, and uneven terrain. These hazards occur due to either poor housekeeping, bad weather conditions, or the uneven terrain caused by soil excavation. Procedures may be developed to reduce the likelihood of slip, trip, and fall injuries. The Site Safety Officer will ensure that good housekeeping practices are followed. This includes the following: keeping tools stored in an accessible but out of the way place; keeping the work area free of soil piles to as great a degree as possible; reminding personnel to be aware of uneven terrain; keeping personnel at least 5 ft from the mesa edge; and marking trench and borehole boundaries.

Explosion/Fire/Oxygen Deficiency

Significant potential for flammable, or combustible, and oxygen deficient atmospheres is not anticipated during drilling, trenching, and tank sampling at the TA-49 OU, with the exception of the possible entry of the experimental chamber in Area 10.

Any work with flammable materials will be done according to LANL Administrative Requirement 6-5, Flammable and Combustible Liquids, and Technical Bulletins 601 (Flammable Liquids), 602 (Flammable Gases), 603 (Solvents), 604 (Epoxies). The ER Program SOP, Health and Safety Monitoring of Combustible Gas Levels, also will be followed.

As necessary, measurements of explosion potential will be made in enclosed spaces or in boreholes using a combustible gas indicator (CGI)/oxygen meter. If the CGI indicator shows concentrations greater than 20% of the LEL (lower explosive limit), activities in that area will cease. The work area will be evacuated and the appropriate safety measures will be implemented. Continued CGI readings will be made by the site safety officer to determine the appropriate time for return to the area.

Oxygen levels will be measured in enclosed or confined spaces and in areas that are not ventilated frequently (e.g., low-lying areas). Air-purifying respirators will be worn when oxygen concentrations are below 19.5% and 21%. If oxygen levels fall below 19.5%, the area must be evacuated or supplied air respirators must be furnished to personnel in these areas.

Oxygen rich atmospheres create an increased potential for fires. Therefore, if levels exceed 25%, the area will also be evacuated. If an evacuation becomes necessary, the area will be ventilated, and the site safety officer will continue monitoring oxygen levels. The Site Safety Officer will determine when it is safe for personnel to return and resume work.

Heat Stress

Heat stress occurs when the body's physiological processes fail to maintain a normal body temperature because of excess heat. This failure is enhanced when impervious clothing is worn during hot summer months. The best cure for heat stress is prevention. Acclimation to heat is the most effective method, but drinking plenty of water, avoiding alcohol consumption, and frequent cooling breaks are also effective. When the body cooling system starts failing, a number of symptoms begin to occur. Heat stress monitoring will be performed according to ER Program SOP 02.06, Heat and Cold Stress and Natural Hazards. Listed below are the physical reactions that can occur, ranging from mild to fatal.

Heat-Related Illness

- Heat Rash - caused by exposure to heat and humid air aggravated by changing clothes. Decreases the ability to tolerate heat and becomes a nuisance. If heat rashes occur, it is best to keep the area cool and dry.
- Heat Cramps - caused by profuse sweating with inadequate fluid intake and chemical replacement (especially salts and potassium). Signs: muscle spasms and pain in the extremities and abdomen. If heat cramps occur, it is best to drink plenty of fluids, (water is best), add slightly more salt to food, and replace potassium by eating bananas.
- Heat Exhaustion - caused by an increased heat stress to the

body and an inability of various organs to meet the increased demand to cool the body. Signs: shallow breathing; pallor; cool, moist skin; profuse sweating; dizziness; and lassitude. If heat exhaustion occurs it is best to get the person to a cool shady area (not in air conditioning) and allow the body to slowly cool and give plenty of fluids. Depending on the severity, one should wait a certain period of time before returning to the hot area.

- Heat Stroke - the most severe of the heat-related injuries occurs when the body's cooling system shuts down completely Signs: red, hot, dry skin; lack of perspiration; nausea; dizziness and confusion; strong rapid pulse; coma. The body must be cooled immediately and sent to the nearest hospital for immediate medical attention to prevent severe injury and/or death.

Work Rest Schedule

When working in protective clothing, the following guidelines for calculating work/rest schedules should be used.

Calculate the adjusted temperature as follows:

T(adjusted) = T(actual) + (13 x sunshine fraction)

100% sunshine	=	no cloud cover	=	1.00
75% sunshine	=	25% cloud cove	=	0.75
50% sunshine	=	50% cloud cover	=	0.50
25% sunshine	=	75% cloud cover	=	0.25
0% sunshine	=	100% cloud cover	=	0.00

Adjusted Temperature	Active Work Time (min/hr)
75° or less	50
80	45
85	40
90	35
95	30
100	20
105	10
110	0

Cold Exposure

Persons working outdoors in temperatures at or below freezing can suffer from cold-related injuries. Exposure to extreme cold for a short periods of time can cause severe injury to the body surface or can result in profound generalized cooling (hypothermia), which can lead cause death in extreme cases. Body areas that have high surface area to volume ratios, such as fingers, toes, and ears, are the most susceptible.

Cold Stress Monitoring will be performed according to ER Program SOP 02.06, Heat and Cold Stress and Natural Hazards.

Cold Related Illness

- Frost nip or incipient frostbite - characterized by a sudden whitening of the skin. If this occurs, warm hands slowly and get the victim into warm dry clothes.
- Superficial frostbite - causes skin to become very waxy or white and superficially firm but flexible underneath. If frostbite occurs, get the victim indoors and place the hands in warm 100–105°) water. Do not rub the affected part. Get the victim to medical attention as soon as possible after the affected part has been warmed.
- Deep frostbite - characterized by cold, pale, solid skin tissue; also may be blistered. Blisters should not be popped, and victim should be warmed in the same manner as above.
- Systemic hypothermia - caused by exposure to freezing or rapidly dropping temperatures. Symptoms are usually exhibited in five stages: 1) shivering; 2) apathy, listlessness, sleepiness, and (sometimes) rapid cooling of the body to less than 95° F; 3) unconsciousness, glassy stare, slow pulse, and slow respirations; 4) freezing of the extremities; and 5) death. Get the victim to a warm area as soon as possible and into warm dry clothing, and transfer to medical attention as soon as possible.

The best cure for cold-related injuries is prevention, which includes dressing in warm, insulated garments. If the potential exists for getting wet, wear wool clothing; take frequent warming breaks.

Electric Shock

Personnel working at TA-49 have the potential for exposure to electrical shock during drilling, trenching, and sampling activities. The source of this hazard may be from overhead and underground utilities, use of portable equipment, and digging and/or hand augering into underground utilities. Compliance with the following requirements will significantly reduce the chance of personnel exposure to electrical shock.

1. Only qualified and licensed personnel will be allowed to operate drilling, trenching or sampling equipment.
2. Heavy equipment and energized tools will be inspected by a competent person before use and will meet all applicable local, state, and federal standards.
3. Installed overhead electrical power lines will conform to the table below. While in use, drill rigs will maintain a 35-ft minimum distance from overhead power lines.
4. In transit, with the boom lowered, the closest approach to a power line will be 16 ft.

5. All areas to be drilled will be cleared through the LANL utilities manager before drilling activities begin.
6. Any cord with the grounding stem removed will be taken out of service and repaired or thrown away.
7. Ground fault interrupters will be used on all portable electrical equipment.

3.1.2 Chemical Hazards

Tables III-1 through III-4 list suspected hazards and health and safety related characteristics by location for the TA-49- OU. Also listed in the tables are the initial levels of required personal protection. Chemical hazards at the TA-49 OU include inhalation, ingestion, or dermal absorption of heavy metals and (much less likely) PCBs, HEs, and other chemicals. If unexpected chemical contaminants are identified during the RFI, they will be added to the list of chemical contaminants of concern. The site safety officer will be responsible for adding chemicals to this table and for notifying field personnel as needed.

The information provided in Tables III-1 and III-2 include the following: threshold limit value (TLV); immediately dangerous to life and health (IDLH) concentrations; exposure symptoms; ionization potential and relative response factor for commonly used instruments (note: this should be re-evaluated when the particular instrument is selected); and the best instrument for screening. The TLV (ACGIH) refers to a concentration of a chemical in which nearly all personnel may work for 40 hours/week over a lifetime without suffering any adverse health affects. Permissible exposure limits (PEL) are regulated standards by OSHA and are very similar to TLVs. The IDLH concentration is a concentration at which nearly all workers may be exposed for 30 minutes without suffering any irreversible health effects or escape impairing symptoms. The ionization potential is a characteristic of chemicals and is used in photoionization detectors to determine if the instrument may see the compound. The relative response factor reflects the percentage of the compound that an instrument will see. There are relative response factors for both photoionization and flame ionization detectors. The Site Safety Officer will be responsible for having available a general reference (e.g., NIOSH publications) with chemical specific information for compounds that are discovered during the RFI.

3.1.3. Radiological Hazards

Radionuclides that are known to be present in significant amounts at the TA-49 OU include ^{238}Pu, $^{239/240}$Pu, $^{235/238}$U, and ^{241}Am. Tritium, ^{137}Cs, ^{90}Sr and other fission products are present in much smaller amounts. Table III-3 summarizes health and safety information for these radionuclides.

There are three principal pathways whereby individuals may be exposed to radioactivity during field investigations at TA-49:

- inhalation or ingestion of radionuclide particulates;
- dermal absorption of radionuclide particulates through wounds; and
- exposure to direct radiation from contaminated materials.

Soils will be screened in accordance with the ER SOP 02.10, Radiation Protection. If new radionuclides are discovered at the TA-49 OU, they will be added to the list for the OU. The Site Safety Officer will be responsible for adding for notifying field personnel as needed.

3.1.4 Biological Hazards

Biological hazards will likely be encountered in some of the areas of TA-49. Mosquitoes, ticks, spiders, and rodents, including mice and rats, are likely be encountered. In addition, rattlesnakes may be encountered, especially near brushy or rocky areas and near structures and debris. Workers who regularly walk through such areas should wear high-top boots or snake leggings and have the grass mowed (where appropriate) to control rodents and snakes.

If snake bite occurs, the Emergency Medical System (EMS) should be notified immediately. The only first aid treatment that should be administered is an ice or a cold pack placed just above the affected area to slow blood flow. The victim's heart rate should be kept as slow as possible by remaining as still and calm as possible. If workers are bitten by insects, first aid creams may be applied by the Site Safety Officer to ease the symptoms caused by the bite. If personnel are bitten by a rodent, attempts should be made to obtain the animal, and medical assistance should be sought as soon as possible.

3.1.5 AT-9 microwave experiments

The microwave group, AT-9, operates a test range (see Chapter 3 of this OU work plan) near Area 12 of TA-49 where experiments are conducted on a regular basis. While most of these experiments are not hazardous, AT-9 does occasionally seal off the area to limit access to the test range. Since the experiments vary , the safety requirements for each experiment do as well. The TA-49 OU Site Safety Officer will coordinate with AT-9 as to the safety precautions that need to be taken on a case by case basis.

3.1.6 Hazardous Devices Team

The HDT uses a small area at the HDT Training Facility at TA-49 (see Chapter 3 of this OU work plan) where explosives training exercises and disposal of explosives and potential bombs are conducted. When the team conducts an exercise, the road leading to the site is sealed off and in some instances other portions of TA-49 are cleared. The TA-49 safety officer will coordinate with the HDT safety officer about firing schedules and make arrangements for appropriate routine and emergency procedures at the site.

3.1.7 M-Division Testing

TA-49 acts as a buffer zone for M-division experiments involving high explosives at the adjacent PHERMEX firing site and other firing sites at TA-15. Due to the proximity of PHERMEX to TA-49, it is possible that workers at the site could be exposed to shrapnel and excessive noise associated with these experiments. Whether personnel need to be evacuated from TA-49 depends on the size of the experiment. M-Division has strict standard operating procedures for the notification and evacuation of personnel. Hazard circles associated with different size experiments are shown in a Figure in Appendix B.

Plan D at PHERMEX includes within the hazard circle a small part of the northeast section of TA-49 and part of the access road from TA-49 into Water Canyon. Plan E at PHERMEX includes about one-half of TA-49 and all of the access road. Plan D and E experiments are very large shots which are conducted very infrequently.

On the workday before all Plan D and E experiments, the M-4 Clearance controller will notify either OM-1 or EM-DO. On test day, at least thirty minutes before the test, the Clearance Controller will confirm with the TA-49 OU Site Safety Officer that clearance of the area has been completed. After the test, M-4 will notify OM-1 and the Site Safety Officer that it is "all clear." If delays are expected to last thirty minutes or more, the M-4 Clearance Controller will notify OM-1 and the Site Safety Officer and will advise if clearance of TA-49 needs to be maintained.

3.1.8 Traffic

Traffic control will be maintained in and around the job site at all times to avoid personnel infuries and prevent equipment damage. Work areas regularly occupied by pedestrians will be delineated so that vehicle equipment operators will not encounter them. Delineation will be accomplished using barricades, warning signs, warning lights, traffic cones, and so forth.

If work takes place in or near heavy traffic areas, these areas will be appropriately marked with the aforementioned devices as necessary to protect personnel. Personnel will wear fluorescent orange and/or reflective clothing, vests, and so forth when working in and around traffic areas.

Sufficient parking will be provided. Vehicles not being actively used will be parked so that they do not interfere with traffic. When a vehicle is being maneuvered in a confined area with limited visibility, personnel positioned outside the vehicle will give assistance to the operator.

Pedestrian and civilian traffic have the right-of-way on site. Personnel on foot will be careful when around heavy equipment and when walking near roads. Ground personnel should always make eye contact and wait for a signal to proceed before passing close to or in front of operating equipment or moving vehicles.

All drivers and operators will adhere to speed limits, signs, and road markings. Equipment operators and ground personnel will be especially careful when air-line respirators are in use because of the potential for injury if an air line were to become tangled in the track or wheel of a vehicle or equipment. Under no circumstances will breathing air systems supplying air to the respirators of ground employees be attached to vehicles or equipment.

3.1.9 Topography

To reduce hazards associated with topography, the Site Safety Officer will inspect each site for potential hazards. Some of these hazards can be alleviated, such as removing any obstacles in immediate work areas, clearing icy surfaces, and placing tools in an accessible but protected area. Boundaries surrounding excavations, trenches, and boreholes will be marked. In general field team members conducting site activities near the edge of a mesa will not be permitted to work closer to the edge than 5 ft. Barrier tape will be used to designate this restricted area. All field team members will be informed of the potentially hazardous locations as well as of the controls. Field team members also will be expected to observe good housekeeping practices for the duration of the work in each area.

3.1.10 Lightning

Lightning usually strikes the tallest object in an area and takes the least conductive route to ground. Buildings or vehicles provide better protection than being in the open. A large building with a metal structure is the safest because electric current will run along the outside metal frame and into the ground. An automobile with a metal roof serves the same purpose; however, convertibles or fabric-topped cars are not safe because lightning can burn through the fabric.

Wood or brick buildings that are not protected by lightning rods have high potential for a strike which travels down natural conductors such as wiring or pipes. Any contact with an undergrounded conductor can be dangerous. Telephones, faucets, electrical equipment, and metal fences are examples of ungrounded conductors.

A person in the open during a lightning storm should crouch to avoid being the tallest object. A tingling sensation or hair standing on end signal that lightning is about to strike and that a crouching position must be assumed immediately. The safest crouching position is to place the hands on the knees and to keep the knees and feet together while remaining as low as possible. Stretching out flat on damp soil could cause the body to attract current running into the ground from a nearby tree. Keeping feet and knees spread or placing the hands on the ground could complete a circuit and cause high-voltage current to run throughout the body.

A grove of trees affords more protection than remaining in the open or taking shelter under a single tree. Lower ground is also safer; however, ditches and ravines in sizable drainage areas present the danger of being carried away by flood waters.

Side strikes injure more people than direct strikes. Side strikes are caused when electric current jumps from its present conductor to a more effective conductor. Since the human body is a better conductor than a tree trunk; a person should stay 6 ft from a tree to avoid a side strike. A group of people taking shelter under a grove of trees should stand 6 ft apart to avoid side strikes from one person to another.

The force of electrical current temporarily disrupts the nervous system. Therefore, even if breathing and heartbeat have stopped, a lightning victim may not be dead. Many victims can be revived by artificial respiration and CPR. Once the lightning flash is over, current is no longer running through the body and it is safe to touch a lightning victim. Even a victim who seems only slightly stunned should receive immediate medical attention because internal organs may be damaged.

3.2. Task-by-task Risk Analysis

According to OSHA 1910.120, a task-by-task risk analysis is required. These tasks are related to specific operations or activities in the field investigation. The preceding section identifies the physical, chemical, radiological, and biological hazards known or suspected to be present at the TA-49 OU. This section is designed to discuss many of the proposed tasks and identify which of the hazards apply and estimate the likelihood of exposure. Sections 3.3, 3.4, and 3.5 of this Annex identify methods for eliminating or reducing the potential exposure to the hazards associated with these tasks.

Task: Drilling

Potential for Exposure: High

Associated Hazards: In drilling, there is a possibility for serious physical injury. The injuries may range from bruised and cut fingers to death. Working around a drill rig allows for entanglement and pinch points in many parts of the rig. These injuries are generally minor but have the potential for amputating fingers. Other severe injuries may occur from failure of wire rope under extreme stress. If the rope breaks under high tension, it will act as a whip, which could decapitate workers in the area.

Chemical and radiological hazards also are created when drilling disturbs or penetrates a contaminated soil.

Task: Hand Augering

Potential for Exposure: Moderate

Associated Hazards: The hazards for hand augering are similar to those of drilling. The potential for contact with contaminated soils is enhanced, and this operation will have a tendency to stir up dust. Powered hand augers still present hazards of operator entanglement and pinch points but to a lesser degree. With a nonpowered hand auger, the probability of physical injury is reduced greatly.

Task: Trenching

Potential for Exposure: High

Associated Hazards: The main physical hazards associated with trenching operations derive from the use of heavy equipment and the potential for cave-ins. Operators of heavy equipment are trained to be aware of personnel around the area. However, operators can be distracted or lose concentration. Therefore, personnel must be alert while backhoes are operating. Cave-ins occur when the wall of the excavation cannot bear the load and collapse. Cave-ins can occur in trenches of all depths, but this hazard can be reduced substantially by limiting trench depths to 5 ft or less. Physical injuries, as a result of cave-ins, range in severity with the most severe being death.

Chemical/radiological hazards may be encountered while trenching is in progress and the most concentrated personnel exposure may occur from the resuspension of contaminated dust. Air monitoring at this time is critical. In contrast, the accumulation of organic vapors inside the trench will most likely occur after the trench has been completed, but this is not expected to be significant at the TA-49 OU due to the lack of significant organic contamination.

3.3 Engineering Controls

OSHA regulations state that when possible, engineering controls should be utilized as the first line of defense for protecting workers from hazards. Engineering controls are mechanical means for reducing the hazard to workers, such as the guarding of moving parts on machinery and tools or utilizing a ventilation hood in a lab to remove contaminant vapors. Unfortunately, engineering controls are not as easily accomplished in an uncontrollable environment, such as outdoors. However, the following are some possibilities that can be utilized while working in the field.

3.3.1. Engineering Controls For Airborne Dust

Airborne dust can be a hazard in two situations: 1) nuisance dust for which standards have been established at 10 mg/m3; and 2) attachment of radionuclides and/or hazardous substances to soil particles. In either case, engineering controls may have limited use when airborne dust becomes a hazard.

During drilling or any other activity where localized dust is being generated, a small garden sprayer of water may be used to wet the soil enough to suppress the dust. Although this technique can be effective in some cases, sprayers do not discharge a large amount of water and spraying must be repeated often to maintain effectiveness.

Where there are high winds in a large, dusty area with little or no vegetation, small quantities of water are not effective. In this instance, a water truck may be used to wet the area enough to suppress the dust. This also will require frequently repeated applications to be effective.

3.3.2. Engineering Controls For Airborne Volatiles

Drilling and trenching activities may produce gases, fumes or mists. These may be easily inhaled or ingested by workers with no protection. Engineering controls may be implemented to reduce the exposure to these hazards. Wind can remove toxic vapors from the work area with careful positioning of equipment, such as a drill rig. For example, a rig might be positioned so that the prevailing wind blows towards the side of the rig. This allows the vapors to be blown away from personnel behind the rig and prevents the vapors from collecting under the rig, and allows for an upwind approach of workers not performing duties directly related to the drilling.

Another method is the use of ventilation by mechanical means, which may not be as effective as wind in open areas, but generally is more practical in closed or confined spaces. Fans may be used to remove vapors or even to supplement a gusting wind. The most effective use of ventilation using mechanical equipment is for sampling tanks or performing confined space work. The fan or other mechanical device may be attached to a large hose to either push, or more effectively pull, the contaminant from the confined space. Each has its advantages. Pulling the air from the space is more effective at removing the vapors, whereas forcing air into the confined area provides for better assurance of acceptable oxygen levels from ambient air. This procedure has been used effectively by fire departments, who may be consulted for information on the most effective method for each situation.

3.3.3 Engineering Controls For Noise

Engineering controls for noise are difficult to implement in uncontrolled environments. Drilling and trenching is likely to produce the highest range of noise levels. Fortunately, noise produced from drilling is generated by the engine itself. On most rigs, the highest range of noise is encountered on the side of the rig, while drillers perform a majority of their work behind the rig. This is because the front and rear of the rig's engine often are covered, whereas the sides are left open to allow cooling of the engine. If noise levels reach 90 dB, additional barriers should be utilized, if possible, to reduce excessive noise exposure.

3.3.4. Engineering Controls For Trenching

Trenching often presents field personnel with hazards associated with slip, trip, fall, and crushing type hazards. In most cases, entry into an excavation deeper than 5 ft is avoided whenever possible. However, it is sometimes necessary to enter these trenches to obtain the needed information. OSHA has developed regulations for trenches and excavations. Included in the regulations are engineering controls for the prevention of cave-ins. These controls include the addition of shoring, sloping, and benching to the excavation. Benching is a systematic series of steps dug around the excavation at a specified angle of repose. The angle of repose is based on the type of soil present. Sloping is a similar system of stabilizing soil but is performed without the steps. Again the angle of repose is determined by the type of soil. This method is generally used for medium-sized excavations, such as a tank removal. In general, neither of these soil stabilization methods are convenient techniques for exploratory trenches. The last method that OSHA suggests is shoring. Shoring is available in many different varieties, but the basic theory is the same. The sides of the excavation are supported by some type of wall that is braced to prevent cave-ins. This method is used most often in deep, narrow trenches for installing water pipe or drainage systems and exploratory trenching. One drawback to utilizing shoring is that it is expensive and time-consuming, especially for a trench that is only scheduled to be open for 1 or 2 days. Administrative controls and personnel protective systems are more desirable and realistic for the RFI work plan at TA-49.

3.3.5 Engineering Controls For Drilling

Working with and around drill rigs presents workers with many hazards, due to the number of moving parts and the power associated with the equipment. Engineering controls for drilling operations include the installation of guarding where possible to prevent crushing injuries and, more importantly, an inspection program to insure replacement of worn or broken parts. As stated earlier, this should be performed at the beginning of the job and on a regular basis during the project.

3.4 Administrative Controls

Administrative controls are necessary when hazards are present and engineering controls are not feasible. Administrative controls are a method for controlling the degree to which personnel are exposed to a hazard. Examples include the amount of time a worker spends in a hazardous area or the distance to a hazardous area. Such controls can be instituted easily in most cases and are effective measures in decreasing personnel exposure.

3.4.1 Administrative Controls For Airborne Chemical and Radiological Hazards

Chemical and radiological hazards are to be monitored during the performance of duties in the contaminated zone. If concentration of radionuclides or toxic materials exceeds the limits established in this plan, personnel may be removed from the area until natural or mechanical ventilation brings the levels to background. This method would prevent the necessity of using personnel protective equipment. In addition, personnel should enter the contaminated zone only when required. This method complies with DOE's policy of maintaining exposures As Low As Reasonably Achievable (ALARA).

Because the exposure limits consider the average amount of exposure during an 8-hr day, personnel exposed at a higher concentration for a portion of the day may conduct tasks in an uncontaminated area to lower the average for the day. For chemical contaminants, those higher concentrations must be lower than the Immediately Dangerous to Life and Health (IDLH) concentration and the TLV Ceiling limits.

3.4.2. Administrative Controls for Noise

Administrative controls for noise include both time and distance. The principle is very much like the controls used for both airborne chemical and radiological hazards. In Section 3.1.1 of this Annex, noise is discussed, and guidelines on administrative controls established by ACGIH are listed in a table. The basic idea is to increase the distance between the noise and the worker or decrease the time spent at the source. Sound pressure or intensity follows the inverse square law where, as the distance from the source increases, the sound level decreases as the square of the distance. For example, if sound levels at 10 ft from the source are 100 dB and the distance (20 ft) from the source is doubled, the sound level drops to 94 dB; at 30 ft, or triple the distance to the source, the sound level drops to 90 dB.

If reduction of exposure time or distance is not possible, personnel protective equipment must be donned to protect workers.

3.4.3. Administrative Controls for Trenching

Administrative controls are the most effective methods for reducing the hazards of trench investigations which may be proposed for the TA-49 RFI. These administrative controls were established by OSHA during the development of the regulations. The basic philosophy behind the administrative controls for trenching is not to create a hazardous condition to begin with. Trenches less than 5 ft deep do not require protective systems (sloping, benching , or shoring). All trenches should be excavated to a depth less than 5 ft, where possible. However, monitoring inside the trench and means of egress (every 25 ft) must be implemented at a depth of 4 ft. Soil piles, tools, and other debris must be stored at least 2 ft from the edge of the excavation. All excavations must be marked when the area is not occupied to restrict access.

Even though standard procedures are followed, accidents may still occur due to human error or other circumstances. A backhoe operator may not see or know if there are workers in the trench. Therefore, any time there are personnel in the trench the operator must shut down the equipment until the excavation has been evacuated. Inspections should be made by a competent person before any field team member is allowed to enter the excavation. Additionally, personnel are required to be aware of conditions inside the trench as well as the activities going on outside the excavation.

3.4.4 Administrative Controls for Working Near the Mesa Edge

Slip, trip, and fall hazards exist around the mesa edge. These hazards may be avoided by good housekeeping around work area nears the edge of the mesa. Additionally, personnel working should not get closer than 5 ft to the edge unless close approach is really required. If necessary, bannerguard will be used to delineate this restricted area.

3.5 Personnel Protective Equipment and Systems

In the event that engineering and administrative controls are not suitable, personnel protective equipment should be used as a last line of defense against hazards. This equipment may be used alone or as a supplement to existing safety systems and to enhance the degree of safety for workers. Personnel protective equipment is a garment or apparatus that is worn by field team members to protect them from a certain type or group of hazards. Some examples of personal protective equipment are, TYVEK, hard hat, gloves, safety harness, respirator, etc. The maintenance, inspection, procedures and training for personal protective equipment usage will follow the H&S Program of the organization that implements this plan. The following sections discuss the protective equipment or systems to be used in certain situations.

3.5.1 Protection Levels and Protective Clothing

The U.S. EPA has established four levels of protection for workers entering potentially hazardous sites. At many of the SWMUs at the TA-49 OU, the contaminants have been identified. Therefore, an assessment of personal protective levels has been made based on each of the contaminants, investigation activities, and the areas to be investigated (see Table III-1). Action levels for upgrades in levels of protection are based on those factors and are given in Section 3.5.2, Action Levels for Upgrade in Protection.

The majority of site characterization will begin in modified level D protection. In certain cases, Levels B or C may be prescribed due to the amount or toxicity of the contaminants present. Personnel entering contaminated zones are required to meet the level of protection designated for that area. The levels of protection and the minimum equipment allowed for each of the levels of protection are as follows:

Level A Protection will include the following:

- a full face, positive pressure, self-contained breathing apparatus (MSHA/NIOSH-approved);
- fully encapsulating chemical-resistant suit;
- inner glove (pvc, latex, or nitrile);
- rubber outer gloves providing an effective barrier between the wearer and contamination;
- steel-toed safety boots made of rubber or leather when disposable boot covers are donned;
- two-way radio communications; and
- hard hat, safety glasses, and hearing protection as needed.

Level B Protection will include the following:

- a full face, positive pressure, self-contained breathing apparatus (MSHA/NIOSH-approved);
- chemical-resistant disposable clothing suitable for protection against the hazards of concern;
- inner glove (pvc, latex, or nitrile);
- rubber outer gloves providing an effective barrier between the wearer and contamination;
- steel-toed safety boots made of rubber or leather when disposable boot covers are donned; and
- hard hat, safety glasses, and hearing protection as needed.

Level C protection will include the following:

- full face, air purifying respirator (MSHA/NIOSH-approved) with cartridges or canisters capable of filtering contaminants of concern;
- contaminant-resistant clothing suitable for protection against the hazards of concern;
- inner glove (pvc, latex, or nitrile);
- rubber outer gloves providing an effective barrier between the wearer and contamination;
- steel-toed safety boots made of rubber or leather when disposable boot covers are donned; and
- hard hat, safety glasses, and hearing protection as needed.

Modified Level D protection will include the following:

- cloth or TYVEK coveralls, or work uniform;
- rubber or leather outer gloves providing the best protection for the activity being performed;
- steel-toed safety boots and optional boot covers as needed; and
- hard hat, safety glasses, and hearing protection as needed.

The field team leaders are required to provide this equipment to each of their field team members.

TA-49 RFI activities will be conducted according to LANL Administrative Requirement 12-1, Personal Protective Equipment; and LANL Technical

Bulletins 1201, Eye and Face Protection; 1202, Protective Clothing; and 1203, Respiratory Protective Equipment.

3.5.2 Action Levels for Upgrade in Protection

Monitoring instruments are to be used in conjunction with lab analysis to establish the exposure levels of field team members. These instruments will monitor for radiation, volatile organics, corrosives, flammable vapors, and particulates. Action levels will be established based on the results obtained during SWMU-specific monitoring. In some instances, laboratory screening and analysis with quick turn around will be necessary to determine the actual level of the specific chemical contaminant in air. For instance, there are no direct reading instruments for PCBs, but there is a real time aerosol monitor (RAM) that determines the amount of respirable dust present in the breathing zone. PCB soil concentrations from laboratory analyses thus can be used to calculate the total PCB concentration in air, based on a total particulate reading from the RAM.

Results of the calculations will be confirmed with air sampling. Air sampling during the TA-49 RFI will be used predominantly for determining alpha contamination in air. The organization selected to implement the monitoring will supply the method of maintenance and calibration for the specific instruments to be used.

The monitoring instruments to be used during this investigation are as follows:

Photoionization Detector (PID) and Flame Ionization Detectors (FID)

Photoionization and flame ionization detectors are used to monitor total organic vapors. A description of these detectors may be found in Section 9.3 of Annex III (H&S Plan) of the IWP.

Combustible Gas Indicator (CGI)

A CGI is used to monitor the concentration of flammable gases and vapors. A description of the CGI may be found in Section 9.3 of Annex III (H&S Plan) of the IWP.

Oxygen Meter

Portable oxygen meters are used to measure ambient oxygen concentrations in confined spaces or areas. A description of the oxygen meter may be found in Section 9.3 of Annex III (H&S Plan) of the IWP.

Real Time Aerosol Monitor

Real time aerosol monitors are designed to monitor respirable particulates (<10 microns). These instruments measure reflected light, which is converted to units of mg/m^3. These measurements are useful if there are known concentrations in soil of alpha contaminants, particulates, metals, and PCBs. Soil samples will be submitted for the laboratory analysis, and the results will be used to determine action levels for the contaminants that are present.

Colorimetric Indicator Tubes

Colorimetric indicator tubes may be used to quickly measure the approximate concentrations of specific vapors or gases. A description of colorimetric indicators is found in Section 9.3 of Annex III (H&S Plan)of the IWP.

High- and Low-Volume Air Samplers

High- and low-volume air samplers are used to collect particulates on a filter that is analyzed subsequently to determine the types and concentrations of airborne contaminants (e.g., alpha contamination). A description of air samplers is found in Section 9.3 of Annex III (H&S Plan) of the IWP.

Radiation Survey Meters

A variety of radiation survey meters will be used in the TA-49 RFI to determine the levels to which workers are exposed to radiation. Alpha scintillometers will be used to screen cores and personnel leaving the contaminated zone. A µR meter or a Gieger-Muller tube detector will be used to establish gamma exposure to field team members. In addition, Thermoluminescent Dosimeters (TLDs) will be worn by all workers while at TA-49 SWMUs.

Action Levels

The following guidelines are to be used at SWMU locations of the TA-49 OU. ER Program SOPs describe measuring procedures and frequency of monitoring.

Organics

Organic contaminant levels at TA-49 SWMUs have been estimated from the historical information gathered during the preparation of this plan. In general, organic contaminants are expected to be at or near background levels. If field monitoring or laboratory analysis proves this conclusion to be unfounded, appropriate guidelines will be instituted to ensure health and safety of workers.

Combustible Vapors

As appropriate, the CGI will be used to monitor for combustible atmospheres during drilling and trenching. One-minute readings will be used for boreholes and trenches to give the instruments time to equilibrate. At 20% of the LEL, personnel will be evacuated and engineering controls will be utilized to reduce the concentration of combustible vapors. Personnel may resume work when levels drop below 10% of the LEL.

Particulates, Metals, PCBs, and Alpha Contamination

As appropriate, real-time aerosol monitors will be used in conjunction with laboratory data to determine the concentrations of contaminants in air. Samples will be obtained to determine the amount of contaminants in soil and an action level will be calculated for that particular work area.

3.5.3 Safety Systems and Equipment

A variety of safety equipment will be used to protect personnel from physical hazards and to minimize exposure to hazardous chemicals and radionuclides during field activities at TA-49.

Hearing protection - If noise levels are above 85 dB and both engineering and administrative controls are not practical, hearing protection will be required. There are two basic types of hearing protection that are available: 1) disposable and reusable ear plugs, and 2) ear muffs. Ear plugs may reduce noise levels 25-30 dB and ear muffs 35-40 db if worn properly. Product information for specific protective devices will be used to determine the effective noise reduction rating.

Trench protection - Trench boxes and trench shields have been developed for trench operations where shoring, benching, and sloping are not feasible. A trench box or shield is a box constructed from a strong metal or wood wide enough for workers to move about inside and perform their duties. OSHA regulations specify criteria for the trench box to be considered safe. The trench box is placed in the trench and attached to a backhoe so that it may be pulled along as the work progresses. This type of system is used often in the installation of water systems. The walls of the trench may not be viewed from the box, and protection is voided when workers leave the box.

Fire Protection - Fire extinguishers are classed by the type of fire it is designed to extinguish, but may be effective for more than one class of fire.

Class A - ordinary combustible materials (wood, paper, and textiles)

Class B - flammable liquids (oil, grease, and paint)

Class C - electrical fires

Class D - metals capable of rapid oxidation (magnesium, sodium, zinc, aluminum, uranium, and zirconium)

Other Safety Equipment - In addition to the personnel protective devices described above, other safety equipment may be used as needed. LANL Administrative Requirement 12-2, Seatbelts, will be followed. Warming and cooling equipment may be necessary to minimize stress from climatic conditions. Emergency equipment will also be necessary for immediate response and emergency treatment. Additionally, the location of such equipment must be clearly marked and personnel should know the location and be trained in its use.

3.5.4 General Safety Practices and Mitigation Measures

Some hazards can be minimized by implementing specific safety procedures, work practices, special equipment, training of personnel, and emergency response equipment in case of an accident. Section 9.4 of Annex III (H&S Plan) of the IWP discusses some of these practices. The following routine measures will be taken:

- Daily planning and/or pre-activity meetings will be held for all personnel involved in field activities. These meetings will discuss health and safety concerns and refresh personnel on the emergency response plans.
- Workers will shower as soon as possible after field work.
- Control zones will be established according to the field activity and level of protection at each area of the OU, and will be specified in the form of maps in site-specific plans prior to the initiation of field work at each area. The plans will include the locations of administrative and medical support. Control zones will be established for safety as well as contamination control and decontamination procedures.
- If troublesome levels of dust are generated during augering or drilling activities, water may be used to suppress dust for the protection of field personnel.
- The buddy system will be employed as a general practice.

3.6 Site-access Control

3.6.1 Restricted-Access and Exclusion Zones

Restricted-access or exclusion zones will be established before work begins at contaminated sites to protect workers from unnecessary exposure to toxic materials and to prevent the spread of contamination. A general description of exclusion zones is found in Section 7.0 of Annex III (H&S Plan) of the IWP.

3.6.2 Decontamination

Personnel, equipment, and vehicles that have been in contaminated areas may carry residual contamination. Although protective clothing, respirators, and good work practices can help reduce contamination, decontamination may be necessary to prevent exposure of personnel and the inadvertent spread of contaminants.

Vehicles and equipment that are suspected of being contaminated will be cleaned with high pressure steam or equally effective systems. Vehicles and equipment suspected of being contaminated with alpha contamination will be screened with alpha survey instruments before being released from the site.

Personnel decontamination can be performed in all levels of protection. Disposable protective equipment need not be decontaminated but should be disposed of as a hazardous waste. Reusable protective equipment must be decontaminated using a soap and water wash and two successive rinses. Visual inspections of the equipment will help determine the effectiveness of the decontamination process. As with the equipment, personnel will be screened with an alpha scintillometer when working with or near alpha contaminated material. ER Program SOPs, established to guide the decontamination process, will be maintained onsite and will be followed at all times. Personnel decontamination procedures are specified in ER SOP 02.08, Personnel Decontamination. Equipment decontamination will follow ER SOP 02.07, General Equipment Decontamination. LANL Administrative Requirements for Waste Management are 10.1, Radioactive Liquid Waste; 10.2, Low-Level Radioactive Solid Waste; 10.3, Chemical, Hazardous and Mixed Waste; 10.4, Polychlorinated Biphenyls; and 10.5, Transuranic Solid Waste.

In addition to the following list, Section 10.0 of Annex IIII (H&S Plan) of the IWP contains information on decontamination:

1. The level of decontamination required will depend on the nature and magnitude of contamination and the type of protective clothing worn. Disposable clothing (i.e., TYVEK) will not be washed because water may transport contamination through the paper garment to the skin.
2. Waste water and materials used during decontamination will be contained for appropriate disposal. Arrangements will be made with LANL for acquisition and disposal of drums containing soapy water, rinse water, methanol, and trash.

3.7 Worker Training

Worker training will follow the requirements set forth in Section 11.0 of Annex III (H&S Plan) of the IWP. Field personnel will be given copies of all relevant SOPs and will be briefed on their uses. Field personnel also will read this OU Health and Safety Plan and Annex III (H&S Plan) of the IWP.

3.8 Employee Medical Program

In addition to the guidance provided in Section 12.0 of Annex III (H&S Plan) of the IWP, the following paragraph details specific program requirements.

Field team members who are exposed to contaminated materials during ER remedial investigations shall participate in a medical examination program provided by the Laboratory according to 29 CFR Part 1910 or DOE Order 5480.1B (Chapter VIII) Requirements. Suitability of field team members for conducting field sampling activities, including respirator use, shall be evaluated and documented by a physician. Medical programs must comply with the requirements of DOE Order 5480.1B Chapter VIII or 29 CFR Part 1910, as appropriate. LANL Administrative Requirements 2-1, Occupational Medicine Program, 3-6, Biological Monitoring for Radioactive Materials; 6-4, Biological Monitoring for Hazardous Materials; and LANL Technical Bulletin 606, Biological Sample Monitoring, shall be followed.

3.9 Records and Reporting Requirements

The ER H&S PL, working with the OU PL, Site Safety Officer, and Field Teams Manager, will ensure that health and safety records are maintained within the appropriate LANL group as required by DOE orders. The reports are as follows:

- DOE-AL Order 5000.3A, Unusual Occurrence Reporting
- DOE Form 5484.3, Supplementary Record of Occupational Injuries and Illnesses, Attachment 1.
- DOE Form 5484.4, Tabulation of Property Damage Experience, Attachment 2.
- DOE Form 5485.5, Report of Property Damage or Loss, Attachment 4.
- DOE Form 5484.6, Annual Summary of Whole Body Exposures to Ionizing Radiation, Attachment 13.
- DOE Form 5484.1, Summary of Exposures Resulting in Internal Body Depositions of Radioactive Materials for CY 19____, Attachment 14.
- DOE Form 5484.8, Termination Occupational Exposure Report, Attachment 10.
- DOE Form OSHA-200, Log of Occupational Injuries and Illnesses, Attachment 7.
- DOE Form EV-102A, Summary of Department of Energy and Department of Energy Contractor Occupational Injuries and Illnesses, Attachment 8.
- DOE Form 5821.1, Unplanned Releases Form, Attachment 15.

Copies of these reports will be stored with the appropriate LANL group. Specific reporting responsibilities are given in the following sections and in Chapter 1, General Administrative Requirements of the LANL H&S Manual.

3.9.1 Exposure and Medical Records

Confidential records of the medical status of each field team member, obtained through the employee medical program, will be maintained with the appropriate Laboratory group and, as necessary, coordinated with the ER Program office. The requirements established below must be met in addition to the requirements set forth in Section 13.1 of Annex III (H&S Plan) of the IWP. Field team members will be issued a radiation dosimeter by LANL, according to Administrative Requirement 3-1, Personnel Radiation Exposure Control.

DOE Forms 5484.1, Summary of Exposures Resulting in Internal Body Depositions of Radioactive Materials for CY 19___, and 5484.6, Annual Summary of Whole Body Exposures to Ionizing Radiation, will be submitted annually by March 31 for monitored employees. Preparation of these reports will be coordinated with the HS-1 Radiation Protection Group.

3.9.2 Unusual Occurrence

All unusual occurrences must be reported by the OU Site Safety Officer to the H&S PL, Field Teams Manager, and TA-49 OU PL in accordance with Section 13.2 of Annex III (H&S Plan) of the IWP.

3.9.3 Accident/Incident Reports

The LANL Project Leader will submit a completed DOE Form F 5484.X for any of the following accidents/incidents, according to LANL Administrative Requirement 1-1.

1. Occupational Injury is any injury such as a cut, fracture, sprain, or amputation that results from a work accident or from an exposure involving a single incident in the work environment.

NOTE: Conditions resulting from animal bites, such as insect or snake bites, or from one-time exposure to chemicals are considered injuries.

2. Occupational Illness of an employee is any abnormal condition or disorder, other than one resulting from an occupational injury, caused by exposure to environmental factors associated with employment. It includes acute and chronic illnesses or diseases that may be caused by inhalation, absorption, ingestion, or direct contact with a toxic material.
3. Property Damage Losses of $1,000 or more must be reported. Accidents that cause damage to DOE property, regardless of fault, or accidents wherein DOE may be liable for damage to a second party, are reportable where damage is $1,000 or more. Include damage to facilities, inventories, equipment, and properly parked motor vehicles. Exclude damage resulting from a DOE-reported vehicle accident.
4. Government Motor Vehicle Accidents resulting in damages of $150 or more or involving an injury, unless the government vehicle is not at fault, damage of less than $150 is sustained by the government vehicle and no injury is inflicted on the govemment vehicle occupants.

Accidents also are reportable to DOE if

- damage to a govemment vehicle not properly parked is greater than or equal to $250;
- damage to DOE property is greater than or equal to $500 and the driver of a government vehicle is at fault;
- damage to any private property or vehicle is greater than or equal to $250 and the driver of a government vehicle is at fault; and

- any person is injured and the driver of a government vehicle is at fault.

3.10 Employee Information

The site safety officer shall ensure that the following DOE and LANL forms are posted where field team leaders and field team members can easily read them:

- Form F 5480.2, Occupational Safety and Health Protection
- Form F 5480.4, Occupational Safety and Health Complaint Form
- LANL Special Work Permit
- OSHA Job Safety and Health Protection Form

The LANL health and safety standard concerning employees' right-to-know also shall be posted at the work site. Additionally, employees will be required to sign the form in Table III-4 prior to initiation of field work.

Other information which shall be made available to site employees include:

- IWP, TA-49 OU work plan and ancillary documents;
- Pertinent Laboratory H&S documents including administrative policy and SOPs;
- Field monitoring data; and
- Personal monitoring data (e.g., TLD results) and personal medical records for the requesting individual

4.0 Emergency Response and Notification

This section provides information on responding to emergency situations. LANL Administrative Requirement 1-2, Emergency Preparedness, Administrative Requirement 1–8, Working Alone, and Technical Bulletin 101, Emergency Preparedness, were used in developing an emergency response plan.

4.1 Emergency Contacts

The names of persons and services to contact in case of emergencies are given in Attachment III-2. 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.

The emergency contact number for the Laboratory is 9-911 (911 also works).

4.2 Contingency Plans

This section considers contingency plans for specific types of emergencies. The site safety officer, with assistance from the field teams manager and, if needed, the field team leader, shall have responsibility and authority for coordinating all emergency-response activities until the proper authorities arrive and assume control. Evacuation plans and routes are discussed in Section 4.2.3, Emergency Response Plan, of this annex.

4.2.1 Fire/Explosion

In the event of a fire, the work area will be evacuated and the LANL Fire Department will be notified. In the event of an explosion, all personnel will be evacuated, and no one will enter the work area until it has been cleared by Laboratory explosives safety personnel.

If a combustible gas meter indicates gas concentrations at levels of 20% of the lower explosive limit, personnel will be evacuated from that area. The site safety officer will continue monitoring to determine when equipment should be removed or when personnel may re-enter the area and resume work.

4.2.2. Personnel Injuries

In case of serious injuries, the victim(s) will be transported to a medical facility as soon as possible. The Laboratory Fire Department provides emergency transport services. Minor injuries may be treated by trained personnel in the work area. All injuries should be reported to the HS-2 Occupational Medicine Group. In the event that an injured person has been contaminated with chemicals, decontamination will be performed to prevent further exposure (as outlined in Subsection 4.6.2) only if it will not aggravate the injury. Treatment of life-threatening or serious injuries will always be undertaken first. If exposure occurs to hydrofluoric acid, HS-2I must be notified immediately and a special paste will be obtained for application to the affected area.

4.2.3 Emergency Response Plan

A map will be attached to each field copy of this OU Health and Safety Plan which gives the most current information on routes to the Laboratory's HS-2, Occupational Medicine Group and the Los Alamos County Medical Center.

For general emergencies that require evacuation (i.e., fire, medical, security, releases, etc.) an emergency response plan specific to TA-49 is required by OSHA 1986. In a worst case, an evacuation of all personnel from TA-49 would be required; in most instances a safe distance onsite may be established to protect personnel.

The signal for site evacuation will be two long blasts on an air horn. The crew will gather at a specified location (normally at the vehicles) and proceed away from the affected area. One person should find the nearest phone at a safe distance and call the fire department at 9-911. The phone and the evacuation route used by field personnel should be in the direction away from the affected area and toward the TA-49 exit at State Road 4 (this is the only routine exit from TA-49). At the exit, all personnel will wait until every person in the field crew has been accounted for. The OU Site Safety Officer will determine the next course of action.

A major release or fire involving hazardous or radioactive materials may warrant a different approach. This will be signaled by two short blasts on an air horn. If the signal is heard, personnel will meet at a predetermined area, which will be determined based on wind conditions. A portable wind sock or streamer will be positioned at each work location and personnel notified of the location. If the horn is sounded, all personnel will move in an upwind direction as much as possible without entering a plume. If the source of the fire or release is directly upwind, personnel will move away from the plume (if visible). Once a safe distance is reached, all personnel are to be accounted for. The field team manager and the site safety officer will be responsible for this task. At that time, the OU Site Safety Officer will determine the next course of action.

For a less severe accident, such as a minor release or small fire, site evacuation may not be necessary. This scenario will be signaled by one long blast on an air horn. All personnel will meet at a designated area (e.g., the vehicles) and all personnel will be accounted for by the OU Field Team Leader and/or Site Safety Officer. Further instructions will be given by the Site Safety Officer.

These procedures will be reviewed at least once per week to remind field personnel of the procedures and the signals. Summarized below are the signals for easy reference. This information will be posted at prominent locations at each work location with other H&S information.

- Major fire - two long blasts on the air horn
- Major release - two short blasts on the air hom
- Minor fire or release - one long blast on the air hom

4.2.4 Additional Emergencies

For information on accidental release of hazardous materials into the environment, unusual events, site alerts, site emergencies and general emergencies, see Chapter 7 of Annex III (H&S Plan) of the IWP.

4.3 Notification requirements

In emergency situations, field team members will notify the Site Safety Officer. The Site Safety Officer's responsibility is to notify the appropriate emergency assistance personnel (e.g., fire, police, ambulance), the field teams manager and the LANL HS Division Office according to DOE Order 5500.2 and DOE-AL

Order 5500.2B and 5000.3A. The LANL HS Division Office is responsible for implementing notification and reporting requirements according to DOE Order 5484.1A, DOE Order 5484.2, and DOE AL Order 5484.2.

References for Annex III

EPA (US Environmental Protection Agency) 1988, Office of Emergency and Remedial Response, Hazardous Response Support Division, Environmental Response Team, Standard Operating Safety Guides (S0S6) (EPA 1988, 0609).

LANL November 1991. "Installation Work Plan for Environmental Restoration", Revision 1, Volume I and II, No. LA-UR-91-3310,Los Alamos National Laboratory, Los Alamos, New Mexico. (LANL 1991, 0145)

NIOSH(National Institute for Occupational Safety and Health), OSHA (Occupational Safety and Health Administration), USCG (US Coast Guard), and EOA (Environmental Protection Agency), "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities," October 1985. (NIOSH 1985, 0414)

OSHA (Occupational Safety and Health Administration), July 1, 1991. "Hazardous Waste Operations and Emergency Response," Code of Federal Regulations,(title) Title 29, Part 1910.120, Washington, DC. (OSHA 1991, 0610)

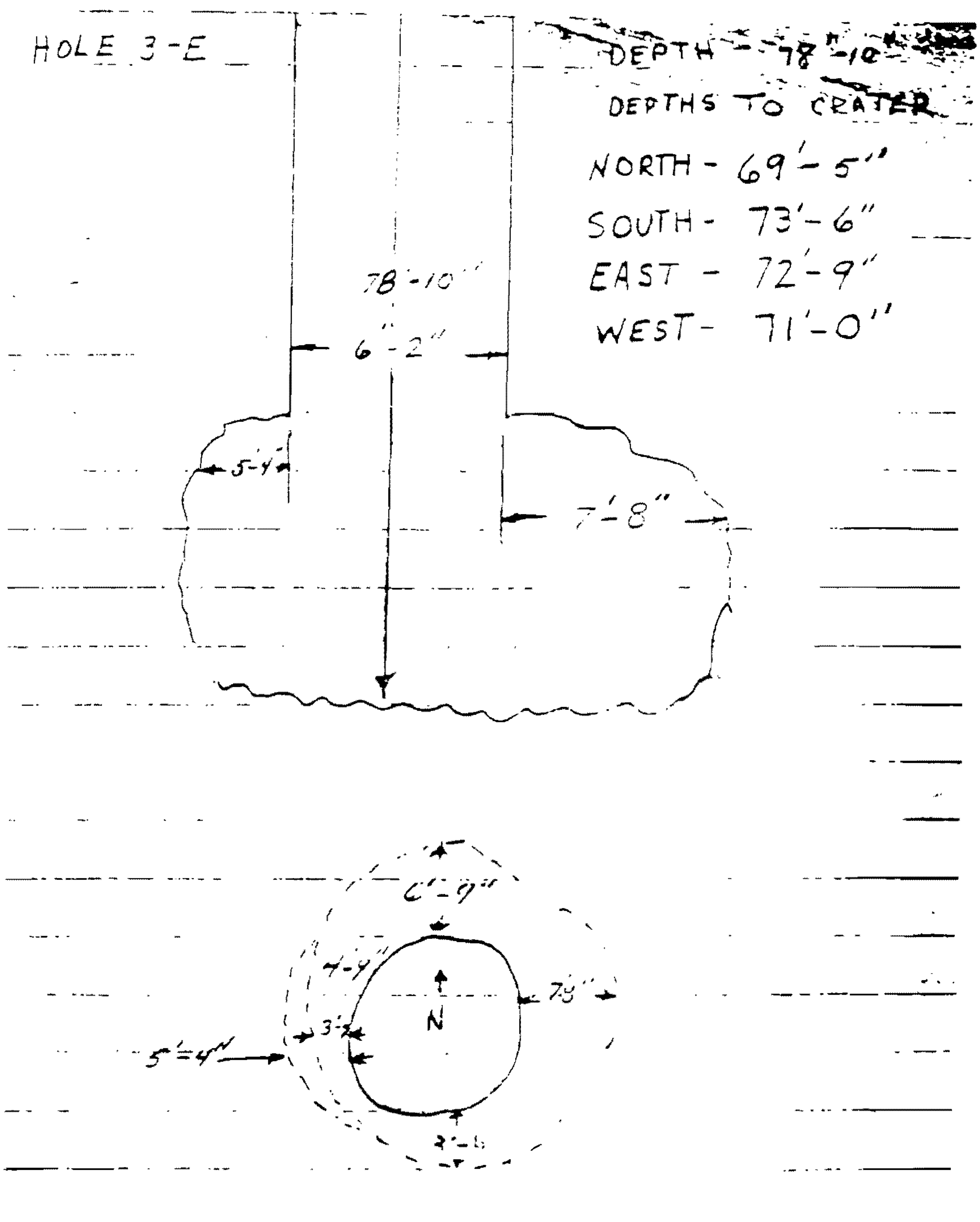


Figure B-18 Sketch of chamber created by detonation in hole 3-E.

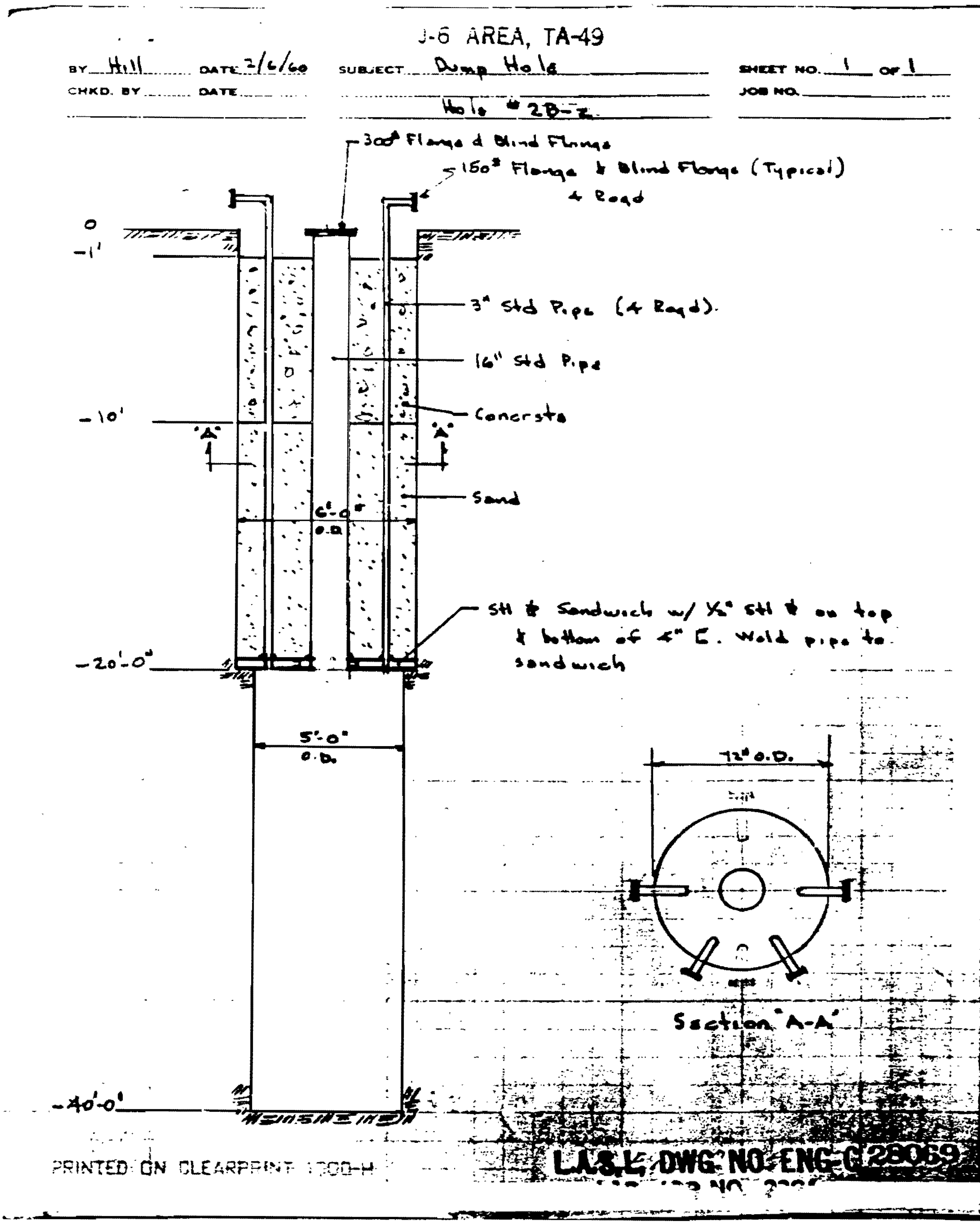


Figure B-17 Dump hole construction details.

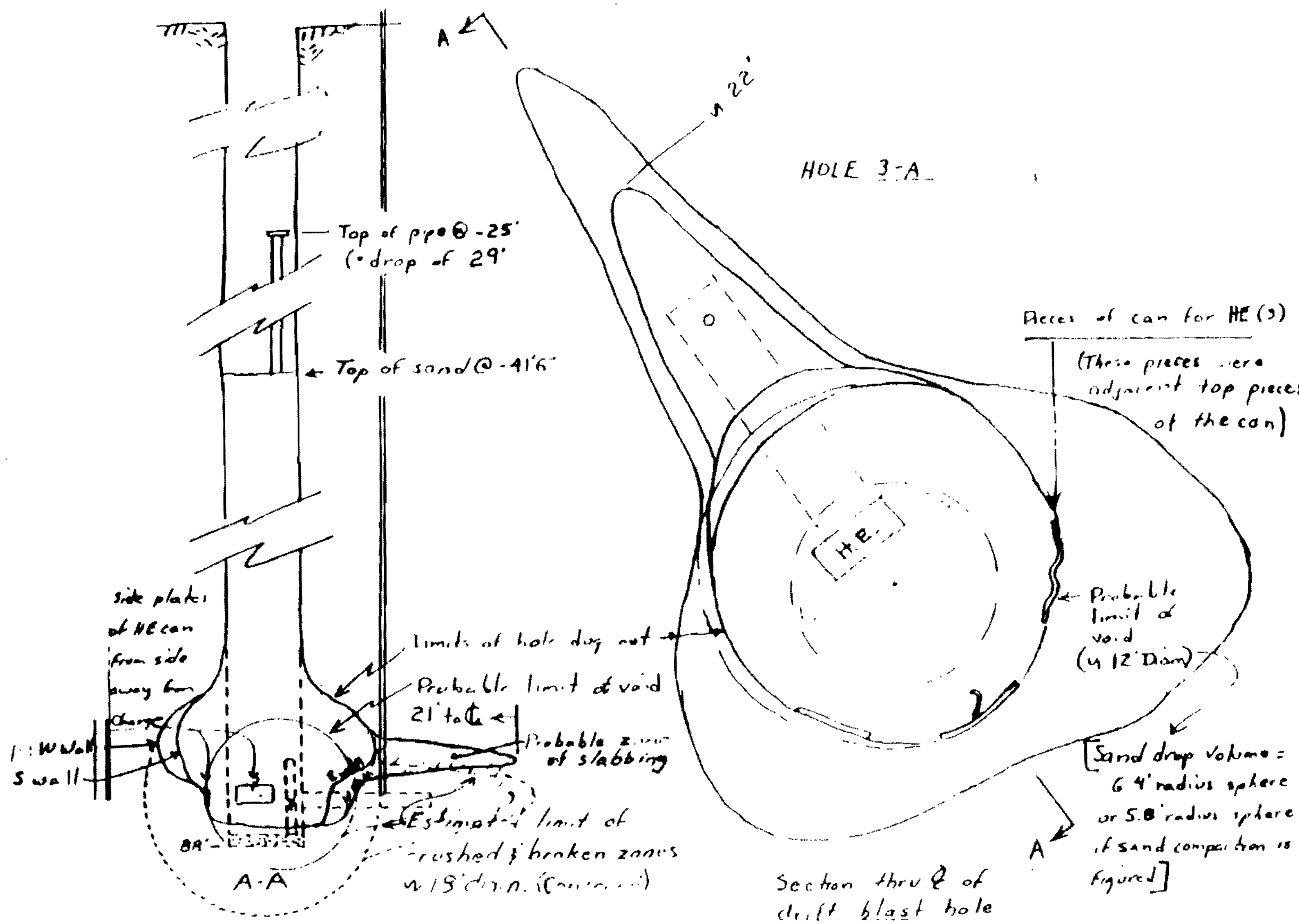


Figure B-19 Sketch of hole 3-A, after excavation.

HOLE 3-A

1. Start with void + Sand driven ~10' up hole + a large positive pressure in hole.

2. Drop broken material //// into void

3. Drop volume "A" by slabbing of incompetent layers of tuff

4 Allow piston to descend throwing sand + powdered tuff into side hole & mixing all debris slightly

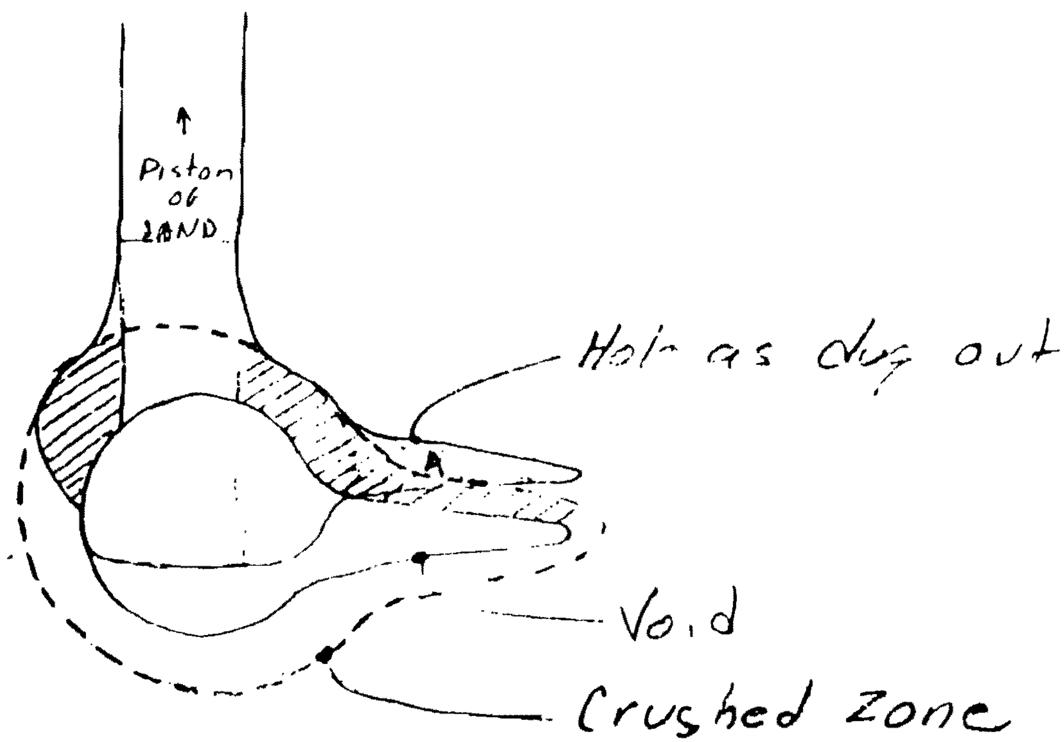


Figure B-20 Sketch of chamber created by detonation, hole 3-A.

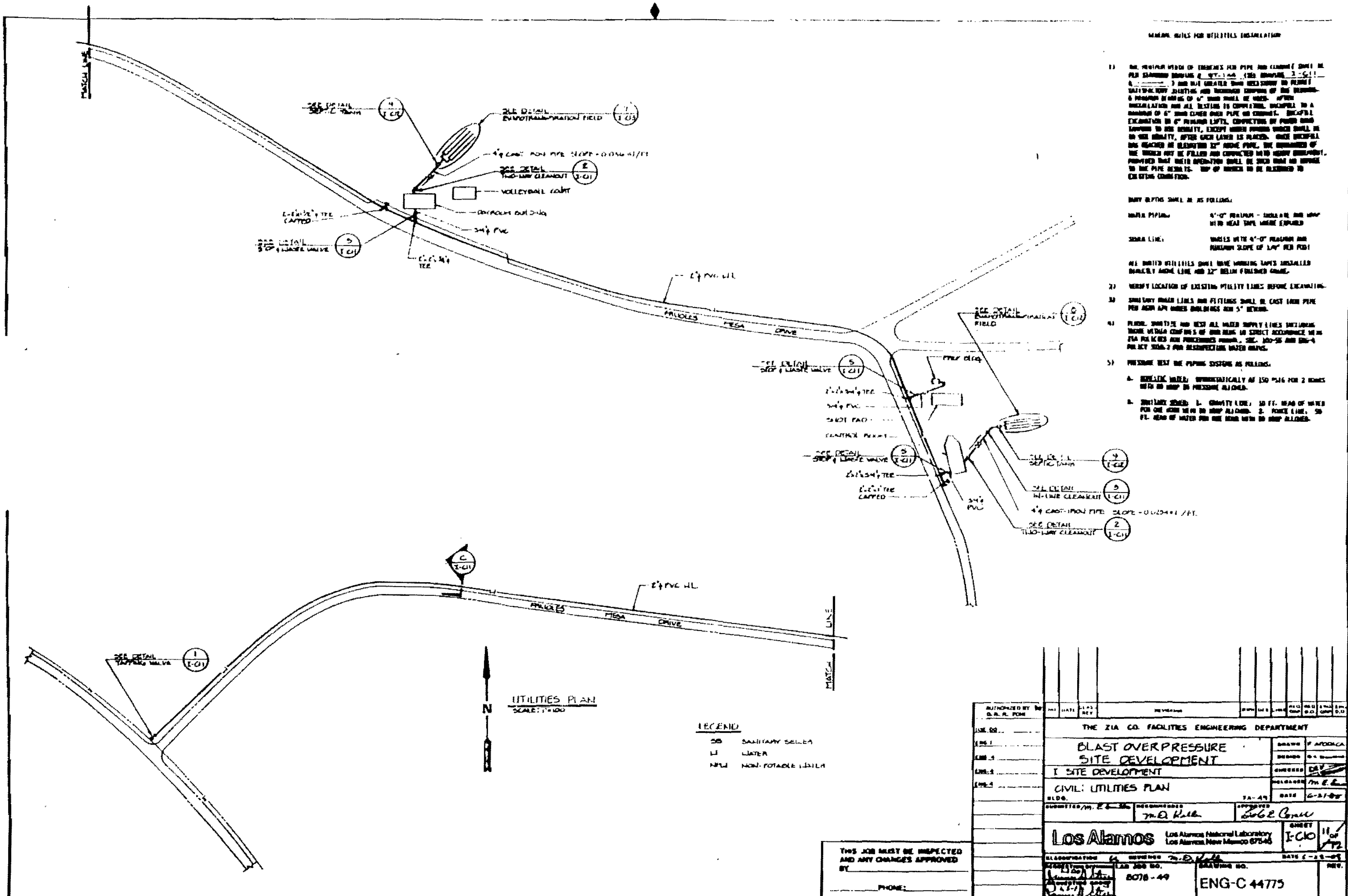


Figure B-21 Location of TA-49 septic systems (6/21/85).

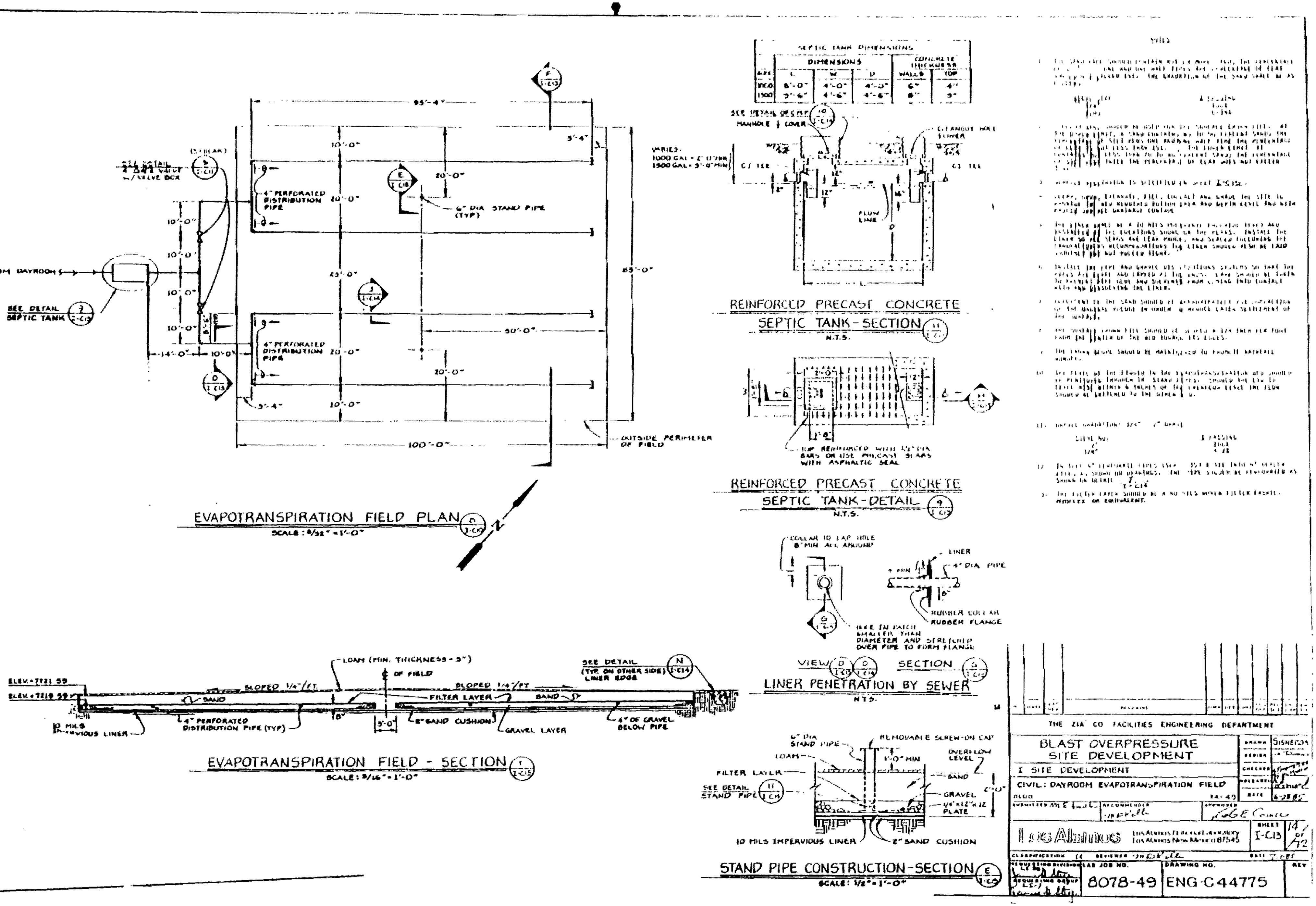


Figure B-22 Engineering details of TA-49 evapotranspiration field and septic tank (6/21/85).

STRUCTURE NUMBER	STRUCTURE DESIGNATION	STRUCTURE NOMENCLATURE	REMARKS	APPROXIMATE GRID LOCATION
TA-15-1	R-1		REMOVED 1962	
TA-15-2	R-2		REMOVED 1967	
TA-15-3	R-3		REMOVED 1955	
TA-15-4	R-4		REMOVED 1955	
TA-15-5	R-5		REMOVED 1962	
TA-15-6	R-6		REMOVED 1959	
TA-15-7	R-7		REMOVED 1962	
TA-15-8	R-8	SHOP BUILDING		S 20+00E 65+00
TA-15-9	R-9	CONTROL CHAMBER	FIRING POINT G	S 65+00E 80+00
TA-15-10	R-10		REMOVED 1967	
TA-15-11	R-11		REMOVED 1967	
TA-15-12	R-12		REMOVED 1967	
TA-15-13	R-13		REMOVED 1967	
TA-15-14	R-14		REMOVED 1967	
TA-15-15	R-15		REMOVED 1967	
TA-15-16	R-16		REMOVED 1967	
TA-15-17	R-17		REMOVED 1967	
TA-15-18	R-18		REMOVED 1967	
TA-15-19	R-19		REMOVED 1960	
TA-15-20	R-20	BRANCH SHOP & LAB BLDG		S 35+00E 85+00
TA-15-21	R-21		REMOVED 1967	
TA-15-22	R-22	EXPLOSIVES PREPARATION BLDG		S 30+00E 55+00
TA-15-23	R-23	LABORATORY BUILDING	FORMERLY TA-20-1	S 30+00E 70+00
TA-15-24	R-24		REMOVED 1951	
TA-15-25	R-25		REMOVED 1951	
TA-15-26	R-26		REMOVED 1952	
TA-15-27	R-27	CONTROL BUILDING	FIRING POINTS E & F	S 50+00E 95+00
TA-15-28	R-28		REMOVED 1967	
TA-15-29	R-29		REMOVED 1967	
TA-15-30	R-30	GUARD STATION		S 15+00E 85+00
TA-15-31	R-31	CONTROL BUILDING	RENUMBERED TA 36-55	
TA-15-32	R-32		REMOVED 1967	
TA-15-33	R-33		REMOVED 1967	
TA-15-34	R-34		REMOVED 1967	
TA-15-35	R-35		REMOVED 1967	
TA-15-36	R-36		REMOVED 1954	
TA-15-37	R-37	AIR COMPRESSOR BUILDING		S 20+00E 85+00
TA-15-38	R-38		REMOVED 1967	
TA-15-39	R-39		REMOVED 1951	
TA-15-40	R-40	OFFICE BUILDING		S 30+00E 70+00
TA-15-41	R-41	STORAGE BUILDING		S 35+00E 90+00
TA-15-42	R-42	MAGAZINE		S 35+00E110+00
TA-15-43	R-43	MAGAZINE		S 35+00E110+00
TA-15-44	R-44	CONTROL BUILDING		S 35+00E120+00
TA-15-45	R-45	CONTROL BUILDING		S 25+00E 85+00
TA-15-46	R-46	LABORATORY BUILDING		S 30+00E 70+00
TA-15-47	R-47	WATER TOWER		S 25+00E 85+00
TA-15-48	R-48	TANK, FUEL U G		S 20+00E 85+00
TA-15-49	R-49		REMOVED 1959	
TA-15-50	R-50	SHOP & LABORATORY BLDG		S 35+00E 85+00
TA-15-51	R-51	TANK, SEPTIC		S 35+00E 45+00
TA-15-52	R-52	TANK, FUEL U G		S 35+00E 85+00
TA-15-53	R-53		REMOVED 1959	
TA-15-54	R-54	TRANSFORMER STATION		S 45+00E 90+00
TA-15-55	R-55	TRANSFORMER STATION		S 30+00E 70+00
TA-15-56	R-56	TRANSFORMER STATION		S 50+00E 95+00
TA-15-57	R-57	TRANSFORMER STATION		S 30+00E105+00
TA-15-58	R-58	TRANSFORMER STATION	RENUMBERED TA-36-59	
TA-15-59	R-59	WIGWAG		S 35+00E105+00
TA-15-60	R-60	WIGWAG		S 35+00E110+00
TA-15-61	R-61	TANK, SEPTIC		S 30+00E 85+00
TA-15-62	R-62	TANK, SEPTIC		S 35+00E120+00
TA-15-63	R-63	TANK, SEPTIC		S 30+00E 70+00
TA-15-64	R-64	TRANSFORMER STATION		S 35+00E 90+00
TA-15-65	R-65	TRANSFORMER STATION		S 25+00E 70+00
TA-15-66	R-66	TANK, WATER U G	RENUMBERED TA 36-60	
TA-15-67	R-67	TANK, SEPTIC	RENUMBERED TA 36-61	
TA-15-68	R-68		REMOVED 1967	
TA-15-69	R-69		REMOVED 1967	
TA-15-70	R-70	TANK, WATER U G		S 50+00E100+00
TA-15-71	R-71		REMOVED 1967	
TA-15-72	R-72	TANK, SEPTIC		S 50+00E 95+00
TA-15-73	R-73		REMOVED 1967	
TA-15-74	R-74	FIRING UNIT CHAMBER	ABANDONED 1962	S 50+00E 65+00
TA-15-75	R-75		REMOVED 1967	
TA-15-76	R-76		REMOVED 1967	
TA-15-77	R-77		REMOVED 1967	
TA-15-78	R-78		REMOVED 1967	
TA-15-79	R-79		REMOVED 1952	
TA-15-80	R-80	TANK, SEPTIC	ABANDONED 1961	S 30+00E 70+00
TA-15-81	R-81	GUARD HOUSE	RELOCATED TO TA-16-1000	
TA-15-82	R-82		REMOVED 1965	
TA-15-83	R-83		REMOVED 1950	
TA-15-84	R-84		REMOVED 1951	
TA-15-85	R-85		REMOVED 1962	
TA-15-86	R-86		REMOVED 1958	
TA-15-87	R-87	ROAD BLOCK	RELOCATED TO TA-33-109	
TA-15-88	R-88	ROAD BLOCK	RELOCATED TO TA-33-115	
TA-15-89	R-89		REMOVED 1959	
TA-15-90	R-90	WIGWAG		S 45+00E110+00
TA-15-91	R-91		REMOVED 1967	
TA-15-92	R-92		REMOVED 1967	
TA-15-93	R-93		REMOVED 1959	
TA-15-94	R-94	WIGWAG		S 40+00E 95+00
TA-15-95	R-95		CANCELLED	
TA-15-96	R-96		REMOVED 1951	
TA-15-97	R-97		REMOVED 1967	

STRUCTURE NUMBER	STRUCTURE DESIGNATION	STRUCTURE NOMENCLATURE	REMARKS	APPROXIMATE GRID LOCATION
TA-15-98	R-98		REMOVED 1967	
TA-15-99	R-99	TANK, FUEL	RELOCATED TO TA-[illegible]	
TA-15-100	R-100		REMOVED 1967	
TA-15-101	R-101		REMOVED 1967	
TA-15-102	R-102		REMOVED 1967	
TA-15-103	R-103		REMOVED 1967	
TA-15-104	R-104		REMOVED 1967	
TA-15-105	R-105		REMOVED 1967	
TA-15-106	R-106		REMOVED 1967	
TA-15-107	R-107	STORAGE BUILDING	RELOCATED TO TA-[illegible]	
TA-15-108	R-108	MANHOLE, PUMP PIT		[illegible]
TA-15-109	R-109		REMOVED 1967	
TA-15-110	R-110		REMOVED 1967	
TA-15-111	R-111		REMOVED 1967	
TA-15-112	R-112		REMOVED 1967	
TA-15-113	R-113		REMOVED 1967	
TA-15-114	R-114		DESTROYED	
TA-15-115	R-115		DESTROYED	
TA-15-116	R-116		DESTROYED	
TA-15-117	R-117		DESTROYED	
TA-15-118	R-118		DESTROYED	
TA-15-119	R-119		DESTROYED	
TA-15-120	R-120			
TA-15-121	R-121	MANHOLE, ELECTRICAL		S 35+00E120+00
TA-15-122	R-122	MANHOLE, ELECTRICAL		S 35+00E120+00
TA-15-123	R-123	MANHOLE, SANITARY		S 35+00E120+00
TA-15-124	R-124	MANHOLE, ELECTRICAL		S 50+00E 95+00
TA-15-125	R-125		REMOVED 1967	
TA-15-126	R-126		REMOVED 1967	
TA-15-127	R-127	MANHOLE, ELECTRICAL		S 50+00E 95+00
TA-15-128	R-128	MANHOLE, ELECTRICAL		S 50+00E100+00
TA-15-129	R-129	MANHOLE, ELECTRICAL		S 50+00E100+00
TA-15-130	R-130	MANHOLE, ELECTRICAL		S 50+00E100+00
TA-15-131	R-131	MANHOLE, ELECTRICAL		S 50+00E100+00
TA-15-132	R-132	MANHOLE, ELECTRICAL		S 50+00E100+00
TA-15-133	R-133	MANHOLE, ELECTRICAL		S 50+00E100+00
TA-15-134	R-134	FIRING UNIT CHAMBER	REPLACED TA 15-26	S 45+00E100+00
TA-15-135	R-135		REMOVED 1967	
TA-15-136	R-136	SHOP BUILDING	RELOCATED TO TA-36-[illegible]	
TA-15-137	R-137		REMOVED 1967	
TA-15-138	R-138		DESTROYED	
TA-15-139	R-139		REMOVED 1965	
TA-15-140	R-140	STORAGE BUILDING		[illegible]
TA-15-141	R-141		DESTROYED	
TA-15-142	R-142		DESTROYED	
TA-15-143	R-143		REMOVED 1962	
TA-15-144	R-144	RETAINING WALL		S 15+00E 85+00
TA-15-145	R-145		REMOVED 1959	
TA-15-146	R-146		[illegible]	
TA-15-147	R-147	TANK, SEPTIC		S 20+00E 65+00
TA-15-148	R-148		REMOVED 1967	
TA-15-149	R-149	MANHOLE, SANITARY		S 10+00E 70+00
TA-15-150	R-150	MANHOLE, INDUSTRIAL WASTE		S 35+00E 65+00
TA-15-151	R-151	MANHOLE, INDUSTRIAL WASTE		S 35+00E 65+00
TA-15-152	R-152		REMOVED 1967	
TA-15-153	R-153		REMOVED 1967	
TA-15-154	R-154		REMOVED 1967	
TA-15-155	R-155		REMOVED 1967	
TA-15-156	R-156		REMOVED 1967	
TA-15-157	R-157	MANHOLE, TELEPHONE		S 30+00E100+00
TA-15-158	R-158	MANHOLE, TELEPHONE		S 30+00E100+00
TA-15-159	R-159	MANHOLE, TELEPHONE		S 30+00E105+00
TA-15-160	R-160	MANHOLE, TELEPHONE		S 30+00E110+00
TA-15-161	R-161	MANHOLE, TELEPHONE		S 30+00E110+00
TA-15-162	R-162	MANHOLE, TELEPHONE		S 30+00E115+00
TA-15-163	R-163	MANHOLE, TELEPHONE		S 30+00E115+00
TA-15-164	R-164	MANHOLE, ELECTRICAL	RENUMBERED TA 36-[illegible]	
TA-15-165	R-165	MANHOLE, ELECTRICAL	RENUMBERED TA 36-[illegible]	
TA-15-166	R-166		REMOVED 1967	
TA-15-167	R-167	MANHOLE, ELECTRICAL	RENUMBERED TA 36-[illegible]	
TA-15-168	R-168	MANHOLE, ELECTRICAL		S 50+00E100+00
TA-15-169	R-169	MANHOLE, ELECTRICAL		S 45+00E100+00
TA-15-170	R-170		DESTROYED 1960	
TA-15-171	R-171		REMOVED 1959	
TA-15-172	R-172	FIRING UNIT BARRICADE		S 45+00E100+00
TA-15-173	R-173	TANK, WATER U G		S 20+00E 65+00
TA-15-174	R-174		REMOVED 1945	
TA-15-175	R-175		REMOVED 1945	
TA-15-176	R-176		REMOVED 1947	
TA-15-177	R-177		REMOVED 1947	
TA-15-178	R-178		REMOVED 1947	
TA-15-179	R-179		REMOVED 1967	
TA-15-180	R-180		REMOVED 1967	
TA-15-181	R-181		REMOVED 1967	
TA-15-182	R-182	SOLVENT STORAGE SHED		S 10+00E 70+00
TA-15-183	R-183	LABORATORY & OFFICE BUILDING		S 45+00E 65+00
TA-15-184	R-184	PHERMEX CHAMBER		S 75+00E105+00
TA-15-185	R-185	POWER CONTROL BUILDING		S 75+00E105+00
TA-15-186	R-186	DETECTION CHAMBER		S 75+00E110+00
TA-15-187	R-187	MANHOLE, ELECTRICAL		S 75+00E110+00
TA-15-188	R-188	MANHOLE, ELECTRICAL		S 75+00E110+00
TA-15-189	R-189	FIRING POINT SUBSTATION		S 75+00E105+00
TA-15-190	R-190		DESTROYED	
TA-15-191	R-191	SUBSTATION		S 35+00E 65+00
TA-15-192	R-192	TANK, FUEL	RELOCATED TO TA 49-56	
TA-15-193	R-193		REMOVED 1963	
TA-15-194	R-194	ELECTRON GUN BUILDING		S 35+00E 65+00

STRUCTURE NUMBER	STRUCTURE DESIGNATION	STRUCTURE NOMENCLATURE	REMARKS	APPROXIMATE GRID LOCATION
TA-15-195	R-195	[illegible]		S 45+00E 85+00
TA-15-196	R-196	[illegible]		S 45+00E 85+00
TA-15-197	R-197	[illegible]		S 70+00E 85+00
TA-15-198	R-198	TUNNEL		S 75+00E105+00
TA-15-199	R-199	TUNNEL		S 75+00E105+00
TA-15-200	R-200	TUNNEL		S 75+00E110+00
TA-15-201	R-201	TUNNEL		S 75+00E110+00
TA-15-202	R-202	COOLING TOWER		S 75+00E[illegible]
TA-15-203	R-203	PHERMEX SAFETY SHELTER		S 35+00E 65+00
TA-15-204	R-204	FIRE CHAMBER		S 75+00E105+00
TA-15-205	R-205	TANK, SEPTIC		S 75+00E105+00
TA-15-206	R-206	SUBSTATION	[illegible]	S 35+00E 65+00
TA-15-207	R-207	GUN EMPLACEMENT	[illegible]	
TA-15-208	R-208		[illegible]	
TA-15-209	R-209	ROAD BLOCK	[illegible]	S 30+00E 65+00
TA-15-211	R-211	PLATFORM		S 65+00E 65+00
TA-15-212	R-212	TRANSFORMER STATION		S 25+00E 70+00
TA-15-213	R-213	PLATFORM		S 35+00E 65+00
TA-15-214	R-214	SHED		S 70+00E100+00
TA-15-215	R-215	ROAD BLOCK	FORMERLY TA 16 [illegible]	S 35+00E 65+00
TA-15-216	R-216	MANHOLE, ELECTRICAL		S 70+00E100+00
TA-15-217	R-217	MANHOLE, ELECTRICAL		S 70+00E100+00
TA-15-218	R-218	MANHOLE, ELECTRICAL		S 75+00E100+00
TA-15-219	R-219	MANHOLE, ELECTRICAL		S 75+00E100+00
TA-15-220	R-220	MANHOLE, ELECTRICAL		S 75+00E105+00
TA-15-221	R-221	MANHOLE, ELECTRICAL		S 75+00E105+00
TA-15-222	R-222	MANHOLE, SANITARY		S 75+00E105+00
TA-15-223	R-223	MANHOLE, SANITARY		S 75+00E105+00
TA-15-224	R-224	DISTRIBUTION BOX, SANITARY		S 75+00E105+00
TA-15-225	R-225	MANHOLE, SANITARY		S 45+00E 65+00
TA-15-226	R-226	DISTRIBUTION BOX, SANITARY		S 45+00E 65+00
TA-15-227	R-227	MANHOLE, WATER		S 70+00E100+00
TA-15-228	R-228	MOTOR GENERATOR PAD		S 35+00E 65+00
TA-15-229	R-229	MANHOLE, WATER		S 30+00E 65+00
TA-15-230	R-230		[illegible]	
TA-15-231	R-231	RADIO STATION		S 25+00E 65+00
TA-15-232	R-232	GAS CHAMBER		S 75+00E105+00
TA-15-233	R-233	RETAINING BUILDING	REPLACES R 193	S 65+00E 85+00
TA-15-234	R-234	ROAD BLOCK		S 50+00E 85+00
TA-15-235	R-235	SHOCK CONTROL PANEL		S 70+00E100+00
TA-15-236	R-236	BARRICADE		S 50+00E100+00
TA-15-237	R-237	MONITOR CONDUIT PAD		S 75+00E105+00
TA-15-238	R-238	MONITOR CONDUIT PAD		S 75+00E110+00
TA-15-239	R-239	PASSAGEWAY		S 35+00E 65+00
TA-15-241	R-241	READY MAGAZINE		S 50+00E 70+00
TA-15-242	R-242	MAKE UP BUILDING		S 45+00E 70+00
TA-15-243	R-243	MAIN MAGAZINE		S 45+00E 70+00
TA-15-245	R-245	PASSAGEWAY		S 35+00E 65+00
TA-15-246	R-246	TRANSFORMER STATION		S 35+00E 60+00
TA-15-247	R-247	TRANSFORMER STATION	RENUMBERED TA [illegible]	
TA-15-248	R-248	TRANSFORMER STATION		S 35+00E 65+00
TA-15-249	R-249	TRANSFORMER STATION		S 65+00E 80+00
TA-15-250	R-250	EXTERNAL SHOT ALIGNMENT POINT		S 75+00E110+00
TA-15-251	R-251	BARRICADE		S 50+00E 70+00
TA-15-252	R-252	BARRICADE		S 45+00E 70+00
TA-15-253	R-253	BARRICADE		S 45+00E 70+00
TA-15-254	R-254	[illegible] STATION		S 35+00E 65+00
TA-15-255	R-255	RETAINING WALL		S 35+00E 65+00
TA-15-256	R-256	TRANSFORMER STATION		S 50+00E 70+00
TA-15-257	R-257	TRANSFORMER STATION		S 65+00E[illegible]
TA-15-258	R-258	CAPACITOR STATION		S 65+00E[illegible]
TA-15-259	R-259	METERING STATION		S 25+00E 65+00
TA-15-260	R-260	METERING STATION		S 30+00E 65+00
TA-15-261	R-261	TANK, OIL STORAGE		S 35+00E 65+00
TA-15-262	R-262	TRANSFORMER STATION		S 50+00E 95+00
TA-15-263	R-263	LABORATORY BLDG		S 25+00E 95+00
TA-15-264	R-264	[illegible]		S 35+00E[illegible]
TA-15-265	R-265	TEST POINT		S 75+00E105+00
TA-15-266	R-266	TANK, STORAGE [illegible]		S 75+00E105+00

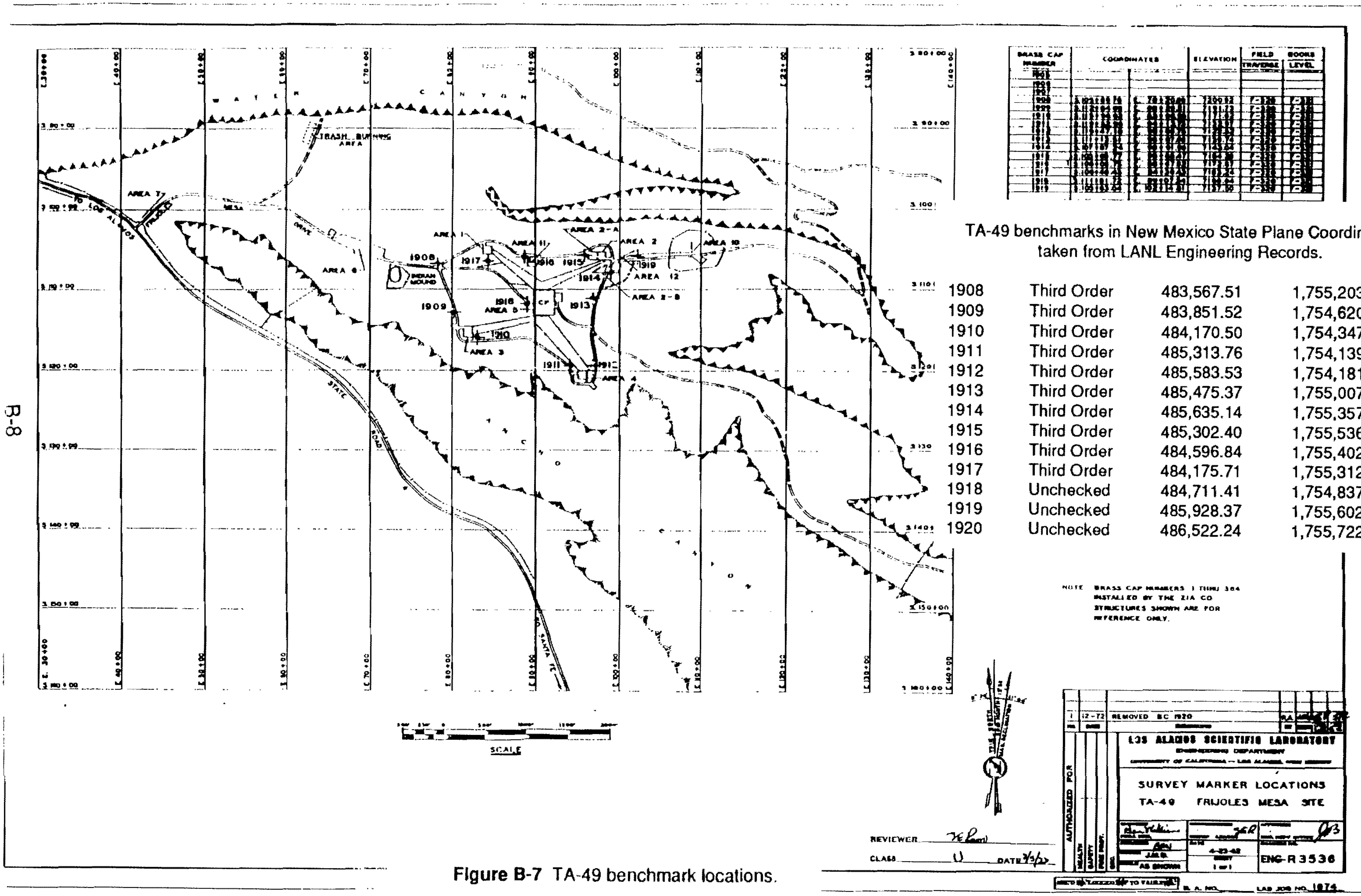
UNIVERSITY OF CALIFORNIA
Los Alamos National Laboratory, Los Alamos, New Mexico 87545

FACILITIES ENGINEERING DIVISION

INDEX SHEET
STRUCTURE LOCATION PLAN
TA-15 R-SITE

DATE 9-19-85 | SHEET NO 1 OF 3 | DRAWING NO ENG-R5110

Figure B-23 Index sheet for TA-15 structure location plan indicating transfer of fuel tank TA-15-192 to TA-49-56.



TA-49 benchmarks in New Mexico State Plane Coordinates taken from LANL Engineering Records.

1908	Third Order	483,567.51	1,755,203.02
1909	Third Order	483,851.52	1,754,620.64
1910	Third Order	484,170.50	1,754,347.88
1911	Third Order	485,313.76	1,754,139.81
1912	Third Order	485,583.53	1,754,181.33
1913	Third Order	485,475.37	1,755,007.57
1914	Third Order	485,635.14	1,755,357.62
1915	Third Order	485,302.40	1,755,536.97
1916	Third Order	484,596.84	1,755,402.48
1917	Third Order	484,175.71	1,755,312.91
1918	Unchecked	484,711.41	1,754,837.92
1919	Unchecked	485,928.37	1,755,602.18
1920	Unchecked	486,522.24	1,755,722.96

Figure B-7 TA-49 benchmark locations.

ATTACHMENT III-1 (7 pages)

HEALTH AND SAFETY CHECKLIST

H&S PLAN

OPERABLE UNIT 1144

Date:________Time:_________FIELD TEAM LEADER Signature______________________________

SITE SAFETY OFFICER Signature:______________________________

Activities Being Conducted, Equipment Being Used, General Condition And Effectiveness Of Decontamination, PPE Being Worn:

____

____

____

____

____

____

____

____

A key indicator of a well-maintained and safely operated site is the appearance of the work area on a daily basis. Work area appearance and safety is the responsibility of all personnel. Work areas shall be straightened on a daily basis before quitting work. Time should be set aside at the end of each work period to remove trash, tools, spare parts, extra materials, rags, plastic, and so forth. Work should be stopped and a general cleanup should be conducted whenever trash, dirt, or other materials are being spread beyond the immediate work area. The Site Safety Officer will complete this check list during a daily health and safety inspection tour of the work area.

This check list is designed so that any "no" responses are indicators of a safety or health deficiency. If any question does not apply, an "NA" will be placed on the line. Not all questions will be applicable to all sites. All "no" responses should be followed up with a written explanation, the corrective action taken, and the date.

HEALTH AND SAFETY CHECK LIST		
TRAINING	**YES**	**NO**
Is a Daily Tailgate Safety Meeting held and documented?		
Are all visitors to the site properly signed in and given site-specific orientation and safety training?		
Are all persons entering the site informed of the contents of the Health and Safety Plan and required to sign a statement indicating such?		
Have all persons entering the site received the appropriate hazardous waste training and is this training documented?		
Have all persons entering the site received a respirator fit test and training?		
Have all persons entering the site received training (hazard communication) on all hazards that may be encountered?		
Have all persons entering the site received the required physical examination?		
Is the H&S Plan available for on-site inspection and review by employees, etc.?		
Are emergency reporting and evacuation procedures known by each person on site and documented on the Emergency Contact sheet?		
Are all persons who enter confined spaces properly trained?		
Is the site-specific organizational structure chart posted at the job site?		
Are personnel who work on or near drill rigs instructed in the location and use of the rig's "kill" switch?		
Do heavy equipment and crane operators possess appropriate and up-to-date required licenses/certifications/permits?		
Are copies of all training records kept on site?		
INSPECTIONS	**YES**	**NO**
Are regulated areas established and defined for each work area in which contaminated materials may be present?		
Is hearing protection worn in areas where sound levels are suspected or shown to exceed 85 dBA?		

HEALTH AND SAFETY CHECK LIST		
INSPECTIONS (Continued)	YES	NO
Are all persons on site using the minimum protective equipment (hard hat, safety glasses with side shields or goggles, steel-toed safety shoes) and appropriate clothing for the anticipated hazards?		
Is there a multipurpose dry-chemical fire extinguisher on each piece of heavy equipment?		
Are all fire extinguishers inspected monthly?		
Is the "no smoking" policy enforced?		
Are approved safety containers used to store fuels?		
Do all contaminated scrap, waste, debris, and clothing containers have labels?		
Is the food and beverage consumption prohibition enforced in the regulated area?		
Is there a method available for employees to wash their faces and hands with soap and water before eating and drinking?		
Are contaminated materials stored in tightly closed containers in well-ventilated areas?		
Does all heavy equipment have a functioning back-up alarm?		
Is the "buddy system" in use throughout the site?		
Is access to the regulated areas controlled so that only authorized personnel are permitted to enter?		
Is a daily log maintained of persons entering the regulated area?		
If benzene is present, are warning signs and benzene hazard signs posted?		
Are MSDSs for the hazardous materials posted at the site?		
Are contact lenses not worn with respiratory protection?		
Are all persons required to wear respirators clean shaven before each day's shift?		

HEALTH AND SAFETY CHECK LIST		
INSPECTIONS (Continued)	**YES**	**NO**
Are adequate potable liquids provided at the job site?		
Is periodic air monitoring conducted?		
Are air-monitoring instruments calibrated daily before use?		
Are emergency services and equipment available at the site and is equipment in appropriate condition?		
Are provisions made for adequate flushing of the skin or eyes in the event of contaminated exposure?		
Are dry-chemical ABC fire extinguishers provided at each site?		
Do all work activities begin after sunrise and end before sunset?		
Are potable water containers clearly marked as to their contents and not used for any other purpose?		
Are outlets for nonpotable water clearly marked?		
If permanent toilet facilities are unavailable, are chemical toilets provided?		
Do employees shower at the end of their work shift and when leaving the hazardous waste site?		
Are appropriate warning signs placed around open excavations?		
Are excavations sloped (1 ft to 1 ft), or shored if more than 4 ft deep?		
Is a standby person available when entry into an excavation is required?		
Are appropriate access methods, such as ladders, used to enter the excavation?		
Are equipment and materials stored and handled at all times so as not to endanger personnel?		
Is a check-in/check-out roster maintained at the site?		
Are crane operators controlling the lift area maintaining a safe perimeter to prevent any site personnel from coming under or within an unsafe distance of a live load?		

HEALTH AND SAFETY CHECK LIST		
INSPECTIONS (Continued)	**YES**	**NO**
If personnel are required to work in or near high-traffic areas, are they wearing fluorescent orange and/or reflective clothing or vests?		
Are vehicles not actively used in operations parked so that they do not interfere with work or traffic?		
Are cutting and welding operations not allowed within 300 ft of a potential liquid fuel source or a building?		
Are supplied air respirators required for employees performing hot work on painted, galvanized, coated, or previously contaminated metal?		
Are two 10-lb or more ABC multipurpose fire extinguishers available in the immediate vicinity of hot work?		
Are seat belts used by persons riding in/on vehicles and equipment?		
Are personnel riding in/on vehicles or equipment in a manner designated for the conveyance of people?		
Is noncrane heavy equipment used to "pull" (lift) material properly equipped and designed to do so?		
Is a drilling-equipment safety-inspection report completed by the drilling operator before beginning any site work?		
Is all equipment used to handle or transfer flammable liquids bonded and grounded, spark proof, and explosion proof, as appropriate?		
Are all fuels stored in approved safety containers?		
Are fuel storage locations marked with the warning signs, "Flammable Liquids" and "No Smoking"?		
Are spark-proof hand tools used when working with flammable/combustible materials or when breaking lines?		
Are safety glasses and gloves worn when handling or hooking up compressed-gas cylinders?		
Are compressor hose segments secured using chains and/or locking pins?		
Are all electric connections made through a GFCI?		

HEALTH AND SAFETY CHECK LIST		
INSPECTIONS (Continued)	YES	NO
Are extension cords routed and stored to prevent damage and tripping hazards?		
Does a second person secure or steady a ladder while an employee is ascending and descending?		
Is stockpiled soil piled at an angle less than 45 degrees and at least 2 ft from the edge of an excavation?		
Is the regulated area isolated from the rest of the work site in a manner that minimizes the number of employees exposed to site containers?		
If heat stress is a concern, has a work/rest regimen been established and implemented, including physiological monitoring?		
If contaminants at the site are unknown, is Level B protection worn?		
Are suitable quantities of absorbent, appropriate drums and labels complying with DOT, OSHA, and EPA regulations on hand where leaks, spills, or ruptures may occur?		
Have procedures for all phases of decontamination been developed and implemented?		
Is the direction of emergency egress away from high-hazard areas?		
Are means of emergency egress maintained free of obstructions and available for full and instant use?		
Are work areas kept clean and in good repair, with no unnecessary holes or openings?		
Are wastes (noncontaminated) kept in a closed, nonleaking sanitary container and removed as often as necessary and appropriate in a manner that would avoid creating a health or safety problem?		
Are appropriate labels provided on all chemical containers?		
Are storage areas free of accumulation of materials that could constitute a hazard from tripping, fire, explosion, or pest harborage?		
Is vegetation within the site controlled?		

ATTACHMENT III-2 (1 page)

EMERGENCY CONTACTS	
Site Safety Officer Name:	Call:
Environmental Restoration Health and Safety Project Leader Name:	Call:
24-Hour LANL Health/Safety Coordinator Call:	

ATTACHMENT III-3 (20 pages)

EM SCIENCE™
A Division of EM Industries, Inc.

111 Woodcrest Road, Cherry Hill, New Jersey 08034-0395, Phone (609) 354-9200

MATERIAL SAFETY DATA SHEET

Essentially Similar to U.S. Department of Labor Form OSHA-20

SECTION 1 NAME & PRODUCT

Chemical Name: Beryllium Oxide		Catalog Number: BX0593
Trade Name & Synonyms: Beryllium Monoxide	CAS # 1304-56-9	Chemical Family: Metal Oxide
Formula: BeO		Formula Weight: 25.02

SECTION 2 PHYSICAL DATA

Boiling Point, 760 mm Hg (°C)	3900°	Specific Gravity (H_2O = 1)	3.02
Melting Point (°C)	2530°	Solubility in H_2O, % by wt. at 20 °C	insoluble
Vapor Pressure at 20 °C	N/A	Appearance and Odor	white powder
Vapor Density (air = 1)	unknown		
Percent Volatiles by Volume	None	Evaporation Rate (Butyl Acetate = 1)	N/A

SECTION 3 FIRE AND EXPLOSION HAZARD DATA

Flash Point (test method) Noncombustible	Flammable Limits	Lel N/A	Uel N/A	

Extinguishing Media: As appropriate for adjacent material

Special Hazards and Procedures: Wear self-contained breathing apparatus

Unusual Fire and Explosion Hazards: None

SECTION 4 REACTIVITY DATA

Stable	X	Conditions to Avoid: Avoid dusting (dispersion of fine particles into air)
Unstable		

Materials to Avoid

( ) Water ( ) Acids ( ) Bases ( ) Corrosives ( ) Oxidizers

(XX) Other (specify) Mg & heat

Hazardous Decomposition Products: None

SECTION 5 SPILL OR LEAK PROCEDURES AND DISPOSAL

Steps to be Taken in Case Material is Released or Spilled: Take up and containerize for proper disposal; avoid creating dust

Waste Disposal Method: To be performed in compliance with all current local, state and federal regulations

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BX0593

SECTION 6 HEALTH HAZARD DATA

Threshold Limit Value

0.002 mg/m^3 (TWA)

Effects of Overexposure Highly toxic by inhalation & ingestion; causes bronchitis, chemical pneumonitis, beryllium granulomatosis; effects can be delayed for years after exposure. Contact causes dermatitis, skin ulcers, conjunctivitis

First Aid Procedures GET MEDICAL ASSISTANCE FOR ALL CASES OF OVEREXPOSURE

Skin: Wash thoroughly with soap and water. Remove contaminated clothing. Use care in laundering to avoid contact with contaminant.
Eyes: Flush immediately and thoroughly with water for at least 15 minutes
Inhalation: Remove to fresh air. Get immediate medical attention
Ingestion: if conscious, induce vomiting

SECTION 7 SPECIAL PROTECTION INFORMATION

Ventilation, Respiratory Protection, Protective Clothing, Eye Protection

Use adequate general and local exhaust ventilation.
Use air-supplied respirator if dust concentration is above TLV.
Wear protective gloves, protective clothing and safety goggles
Use extreme caution in washing gloves and clothing to avoid personal contamination
Do not breathe dust; do not take internally; do not get in eyes, on skin, or on clothing

SECTION 8 SPECIAL HANDLING AND STORING PRECAUTIONS

Keep container closed
Store at controlled room temperature
Wash gloves carefully before removing
Wash hands and face thoroughly before eating, drinking, smoking or applying make-up

DOT Hazard Class: Poison B

SECTION 9 HAZARDOUS INGREDIENTS

(refer to section 3 through 8)

N/A

SECTION 10 OTHER INFORMATION

Product is highly suspected to be carcinogenic (U.S. Public Health Service, Third Annual Report on Carcinogens, Sept., 1983)

AUTHORIZED SIGNATURE Joseph D. Klaus

DATE ISSUED: 11/84

DATE REVISED: ____

EM0014TA

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A Division of EM Industries, Inc.

UPDATED

111 Woodcrest Road, Cherry Hill, New Jersey 08034-0395, Phone (609) 354-9200

MATERIAL SAFETY DATA SHEET

Essentially Similar to U.S. Department of Labor Form OSHA-20

SECTION 1 NAME & PRODUCT

Chemical Name: Lead	Catalog Number: LX0085, LX0090, LX0095, LX0103, LX0105, LX0110
Trade Name & Synonyms: None CAS #7439-92-1	Chemical Family: Metal
Formula: Pb	Formula Weight: 207.19

SECTION 2 PHYSICAL DATA

Boiling Point, 760 mm Hg (°C)	1740°	Specific Gravity (H_2O = 1)	11.34
Melting Point (°C)	327.4°	Solubility in H_2O, % by wt. at 20°C	Insoluble
Vapor Pressure at 20°C	N/A	Appearance and Odor	bluish-white metal
Vapor Density (air = 1)	N/A		
Percent Volatiles by Volume	N/A	Evaporation Rate (Butyl Acetate = 1)	N/A

SECTION 3 FIRE AND EXPLOSION HAZARD DATA

Flash Point (test method)	None	Flammable Limits	Lel	N/A	Uel	N/A

Extinguishing Media N/A

Special Hazards and Procedures None

Unusual Fire and Explosion Hazards None

SECTION 4 REACTIVITY DATA

Stable	X	Conditions to Avoid None
Unstable		

Materials to Avoid

( ) Water ( ) Acids ( ) Bases ( ) Corrosives (X) Oxidizers

(X) Other (specify) Sodium, Potassium

Hazardous Decomposition Products None

SECTION 5 SPILL OR LEAK PROCEDURES AND DISPOSAL

Steps to be Taken in Case Material is Released or Spilled Sweep up & containerize for proper disposal

Waste Disposal Method To be performed in compliance with all current local, state and federal regulations

The statements contained herein are offered for informational purposes only and are intended to be followed only by persons having related technical skills and at their own discretion and risk. Since conditions and manner of use are outside our control, we make no warranties, express or implied, and assume no liability in connection

Lead

SECTION 6 HEALTH HAZARD DATA

Threshold Limit Value

0.05 mg/m^3

Effects of Overexposure

Cumulative poison; harmful if swallowed; harmful by inhalation of dust or fumes. Symptoms: lassitude, insomnia, pallor, anorexia, weight loss, malnutrition, headache, constipation, abdominal pain, colic, anemia

First Aid Procedures GET MEDICAL ATTENTION FOR ALL CASES OF OVEREXPOSURE

Skin: wash with soap/water
Eyes: flush thoroughly with water
Inhalation: remove to fresh air

SECTION 7 SPECIAL PROTECTION INFORMATION

Ventilation, Respiratory Protection, Protective Clothing, Eye Protection

Provide adequate general mechanical and local exhaust ventilation
Protect eyes and skin with safety goggles and gloves
Do not breathe dust
Do not get in eyes, on skin, or on clothing
Wear dust mask or cartridge respirator if necessary

SECTION 8 SPECIAL HANDLING AND STORING PRECAUTIONS

Keep container closed when not in use
Store in a dry, well-ventilated area
Wash thoroughly after handling

DOT Hazard Class: Not Regulated

SECTION 9 HAZARDOUS INGREDIENTS

(refer to section 3 through 8)

N/A

SECTION 10 OTHER INFORMATION

Tests on laboratory animals indicate material may be mutagenic and teratogenic.

AUTHORIZED SIGNATURE [signature]

DATE ISSUED: 6/84

DATE REVISED:

E M SCIENCE
A DIVISION OF E M INDUSTRIES, INC.
111 WOODCREST DRIVE, CHERRY HILL, N.J. 08034
PHONE (609) 354-9200

MATERIAL SAFETY DATA SHEET
ESSENTIALLY SIMILAR TO U.S. DEPARTMENT OF LABOR FORM OSHA-20
DATE OF PREP. 12/10/85

SECTION 1 NAME & PRODUCT

CHEMICAL NAME: LEAD OXIDE, YELLOW

CATALOG NUMBER: LX0175 LX0176

TRADE NAME: LEAD MONOXIDE; LITHARGE, YELLOW
CAS #: 1317-36-8 CHEMICAL FAMILY: METAL OXIDE
FORMULA: PbO

MOLECULAR WEIGHT 223.21

SECTION 2 PHYSICAL DATA

BOILING POINT 760 MM HG UNKNOWN	SPECIFIC GRAVITY (H2O=1) 9.53
MELTING POINT 888C	SOLUBILITY IN H2O,% BY WT @20 C INSOLUBLE
VAPOR PRES. @ 20C N/A MM HG	EVAPORATION RATE (BUTYL ACETATE=1) N/A
VAPOR DENSITY (AIR=1) N/A	APPEARANCE AND ODOR YELLOW POWDER
% VOLATILES BY VOLUME N/A	

SECTION 3 FIRE & EXPLOSION HAZARD DATA

FLASH POINT/TEST METHOD: NONCOMBUSTIBLE FLAMMABLE LIMITS:LEL% N/A UEL% UNKWN

EXTINGUISHING MEDIA:
USE MEDIA SPECIFIED FOR SURROUNDING MATERIAL

SPECIAL HAZARDS:
WEAR SELF-CONTAINED BREATHING APPARATUS

UNUSUAL FIRE AND EXPLOSION HAZARDS:
MAY EMIT TOXIC FUMES ON THERMAL DECOMPOSITION

SECTION 4 REACTIVITY DATA

STABLE S CONDITIONS TO AVOID:
ELEVATED TEMPERATURES

MATERIALS TO AVOID:
( ) WATER ( ) ACIDS ( ) BASES ( ) CORROSIVES ( ) OXIDIZERS
(X) OTHER:CL, ETHYLENE, F, PERCHLORIC ACID

CONTINUED ON PAGE 2

LEAD OXIDE, YELLOW
MATERIAL SAFETY DATA SHEET

SECTION 4 REACTIVITY DATA

HAZARDOUS DECOMPOSITION PRODUCTS:
LEAD FUMES

SECTION 5 SPILL OR LEAK PROCEDURES AND DISPOSAL

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED:
SWEEP UP & CONTAINERIZE FOR PROPER DISPOSAL

WASTE DISPOSAL METHOD: TO BE PERFORMED IN COMPLIANCE WITH ALL CURRENT LOCAL, STATE AND FEDERAL REGULATIONS.

SECTION 6 HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE:
0.15 MG/M3 (AS PB)

TXDS:
IPR-RAT LDLO: 430 MG/KG
ORL-DOG LDLO: 1400 MG/KG

T ESHOLD VALUE:
UNKNOWN

EFFECTS OF OVEREXPOSURE:
CUMULATIVE POISON.
AS LEAD, SYMPTOMS INCLUDE LASSITUDE, INSOMNIA, PALLOR, ANOREXIA, WEIGHT LOSS, MALNUTRITION, CONSTIPATION, ABDOMINAL PAINS, COLIC, ANEMIA, GINGIVAL LEAD LINE.
CONTACT MAY CAUSE SKIN IRRITATION.

FIRST AID PROCEDURES:
SKIN: WASH WITH SOAP/WATER
EYES: FLUSH THOROUGHLY WITH WATER
INHALATION: REMOVE TO FRESH AIR
INGESTION: IF CONSCIOUS, INDUCE VOMITING
GET MEDICAL ASSISTANCE FOR ALL CASES OF OVEREXPOSURE

SECTION 7 SPECIAL PROTECTION INFORMATION

VENTILATION, RESPIRATORY PROTECTION, PROTECTIVE CLOTHING, EYE PROTECTION:
PROVIDE ADEQUATE GENERAL MECHANICAL AND LOCAL EXHAUST

CONTINUED ON PAGE 3

LEAD OXIDE, YELLOW
MATERIAL SAFETY DATA SHEET

SECTION 7 SPECIAL PROTECTION INFORMATION

VENTILATION, RESPIRATORY PROTECTION, PROTECTIVE CLOTHING, EYE PROTECTION:
VENTILATION
PROTECT EYES AND SKIN WITH SAFETY GOGGLES AND GLOVES
DO NOT BREATHE DUST
WEAR APPROVED RESPIRATORY PROTECTION IF TLV IS EXCEEDED
AVOID CONTACT WITH SKIN AND EYES

SECTION 8 SPECIAL HANDLING AND STORING PRECAUTIONS

SPECIAL HANDLING AND STORING PRECAUTIONS:
KEEP CONTAINER CLOSED
STORE IN A WELL-VENTILATED AREA AWAY FROM INCOMPATIBLE MATERIALS
WASH GLOVES BEFORE REMOVING
WASH THOROUGHLY AFTER HANDLING

SECTION 9 HAZARDOUS INGREDIENTS

HAZARDOUS INGREDIENTS:
N/A

SECTION 10 OTHER INFORMATION

NFPA 704 :
HEALTH FLAMMABILITY REACTIVITY

COMMENTS:
TESTS ON LABORATORY ANIMALS INDICATE MATERIAL MAY BE MUTAGENIC AND CARCINOGENIC

ATOMERGIC CHEMETALS CORPORATION
91 Carolyn Boulevard, Farmingdale, New York 11735-1527
Telephone: 516-694-9000 Telex: 6852289 or 144612 Cable: ATOMERGIC NEWYORK

MATERIAL SAFETY DATA SHEET

PRODUCT IDENT.

CHEMICAL NAME	CAS No.	
Uranium Oxide	13444-59-8	
CHEMICAL FORMULA	**PARTICLE SIZE**	**CHEMICAL FAMILY**
U_3O_8	-100 mesh	metal oxide

PHYSICAL PROPERTIES

BOILING POINT, °C	MELTING POINT, °C	FREEZING POINT, °C	CALC. MOLECULAR WEIGHT
N/A	decomposes at 1300° to UO_2	N/A	842.02

DENSITY, gm/cc	SOLUBILITY IN WATER	REACTION WITH WATER
8.30	insoluble	none

APPEARANCE	ODOR
green-black solid	none

OTHER COMMENTS

FIRE & EXPLOSION DATA

FLASH POINT, °C	AUTOIGNITION TEMP., °C	COMMENTS
N/A	unknown	

EXTINGUISHING MEDIA

☐ Water-spray ☐ Water-fog ☐ Water Stream ☐ CO_2 ☐ Dry Chemical ☐ Alcohol foam ☐ Foam ☐ Earth or sand

☒ Other (specify) Agent for metal fires (like G-1 powder, MET-L-X, or dry graphite)

SPECIAL FIRE FIGHTING PROCEDURES

☐ Do not enter building ☐ Do not use water ☐ Allow fire to burn ☐ Other (specify) SCBA should be worn when fighti fires involving radioactive material.

UNUSUAL FIRE & EXPLOSION HAZARDS

☐ Dust explosion hazard ☐ Sensitive to shock ☒ Contamination ☐ Temperature ☐ Other (specify)

REACTIVITY DATA

STABILITY

☒ Stable ☐ Unstable

CONDITIONS CONTRIBUTING TO UNSTABILITY

☐ Thermal decomposition ☐ Photo degradation ☐ Polymerization

INCOMPATABILITY - Avoid contact with

☐ Strong acids ☐ Strong alkalis ☐ Strong oxidizers ☐ Other (specify)

HAZARDOUS DECOMPOSITION PRODUCTS — THERMAL AND OTHER (list)

alpha and gamma radiation, radon daughters

CONDITIONS TO AVOID

☐ Heat ☐ Open flames ☐ Sparks ☐ Ignition sources ☐ Other (specify)

SPILLS OR LEAKS

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED

☐ Flush with water ☐ Absorb with sand or inert material ☐ Neutralize ☒ ~~Sweep or scoop~~ XXXX up and remove ☐ Keep upwind Evacuate enclosed spaces ☐ Prevent spread or spill

☒ Other (specify) vacuum equipped with high efficiency filter

WASTE DISPOSAL METHOD — *Consult federal, state, or local authorities for proper disposal procedures.*

Limits for disposal:
Sanitary Sewage System: 3×10^{-5} mCi/ml
Air: 5×10^{-12} mCi/ml
Dispose of contaminated waste in authorized landfills only.
Check with NRC for further restrictions.

Reference 10CFR, Part 2
Appendix "B"

CONTINUED ON REVERSE SIDE

OCCUPATIONAL HEALTH SERVICES, INC.
450 SEVENTH AVENUE, SUITE 2407
NEW YORK, NEW YORK 10123
(800) 445-MSDS (212) 967-1100

EMERGENCY CONTACT:
JOHN S. BRANSFORD, JR. (615) 292-1130

SUBSTANCE IDENTIFICATION

CAS-NUMBER 15117-48-3

SUBSTANCE: PLUTONIUM-239

TRADE NAMES/SYNONYMS:
PLUTONIUM: PLUTONIUM, ISOTOPE OF MASS 239: PLUTONIUM METAL: STCC 4929140: UN 2918: PU-239: PU: OHS19088

CHEMICAL FAMILY:
METAL: RADIOACTIVE

MOLECULAR FORMULA: PU MOLECULAR WEIGHT: 239.05

CERCLA RATINGS (SCALE 0-3): HEALTH=U FIRE=3 REACTIVITY=2 PERSISTENCE=3
NFPA RATINGS (SCALE 0-4): HEALTH=U FIRE=3 REACTIVITY=2

COMPONENTS AND CONTAMINANTS

COMPONENT: PLUTONIUM-239 CAS# 15117-48-3 PERCENT: 100.0

OTHER CONTAMINANTS: NONE

EXPOSURE LIMIT:
OCCUPATIONAL EXPOSURE TO RADIOACTIVE SUBSTANCES MUST ADHERE TO STANDARDS ESTABLISHED BY THE OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION, 29 CFR 1910.96, AND/OR THE NUCLEAR REGULATORY COMMISSION, 10 CFR PART 20.

PHYSICAL DATA

DESCRIPTION: SILVER-WHITE CRYSTALLINE SOLID.

BOILING POINT: 5850 F (3232 C) (ALPHA FORM)

MELTING POINT: 1186 F (641 C) (ALPHA FORM)

SPECIFIC GRAVITY: 19.84 (ALPHA FORM) SOLUBILITY IN WATER: INSOLUBLE

OTHER SOLVENTS (SOLVENT - SOLUBILITY):
SOLUBLE IN HYDROCHLORIC ACID; INSOLUBLE IN NITRIC ACID, CONCENTRATED SULFURIC ACID.

OTHER PHYSICAL DATA
SPECIFIC ACTIVITY: 0.062 CI/G
HALF LIFE: 24,411.0 YEARS
CRITICAL MASS: 10 LBS.

-05-1991 17:44 FROM NMT 6 TO 53403 P.01

FIRE AND EXPLOSION DATA

FIRE AND EXPLOSION HAZARD
NEGLIGIBLE FIRE HAZARD IN METALLIC FORM; HOWEVER, DUST, POWDER, OR FUMES ARE FLAMMABLE OR EXPLOSIVE WHEN EXPOSED TO HEAT OR FLAMES.

FIREFIGHTING MEDIA:
DRY CHEMICAL, CARBON DIOXIDE, HALON, WATER SPRAY OR STANDARD FOAM (1987 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.4).

FOR LARGER FIRES, USE WATER SPRAY OR FOG (FLOODING AMOUNTS) (1987 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.4).

FIREFIGHTING:
DO NOT MOVE DAMAGED CONTAINERS. MOVE UNDAMAGED CONTAINERS OUT OF FIRE ZONE. FOR MASSIVE FIRE IN STORAGE AREA, USE UNMANNED HOSE HOLDER OR MONITOR NOZZLES. FIGHT FIRE FROM MAXIMUM DISTANCE. STAY AWAY FROM STORAGE TANK ENDS (1987 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.4, GUIDE PAGE 63).

CONTACT THE LOCAL, STATE, OR DEPARTMENT OF ENERGY RADIOLOGICAL RESPONSE TEAM. EXTINGUISH FIRE USING AGENT SUITABLE FOR TYPE OF SURROUNDING FIRE. KEEP CONTAINERS COOL WITH FLOODING QUANTITIES OF WATER, APPLIED FROM AS FAR A DISTANCE AS POSSIBLE. AVOID CONTAMINATION OF WATER SOURCES AND SEWERS. AVOID BREATHING DUSTS AND FUMES OF BURNING MATERIAL. KEEP UNNECESSARY PEOPLE OUT OF INCIDENT AREA UNTIL AREA IS DECLARED SAFE BY RADIOLOGICAL RESPONSE TEAM.

TRANSPORTATION

DEPARTMENT OF TRANSPORTATION HAZARD CLASSIFICATION 49 CFR 172.101:
RADIOACTIVE MATERIAL

DEPARTMENT OF TRANSPORTATION LABELING REQUIREMENTS 49 CFR 172.101 AND SUBPART E:
RADIOACTIVE

DEPARTMENT OF TRANSPORTATION PACKAGING REQUIREMENTS: 49 CFR 173.417
EXCEPTIONS: 49 CFR 173.453

TOXICITY

PLUTONIUM-239:
CARCINOGEN STATUS: NONE. HOWEVER, EXPOSURE TO IONIZING RADIATION MAY CAUSE CANCER.
ACUTE TOXICITY LEVEL: NO DATA AVAILABLE.
TARGET EFFECTS: PLUTONIUM IN THE BODY MOST OFTEN ACCUMULATES IN THE LIVER AND SKELETON; HOWEVER SIGNIFICANT QUANTITIES MAY BE FOUND IN THE SPLEEN, GONADS, AND THYROID. THE BIOLOGICAL HALF-LIVES HAVE BEEN REPORTED TO BE 40 YEARS IN THE LIVER AND 100 YEARS IN THE BONE. A RADIOACTIVE MATERIAL PRESENTS THE GREATEST HAZARD TO THOSE PARTS OF THE BODY IN WHICH IT IS MOST CONCENTRATED.

ADDITIONAL DATA: PLUTONIUM-239 IS AN EMITTER OF ALPHA PARTICLES AND SOME VERY SOFT GAMMA RAYS. EXPOSURE TO RADIOACTIVE PLUTONIUM MAY RESULT IN SIGNIFICANT WHOLE-BODY IRRADIATION.

HEALTH EFFECTS AND FIRST AID

INHALATION:

PLUTONIUM-239:

ACUTE EXPOSURE- WHEN INHALED, PLUTONIUM IS RETAINED IN THE LUNG WITH AN EFFECTIVE HALF-LIFE THAT VARIES FROM HUNDREDS OF DAYS FOR PLUTONIUM OXIDES TO TENS OF DAYS FOR MORE SOLUBLE FORMS. PLUTONIUM SOLUBILIZED WITHIN THE LUNGS IS TRANSLOCATED TO THE LIVER AND SKELETON WHERE IT IS RETAINED. FOLLOWING AN INHALATION OF AN AEROSOL CONTAINING PLUTONIUM, THE PATTERN OF ITS DEPOSITION AND CLEARANCE FROM THE RESPIRATORY TRACT AND THE FRACTION ELIMINATED FROM THE BODY AS WELL AS THE FRACTION DEPOSITED IN THE TARGET ORGAN DEPENDS ON A VARIETY OF FACTORS, INCLUDING THE SIZE, SHAPE AND DENSITY OF THE PARTICLES INHALED AND THE CHEMICAL FORM.

CHRONIC EXPOSURE- NO CLINICAL ILLNESS HAS BEEN ATTRIBUTED TO LONG-TERM INTERNALLY DEPOSITED PLUTONIUM AS A RESULT OF OCCUPATIONAL EXPOSURE, AND A MORTALITY STUDY OF 224 PLUTONIUM WORKERS HAS SHOWN NO EXCESS DEATHS FROM ANY CAUSE. LONG TERM EXPOSURE OF PLUTONIUM OXIDE TO DOGS RESULTED IN RADIATION PNEUMONITIS, PULMONARY FIBROSIS, AND DEATH DUE TO PRIMARY NEOPLASIA.

SEE THE FOLLOWING SECTIONS REGARDING ADVERSE EFFECTS FROM EXPOSURE TO ALPHA RADIATION.

ALPHA RADIATION:

ACUTE EXPOSURE- ALPHA RADIATION IS DENSELY IONIZING WITH VERY HIGH ENERGY AND WILL KILL CELLS IMMEDIATELY ADJACENT TO THE SOURCE OF CONTACT. DAMAGED CELLS MAY NOT RECOVER OR BE REPAIRED. ALPHA EMITTERS MAY OR MAY NOT BE ABSORBED, DEPENDING ON THE SOLUBILITY AND PARTICLE SIZE. INSOLUBLE COMPOUNDS MAY REMAIN AT OR NEAR THE SITE OF DEPOSITION, AND SOLUBLE COMPOUNDS MAY RAPIDLY ENTER THE BLOODSTREAM. HEAVIER PARTICLES WILL BE BROUGHT UP TO THE THROAT BY CILIARY ACTION, AND MAY THEN BE SWALLOWED. THE LIGHTER PARTICLES MAY BE LODGED DEEP IN THE ALVEOLAR AIR SACS AND REMAIN. THE DAMAGE DEPENDS ON HOW QUICKLY THEY ARE ELIMINATED, AND THE SUSCEPTIBILITY OF THE TISSUE IN WHICH THEY ARE STORED. A SINGLE LARGE DOSE OF RADIATION MAY LEAD TO RADIATION SICKNESS.

CHRONIC EXPOSURE- THE EFFECTS OF CHRONIC EXPOSURE BY INTERNALLY DEPOSITED ALPHA RADIATION IS DEPENDENT UPON THE DOSE AND TARGET ORGAN(S). IF THE TOTAL DOSE IS SUFFICIENT, RADIATION SICKNESS MAY OCCUR. POSSIBLE DISORDERS INCLUDE LUNG CANCER, STERILITY, ANEMIA, LEUKEMIA, OR BONE CANCER.

RADIATION SICKNESS

THE SYMPTOMS OF RADIATION SICKNESS ARE DEPENDENT UPON THE DOSE, DOSE RATE, AREA OF THE BODY AFFECTED AND THE TIME AFTER EXPOSURE. RADIATION SICKNESS MAY RESULT FROM INTERNAL OR EXTERNAL SOURCES, AND ACUTE OR CHRONIC EXPOSURE. THE TOTAL DOSE RECEIVED IS THE DETERMINING FACTOR. RADIATION SICKNESS HAS THREE (3) CLEARLY DEFINED SYNDROMES: THE HEMATOPOIETIC, THE GASTROINTESTINAL AND THE CEREBRAL SYNDROMES.

THE HEMATOPOIETIC SYNDROME: THIS SYNDROME MAY OCCUR WHEN DOSAGES OF 200 TO 1000 RADS ARE RECEIVED AS A WHOLE BODY DOSE. IT IS CHARACTERIZED BY ANOREXIA, APATHY, NAUSEA AND VOMITING, AND MAY BECOME MAXIMAL WITHIN 6 TO 12 HOURS AFTER EXPOSURE. SYMPTOMS THEN SUBSIDE, SO THAT 24 TO 36 HOURS AFTER EXPOSURE THE SUBJECT IS ASYMPTOMATIC. DURING THIS PERIOD OF APPARENT WELL-BEING, THE LYMPH NODES, SPLEEN AND BONE MARROW BEGIN TO ATROPHY.

THIS ATROPHY IS THE RESULT OF 2 DISTINCT PROCESSES: DIRECT KILLING OF RADIOSENSITIVE CELLS AND INHIBITION OF NEW CELL PRODUCTION. IN THE PERIPHERAL BLOOD, LYMPHOPENIA COMMENCES IMMEDIATELY, BECOMING MAXIMAL WITHIN 24 TO 36 HOURS. NEUTROPENIA DEVELOPS MORE SLOWLY. THROMBOCYTOPENIA MAY BE PROMINENT WITHIN 3 TO 4 WEEKS. IF THE BONE MARROW DEPRESSION PROGRESSES TO A CRITICAL LEVEL SUCH THAT THE VICTIM IS NOT ABLE TO SEND SUFFICIENT NUMBERS OF GRANULOCYTES AND THROMBOCYTES TO THE CIRCULATING BLOOD, DEATH FROM OVERWHELMING INFECTION MAY OCCUR.

THE GASTROINTESTINAL SYNDROME: THIS SYNDROME OCCURS WHEN 400 OR MORE RADS ARE RECEIVED AS A WHOLE BODY DOSE. IT IS CHARACTERIZED BY INTRACTABLE NAUSEA, VOMITING AND DIARRHEA THAT MAY LEAD TO SEVERE DEHYDRATION, DIMINISHED PLASMA VOLUME, VASCULAR COLLAPSE AND DEATH. THE GASTROINTESTINAL SYNDROME RESULTS FROM THE INITIAL "TOXEMIA" DUE TO NECROSIS OF TISSUE AND IS PERPETUATED BY PROGRESSIVE ATROPHY OF THE GASTROINTESTINAL MUCOSA. ULTIMATELY THE INTESTINAL VILLI ARE DENUDED, WITH MASSIVE LOSS OF PLASMA INTO THE INTESTINE. REGENERATION OF INTESTINAL EPITHELIAL CELLS MAY BE POSSIBLE AFTER LARGE DOSES OF RADIATION; MASSIVE PLASMA REPLACEMENT AND ANTIBIOTICS DURING THE FIRST 4 TO 6 DAYS MAY KEEP THE PATIENT ALIVE UNTIL THE EPITHELIUM REGENERATES. HOWEVER, EVEN IF THE PATIENT SURVIVES, THE RESPITE MAY BE TEMPORARY, SINCE HEMATOPOIETIC FAILURE MAY ENSUE, COMMENCING WITHIN 2 OR 3 WEEKS.

WITH ACUTE TOTAL BODY RADIATION DOSES OF >600 RADS, HEMATOPOIETIC OR GASTROINTESTINAL MALFUNCTION MAY BE FATAL. WITH RADIATION DOSES OF <600 RADS, THE POSSIBILITY OF SURVIVAL IS INVERSELY RELATED TO THE TOTAL DOSE.

THE CEREBRAL SYNDROME: THIS SYNDROME IS PRODUCED BY EXTREMELY HIGH TOTAL BODY DOSES OF RADIATION, USUALLY >3000 RADS, AND GENERALLY CAUSES DEATH. IT CONSISTS OF 3 PHASES: A PRODROMAL PERIOD OF NAUSEA AND VOMITING; THEN LISTLESSNESS AND DROWSINESS RANGING FROM APATHY TO PROSTRATION, POSSIBLY CAUSED BY NON-BACTERIAL INFLAMMATION FOCI OF THE BRAIN OR THE EFFECTS OF RADIATION-INDUCED TOXIC PRODUCTS; AND FINALLY, A MORE GENERALIZED COMPONENT CHARACTERIZED BY TREMORS, CONVULSIONS, ATAXIA AND DEATH WITHIN A FEW HOURS.

OTHER ACUTE EFFECTS:

THE SKIN IS MORE SUBJECT TO RADIATION EXPOSURE ESPECIALLY TO BETA OR X-RAYS THAN OTHER TISSUE. A SLIGHT EXPOSURE CAN RESULT IN ERYTHEMA, CHANGES IN PIGMENTATION, EPILATION, BLISTERING, NECROSIS, AND ULCERATION. THE GONADS ARE ALSO PARTICULARILY RADIOSENSITIVE. A SINGLE DOSE OF 30 RADS RESULTS IN TEMPORARY STERILITY AMONG MEN. IN WOMEN, LOSS OF FERTILITY IS INDICATED BY LOSS OF MENSTRUATION. THE EYES ARE ALSO VERY RADIOSENSITIVE; A SINGLE DOSE OF 100 RADS MAY CAUSE CONJUNCTIVITIS AND KERATITIS.

DELAYED OR CHRONIC EFFECTS OF RADIATION SICKNESS:

THE DELAYED EFFECTS OF RADIATION MAY BE DUE EITHER TO A SINGLE LARGE OVEREXPOSURE OR CONTINUING LOW-LEVEL OVEREXPOSURE. AMONG THE DELAYED EFFECTS ARE CANCER, GENETIC EFFECTS, SHORTENING OF LIFE SPAN, AND CATARACTS.

RADIATION-INDUCED CANCER IS OBSERVED MOST FREQUENTLY IN THE HEMOPOIETIC SYSTEM, THYROID, BONE, AND SKIN. LEUKEMIA IS AMONG THE MOST LIKELY FORMS OF MALIGNANCY RESULTING FROM OVEREXPOSURE TO TOTAL BODY RADIATION. BONE SEEKERS CAN DAMAGE THE RADIOSENSITIVE HEMOPOIETIC TISSUE IN THE BONE MARROW AND THEY ALL PRODUCED CANCER WHEN INJECTED INTO LABORATORY ANIMALS IN SUFFICIENT QUANTITY. LONG TERM CONTINUOUS RADIOACTIVE MATERIALS RESIDING IN THE LUNG MAY PRODUCE CANCER. THE GONADS ARE ALSO PARTICULARILY RADIOSENSITIVE. A SINGLE DOSE OF 30 RADS RESULTS IN TEMPORARY STERILITY AMONG MEN. IN WOMEN, LOSS OF FERTILITY IS INDICATED BY LOSS OF MENSTRUATION.

IONIZING RADIATION IS KNOWN TO PRODUCE A VARIETY OF TYPES OF GENETIC

INJURY RANGING FROM POINT MUTATIONS TO SEVERE CHROMOSOME DAMAGE SUCH AS STRAND BREAKAGE, TRANSLOCATIONS, AND DELETIONS. MUTATIONS IN SOMATIC CELLS MAY BE RESPONSIBLE, IN PART, FOR THE INITIATION OF RADIOGENIC CANCERS. IF THE GERM CELLS HAVE BEEN AFFECTED, THE EFFECTS OF THE MUTATION MAY NOT BECOME APPARENT UNTIL THE NEXT GENERATION, OR EVEN LATER.

FIRST AID- REMOVE FROM EXPOSURE AREA TO A RESTRICTED AREA WITH FRESH AIR AS QUICKLY AS POSSIBLE. IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION BY ADMINISTERING OXYGEN; MOUTH-TO-MOUTH RESUSCITATION SHOULD BE AVOIDED, TO PREVENT EXPOSURE TO THE PERSON RENDERING FIRST AID. ANY EVIDENCE OF SERIOUS CONTAMINATION INDICATES THAT TREATMENT MUST BE INSTITUTED. INHALATION OF RADIOACTIVE PARTICLES MAY INDICATE THAT OTHER PARTS OF THE BODY WERE ALSO CONTAMINATED, SUCH AS THE DIGESTIVE TRACT, SKIN AND EYES. IF TIME PERMITS, WIPE THE FACE WITH WET FILTER PAPER, FORCE COUGHING AND BLOWING OF THE NOSE. GET MEDICAL ATTENTION IMMEDIATELY (INTERNATIONAL ATOMIC ENERGY ASSOCIATION #3, PG.65).

!! WARNING!!

THE VICTIM MAY BE CONTAMINATED WITH RADIOACTIVE PARTICLES. THOROUGH DECONTAMINATION SHOULD BE STARTED BEFORE THE VICTIM IS MOVED TO THE MEDICAL AREA.

ANY PERSONNEL INVOLVED IN RENDERING FIRST AID MUST BE MONITORED FOR RADIOACTIVITY AND THROUGHLY DECONTAMINATED IF NECESSARY (IAEA #3, PG.65).

SKIN CONTACT:

PLUTONIUM-239:

ACUTE EXPOSURE- PENETRATION THROUGH HEALTHY SKIN HAS NEVER BEEN REPORTED, HOWEVER CONTAMINATION MAY OCCUR THROUGH BROKEN SKIN.

CHRONIC EXPOSURE- NO DATA AVAILABLE.

SEE THE FOLLOWING SECTIONS REGARDING ADVERSE EFFECTS FROM EXPOSURE TO ALPHA RADIATION.

ALPHA RADIATION:

ACUTE EXPOSURE- ALPHA RADIATION IS NOT USUALLY AN EXTERNAL HAZARD. HOWEVER, LOCAL DAMAGE MAY OCCUR AT THE SITE OF A WOUND. ABSORPTION OR PENETRATION THROUGH DAMAGED SKIN MAY RESULT IN RADIATION SICKNESS.

CHRONIC EXPOSURE- PROLONGED OR REPEATED CONTACT MAY RESULT IN RADIATION SICKNESS.

RADIATION SICKNESS

THE CLINICAL COURSE OF RADIATION SICKNESS DEPENDS UPON THE DOSE, DOSE RATE, AREA OF THE BODY AFFECTED AND TIME AFTER EXPOSURE. EXTERNAL AND INTERNAL RADIOACTIVITY OF ANY TYPE MAY CAUSE RADIATION SICKNESS.

RADIATION SICKNESS HAS THREE (3) CLEARLY DEFINED SYNDROMES WHICH ARE DESCRIBED IN DETAIL IN THE INHALATION SECTION.

FIRST AID- REMOVE VICTIM TO A SUITABLE AREA FOR DECONTAMINATION AS QUICKLY AS POSSIBLE. REMOVE CLOTHING AND SHOES IMMEDIATELY. THOROUGHLY WASH THE VICTIM WITH SOAP AND WATER, PAYING PARTICULAR ATTENTION TO THE HEAD, FINGER NAILS AND PALMS OF THE HANDS. UPON COMPLETION OF WASHING, MONITOR THE VICTIM FOR RADIOACTIVITY. IT IS IMPERATIVE THAT THE SKIN SHOULD BE DECONTAMINATED AS QUICKLY AS POSSIBLE. MINUTE SKIN INJURIES GREATLY INCREASE THE DANGER OF ISOTOPE PENETRATION INTO THE VICTIM; SHAVING SHOULD NOT BE ATTEMPTED. IF WATER AND SOAP HAVE BEEN INADEQUATE IN REMOVING THE RADIOACTIVE COMPOUND, DECONTAMINATING COMPOUNDS CONSISTING OF SURFACTANTS AND ABSORBENT SUBSTANCES MAY BE EFFECTIVE. COMPLEXING REAGENTS MAY ALSO BE OF USE. THE USE OF ORGANIC SOLVENTS IS TO BE AVOIDED, AS THEY MAY INCREASE THE SOLUBILITY AND ABSORPTION OF THE RADIOACTIVE SUBSTANCE. SKIN CONTAMINATION WITH RADIATION MAY BE AN INDICATION THAT OTHER PARTS

OF THE BODY HAVE BEEN EXPOSED (INTERNATIONAL ATOMIC AGENCY ASSO #47 PG 9; INTERNATIONAL ATOMIC ENERGY ASSO. #3, PG. 62).

!! WARNING!!

CONTAMINATED CLOTHING MUST BE STORED IN A METAL CONTAINER FOR LATER DECONTAMINATION OR DISPOSAL. THE WATER USED TO WASH THE VICTIM MUST BE STORED IN METAL CONTAINERS FOR LATER DISPOSAL.

ANY PERSONNEL INVOLVED IN RENDERING FIRST AID TO THE VICTIM MUST BE MONITORED FOR RADIOACTIVITY AND DECONTAMINATED IF NECESSARY (IAEA #47, PG.9; IAEA #3, PG.62).

EYE CONTACT:

PLUTONIUM-239:

ACUTE EXPOSURE- NO SPECIFIC DATA AVAILABLE.

CHRONIC EXPOSURE- NO SPECIFIC DATA AVAILABLE.

SEE THE FOLLOWING SECTIONS REGARDING ADVERSE EFFECTS FROM EXPOSURE TO ALPHA RADIATION.

ALPHA RADIATION:

ACUTE EXPOSURE- RADIATION AFFECTS THE EYE BY INDUCING ACUTE INFLAMMATION OF THE CONJUNCTIVA AND THE CORNEA. THE MOST SENSITIVE PART OF THE EYE IS THE CRYSTALLINE LENS. A LATE EFFECT OF EYE IRRADIATION IS CATARACT FORMATION. IT MAY BEGIN ANYWHERE FROM 6 MONTHS TO SEVERAL YEARS AFTER A SINGLE EXPOSURE. CATARACT FORMATION BEGINS AT THE POSTERIOR POLE OF THE LENS, AND CONTINUES UNTIL THE ENTIRE LENS HAS BEEN AFFECTED. GROWTH OF THE OPACITY MAY STOP AT ANY POINT. THE RATE OF GROWTH AND THE DEGREE OF OPACITY ARE DEPENDENT UPON THE DOSE OF RADIATION.

CHRONIC EXPOSURE- REPEATED OR PROLONGED EXPOSURE TO ALPHA RADIATION MAY RESULT IN CATARACT FORMATION, AS DESCRIBED ABOVE. OF THE WELL-DOCUMENTED LATE EFFECTS OF RADIATION ON MAN, LEUKEMIA AND CATARACTS HAVE BEEN OBSERVED AT DOSES LOWER THAN THOSE PRODUCING SKIN SCARRING AND CANCER OR BONE TUMORS. THE LENS OF THE EYE SHOULD BE CONSIDERED TO BE A CRITICAL ORGAN.

RADIATION SICKNESS

THE EYES ARE VERY RADIOSENSITIVE; A SINGLE DOSE OF 100 RADS MAY CAUSE CONJUNCTIVITIS AND KERATITIS.

IT IS UNLIKELY THAT A DOSE SUFFICIENT TO CAUSE RADIATION SICKNESS WOULD OCCUR IF ONLY THE EYES WERE IRRADIATED. HOWEVER, IF EYE DAMAGE BY IONIZING RADIATION OCCURS, IT MAY BE BEST TO ASSUME THAT OTHER PARTS OF THE BODY HAVE ALSO BEEN CONTAMINATED. SYMPTOMS OF RADIATION SICKNESS ARE DESCRIBED IN THE INHALATION SECTION.

FIRST AID- REMOVE VICTIM TO A RESTRICTED AREA FOR DECONTAMINATION. THOROUGHLY WASH EYES WITH LARGE AMOUNTS OF WATER, OCCASIONALLY LIFTING THE THE UPPER AND LOWER LIDS (APPROXIMATELY 15 MINUTES). FOLLOWING THE WATER TREATMENT, PROVIDE AN ISOTONIC SOLUTION. DO NOT USE EYEBATHS, RATHER PROVIDE A CONTINUOUS AND COPIOUS SUPPLY OF FLUID. MONITOR THE VICTIM FOR RADIOACTIVITY. IF ACTIVITY IS PRESENT, REWASH THE EYES, AND REMONITOR UNTIL LITTLE OR NO RADIOACTIVITY IS PRESENT. GET MEDICAL ATTENTION IMMEDIATELY (INTERNATIONAL ATOMIC ENERGY ASSO. #3, PG.65; #47, PG.35).

!! WARNING!!

ANY WATER USED TO WASH THE VICTIMS EYES MUST BE STORED IN A METAL CONTAINER FOR LATER DISPOSAL. ANY OTHER ARTICLES THAT ARE USED TO

DECONTAMINATE THE VICTIM MUST ALSO BE STORED IN METAL CONTAINERS FOR LATER DECONTAMINATION OR DISPOSAL.
ANY PERSONNEL INVOLVED IN RENDERING FIRST AID TO THE VICTIM MUST BE MONITORED FOR RADIOACTIVITY AND DECONTAMINATED IF NECESSARY (IAEA #3, PG.65; #47, PG.35).

INGESTION:
PLUTONIUM-239:
ACUTE EXPOSURE- INTESTINAL ABSORPTION IS VIRTUALLY ZERO; 0.003% FOR SOLUBLE COMPOUNDS AND 0.0001% FOR INSOLUBLE COMPOUNDS.
CHRONIC EXPOSURE- NO DATA AVAILABLE.

SEE THE FOLLOWING SECTIONS REGARDING ADVERSE EFFECTS FROM EXPOSURE TO ALPHA RADIATION.

ALPHA RADIATION:
ACUTE EXPOSURE- THE FATE OF INGESTED ALPHA EMITTERS DEPENDS ON THEIR SOLUBILITY AND VALENCE. HIGH DOSES MAY LEAD TO RADIATION SICKNESS AS DESCRIBED IN INHALATION EXPOSURE.
CHRONIC EXPOSURE- REPEATED INGESTION OF ALPHA EMITTERS MAY LEAD TO RADIATION SICKNESS AS DESCRIBED IN INHALATION EXPOSURE.

RADIATION SICKNESS

THE SYMPTOMS OF RADIATION SICKNESS DEPENDS UPON THE DOSE RECEIVED. IT MAY RESULT FROM ACUTE OR CHRONIC EXPOSURE TO ANY FORM OF RADIATION. THE SYMPTOMS ARE DESCRIBED IN THE INHALATION SECTION.

FIRST AID: IN THE CASE OF INGESTION OF RADIOACTIVE SUBSTANCES, THE MOUTH SHOULD BE RINSED OUT IMMEDIATELY AFTER THE ACCIDENT, CARE BEING TAKEN NOT TO SWALLOW THE WATER USED FOR THIS PURPOSE. VOMITING SHOULD BE INDUCED EITHER MECHANICALLY, OR WITH SYRUP OF IPECAC. DO NOT INDUCE VOMITING IN AN UNCONSCIOUS PERSON. LAVAGE MAY BE USEFUL. CARE SHOULD BE TAKEN TO AVOID ASPIRATION. THE VOMITUS AND LAVAGE FLUIDS SHOULD BE SAVED FOR EXAMINATION AND MONITORING. FURTHER ACTION DEPENDS ON THE NATURE OF THE RADIOACTIVE SUBSTANCE. GET MEDICAL ATTENTION IMMEDIATELY (INTERNATIONAL ATOMIC ENERGY ASSO. #47, PG.9; #3, PP.59 AND 66).

!!WARNING!!

THE GASTRIC FLUIDS AND FLUIDS USED FOR LAVAGE MUST BE STORED IN METAL CONTAINERS FOR LATER DISPOSAL. THE VICTIM MUST BE MONITORED FOR RADIOACTIVITY AND DECONTAMINATED, IF NECESSARY, BEFORE BEING TRANSPORTED TO A MEDICAL FACILITY.
ANY PERSONNEL INVOLVED IN RENDERING FIRST AID TO THE VICTIM MUST BE MONITORED FOR RADIOACTIVITY AND DECONTAMINATED IF NECESSARY (IAEA #47, PG.9; #3, PP. 59 AND 66).

ANTIDOTE:
FOR PLUTONIUM POISONING:
GIVE 0.5 GRAM OF THE CALCIUM SALT OF DIETHYLENETRIAMINEPENTAACETIC ACID (DTPA) DILUTED IN 250 ML OF PHYSIOLOGICAL SALINE GIVEN BY SLOW INTRAVENOUS INJECTION. (IAEA SAFETY SERIES #47).

FOR INHALATION CONTAMINATION:
PREPARE AN CA-DTPA AEROSOL IMMEDIATELY USING A CA-DTPA AMPULE IN A CONVENTIONAL GENERATOR OR, PREFERABLY, A CAPSULE OF MICRONIZED CA-DTPA IN A GENERATOR PRODUCING AN AEROSOL OF SUITABLE PARTICLE SIZE, AND ALWAYS INJECT 0.5 G OF CA-DTPA INTRAVENOUSLY; PULMONARY LAVAGE SHOULD BE CONSIDERED BY QUALIFIED MEDICAL PERSONNEL. (IAEA SAFETY SERIES #47).

FOR CONTAMINATED WOUND:
INJECT CA-DTPA INTRAVENOUSLY AND WASH THE WOUND LOCALLY WITH A CONCENTRATED CA-DTPA SOLUTION ONE AMPULE); POSSIBLE SURGICAL REMOVAL OF THE PLUTONIUM IN THE WOUND SHOULD ONLY BE CONSIDERED BY QUALIFIED MEDICAL PERSONNEL. (IAEA SAFETY SERIES #47).

REACTIVITY SECTION

REACTIVITY:
MAY FORM PYROPHORIC PRODUCTS ON EXPOSURE TO AIR AND MOISTURE WHICH MAY PRESENT A FIRE HAZARD WITH SUBSEQUENT SPREAD OF RADIOACTIVE MATERIAL.

INCOMPATIBILITIES:
PLUTONIUM:
  CARBON TETRACHLORIDE: MAY IGNITE OR EXPLODE.

DECOMPOSITION:
PLUTONIUM-239 DECAYS TO RADIOACTIVE URANIUM-235 WITH A HALF-LIFE OF 24,000 YEARS.

POLYMERIZATION:
HAZARDOUS POLYMERIZATION HAS NOT BEEN REPORTED TO OCCUR UNDER NORMAL TEMPERATURES AND PRESSURES.

STORAGE-DISPOSAL

OBSERVE ALL FEDERAL, STATE AND LOCAL REGULATIONS WHEN STORING OR DISPOSING OF THIS SUBSTANCE. FOR ASSISTANCE, CONTACT THE DISTRICT DIRECTOR OF THE ENVIRONMENTAL PROTECTION AGENCY.

STORAGE

STORE IN ACCORDANCE WITH 10 CFR PART 20.

DISPOSAL

DISPOSAL MUST BE IN ACCORDANCE WITH 10 CFR PARTS 20 AND 60.

CONDITIONS TO AVOID

MAY BURN BUT DOES NOT IGNITE READILY. AVOID DISPERSION OF DUST IN AIR.

CARE MUST BE TAKEN IN THE HANDLING OF PLUTONIUM TO AVOID UNINTENTIONAL FORMATION OF A CRITICAL MASS. PLUTONIUM IN LIQUID SOLUTIONS IS MORE APT TO BECOME CRITICAL THAN SOLID PLUTONIUM.

OCCUPATIONAL-SPILL:
DO NOT TOUCH DAMAGED CONTAINERS OR SPILLED MATERIAL. DAMAGE TO OUTER CONTAINER MAY NOT AFFECT PRIMARY INNER CONTAINER. FOR SMALL LIQUID SPILLS, TAKE UP WITH SAND, EARTH OR OTHER ABSORBENT MATERIAL. FOR LARGE SPILLS, DIKE FAR AHEAD OF SPILL FOR LATER DISPOSAL. KEEP UNNECESSARY PEOPLE AT LEAST 150 FEET UPWIND; GREATER DISTANCES MAY BE NECESSARY IF ADVISED BY QUALIFIED RADIATION AUTHORITY. ISOLATE HAZARD AREA AND DENY ENTRY. ENTER SPILL AREA ONLY TO SAVE LIFE; LIMIT ENTRY TO SHORTEST POSSIBLE TIME. DETAIN UNINJURED PERSONS AND EQUIPMENT EXPOSED TO RADIOACTIVE MATERIAL UNTIL ARRIVAL OR INSTRUCTION OF QUALIFIED RADIATION AUTHORITY. DELAY CLEANUP UNTIL ARRIVAL OR INSTRUCTION OF QUALIFIED RADIATION AUTHORITY.

PROTECTIVE EQUIPMENT SECTION

VENTILATION:
PROVIDE LOCAL EXHAUST OR PROCESS ENCLOSURE VENTILATION. VENTILATION EQUIPMENT MUST BE EXPLOSION-PROOF.

ONE METHOD OF CONTROLLING EXTERNAL RADIATION EXPOSURE IS TO PROVIDE ADEQUATE SHIELDING. THE ABSORBING MATERIAL USED AND THE THICKNESS REQUIRED TO ATTENUATE THE RADIATION TO ACCEPTABLE LEVELS DEPENDS ON THE TYPE OF RADIATION, ITS ENERGY, THE FLUX AND THE DIMENSIONS OF THE SOURCE.
ALPHA PARTICLES- FOR THE ENERGY RANGE OF ALPHA PARTICLES USUALLY ENCOUNTERED, A FRACTION OF A MIL[illegible]TER OF ANY ORDINARY MATERIAL IS SUFFICIENT FOR ABSORBANCE. THIN RUB[illegible] ACRYLIC, STOUT PAPER, OR CARDBOARD WILL SUFFICE.
BETA PARTICLES- BETA PAR[illegible]S ARE MORE PENETRATING THAN ALPHA, AND REQUIRE MORE SHEILDING. MATERIAL[illegible]MPOSED MOSTLY OF ELEMENTS OF LOW ATOMIC NUMBER SUCH AS ACRYLIC, ALUMINUM AND THICK RUBBER ARE MOST APPROPRIATE FOR THE ABSORPTION OF BETA PARTICLES. FOR EXAMPLE, 1/4 INCH OF ACRYLIC WILL ABSORB ALL BETA PARTICLES UP TO 1 MEV. WITH HIGH ENERGY BETA RADIATION FROM LARGE SOURCES, BREMSSTRAHLUNG (X RAY PRODUCTION) CONTRIBUTION MAY BECOME SIGNIFICANT AND IT MAY BE NECESSARY TO PROVIDE ADDITIONAL SHEILDING OF HIGH ATOMIC WEIGHT MATERIAL, SUCH AS LEAD, TO ATTENUATE THE BREMSSTRAHLUNG RADIATION.
GAMMA RAYS- THE MOST SUITABLE MATERIALS FOR SHIELDING GAMMA RADIATION ARE LEAD AND IRON. THE THICKNESS REQUIRED WILL DEPEND ON WHETHER THE SOURCE IS PRODUCING NARROW OR BROAD BEAM RADIATION. PRIMARY AND SECONDARY PROTECTIVE BARRIERS MAY BE REQUIRED TO BLOCK ALL RADIATION.

RESPIRATOR:
THESE RECOMMENDED RESPIRATORS SHOULD PROVIDE PROTECTION FOR THE RESPIRATORY TRACT AGAINST MOST OF THE RADIOACTIVE PARTICLES ENCOUNTERED IN THE WORK PLACE. THESE RESPIRATORS WILL NOT OFFER PROTECTION AGAINST BETA AND GAMMA RADIATION, BUT MAY BLOCK ALPHA PARTICLES. FROM 10CFR20.103 APPENDIX A. RESPIRATORY EQUIPMENT MUST BE CERTIFIED BY NIOSH/MSHA.

TYPE 'C' SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE OR WITH A FULL FACEPIECE, HELMET OR HOOD OPERATED IN CONTINOUS-FLOW MODE.

SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

FOR FIREFIGHTING AND OTHER IMMEDIATELY DANGEROUS TO LIFE OR HEALTH CONDITIONS:

SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

SUPPLIED-AIR RESPIRATOR WITH FULL FACEPIECE AND OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE IN COMBINATION WITH AN AUXILIARY SELF-CONTAINED BREATHING APPARATUS OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

CLOTHING:

DIPOSABLE OVERGARMENTS, INCLUDING HEAD COVERINGS AND FOOT COVERING, SHOULD BE WORN BY ANY EMPLOYEE ENGAGED IN HANDLING ANY RADIACTIVE SUBSTANCE. THESE GARMENTS ARE ALSO RECOMMENDED EVEN IF THE EMPLOYEE IS WORKING WITH A "GLOVE BOX" CONTAINMENT SYSTEM. CERTAIN CLOTHING FIBERS MAY BE USEFUL IN DOSIMETRY SO CLOTHING SHOULD BE KEPT.
IN THE EVENT OF AN ACCIDENT, LARGE SCALE RELEASE OR A LARGE SCALE CLEAN-UP FULL PROTECTIVE CLOTHING WILL BE NECESSARY.

GLOVES:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE GLOVES TO PREVENT CONTACT WITH THIS SUBSTANCE.

WARNING!

USED GLOVES MAY PRESENT A RADIATION HAZARD AND SHOULD BE DISPOSED OF AS RADIOACTIVE WASTE.

EYE PROTECTION:
EMPLOYEE MUST WEAR APPROPRIATE EYE PROTECTION THAT WILL NOT ALLOW THE INTRODUCTION OF PARTICLES INTO THE EYES. CONTACT LENSES SHOULD NOT BE WORN.

CLOTHING, GLOVE, AND EYE PROTECTION EQUIPMENT WILL PROVIDE PROTECTION AGAINST ALPHA PARTICLES, AND SOME PROTECTION AGAINST BETA PARTICLES, DEPENDING ON THICKNESS, BUT WILL NOT SHIELD GAMMA RADIATION.

AUTHORIZED BY- OCCUPATIONAL HEALTH SERVICES, INC.

CREATION DATE: 03/09/89 REVISION DATE: 04/12/90

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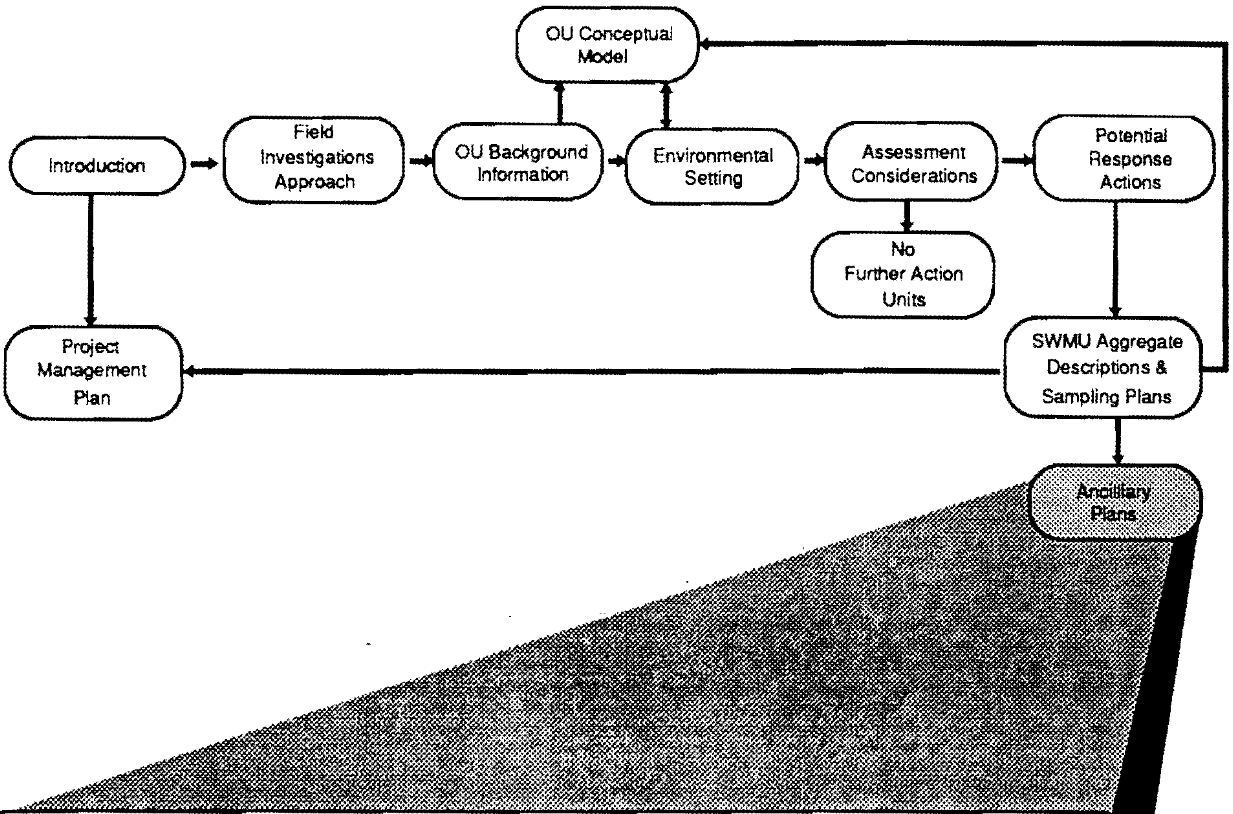
Annex IV



Records Management Project Plan

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ANNEX IV: RECORDS MANAGEMENT PROJECT PLAN

1.0 Introduction

The Records Management Plan (RMP) for the Environmental Restoration (ER) Program at Los Alamos National Laboratory (the Laboratory) is described in Annex IV of the Installation Work Plan (IWP) (LANL 1991, 0553). The purposes of the RMP are to meet the requirements for protecting and managing records (including technical data), to provide an ongoing tool to support the technical efforts of the ER Program, and to function as a support system for management decisions throughout the existence of the ER Program.

In the ER Program, the following statutory definition of a record [44 USC 3301 (ref.)] is used.

> Records are defined as "...books, papers, maps, photographs, machine-readable materials, or other documentary materials, regardless of physical form or characteristics,...appropriate for preservation...because of the informational value of the data in them."

The RMP establishes general guidelines for managing records, regardless of their physical form or characteristics, that are generated and/or used by the ER Program. The RMP will be implemented consistently to meet the requirements of the Quality Assurance Program Plan (Annex II of the IWP) and to provide an auditable and legally defensible system for records management. Another important function of the RMP is to maintain the publicly accessible documentation comprising the Administrative Record required by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA).

2.0 Implementation of the Records Management Plan

Chapter 2 of the RMP describes the implementation of the records management program. Records management activities at Operable Unit (OU) 1144 will follow the guidelines summarized in that chapter. As the RMP develops to support OU needs, additional detail will be provided in annual updates of the IWP.

The RMP incorporates a threefold approach based on records control and commitment to quality guidelines: a structured work flow for records, the use of approved procedures, and the compilation of a referable information base. ER Program records are those specifically identified in quality procedures (QPs), administrative procedures (APs), standard operating procedures (SOPs), ER RMPs; management guidance documents, or records identified by ER Program participants as being essential to the program. Records are processed in a structured work flow. The records management procedure (LANL-ER-AP-02.1) governs records management activities, which include records identification, submittal, review, indexing, retention, protection, access, retrieval, and correction (if necessary). Other procedures, such as LANL-ER-AP-01.3, LANL-ER-AP-01.4, and LANL-ER-AP-01.5, are also followed.

Records (including data) will be protected in and accessed through the referable information base. The referable information base is composed of the Records-Processing Facility (RPF) and the Facility for Information Management, Analysis, and Display (FIMAD). RPF personnel receive ER Program records, assign an ER identification number, and process records for delivery to the FIMAD. The RPF will complement FIMAD in certain aspects of data capture, such as scanning. The RPF also functions as an ER Program reference library for information that is inappropriate either in form (e.g. old records) or in content (e.g., Federal Register) for storage at the FIMAD. FIMAD provides the hardware and software necessary for data capture, display, and analysis. The information will be readily accessible through a network of work stations. Configuration management accounts for, controls, and documents the planned and actual design components of FIMAD.

3.0 Use of ER Program Records Management Facilities

The Environmental Restoration Program's RPF and FIMAD facilities will be utilized for management of records resulting from the conduct of work on Operable Unit 1144. Interaction with these facilities is detailed in LANL -ER-AP-2.01, Annex IV of the Installation Work Plan, and other Program procedures and management guidance documents as appropriate.

4.0 Coordination with the Quality Program

Records will be protected throughout the process, as described in Chapter 4 of the RMP and in LANL-ER-AP-02.1. The originator is responsible for protecting records until they are submitted to the RPF. The level of protection afforded by the originator will be commensurate with the value of the information contained in the record. Upon receipt of a record, the RPF will temporarily store the original of the record in one-hour, fire-rated equipment and will provide a copy of the record to the FIMAD. The RPF will then send the original record to a dual storage area for long-term storage in a protected environment.

5.0 Coordination with the Health and Safety Program

Chapter 5 of the RMP notes two exceptions to the records storage process. The Laboratory's Occupational Medicine Group (HS-2) will maintain medical records because of their confidential nature. Training records will be maintained by the RPF in coordination with the Laboratory Training Office (LTO) within the Human Resources Development (HRD) Division. FIMAD will only contain information about the completion of training, the dates of required refresher training, and the location of training records.

6.0 Coordination with the ER Program's Management Information System

Specific reporting requirements are ER Program deliverables and, as such, are monitored through the ER management information system. Records resulting from the conduct of work on operable units contribute to the development of the deliverables.

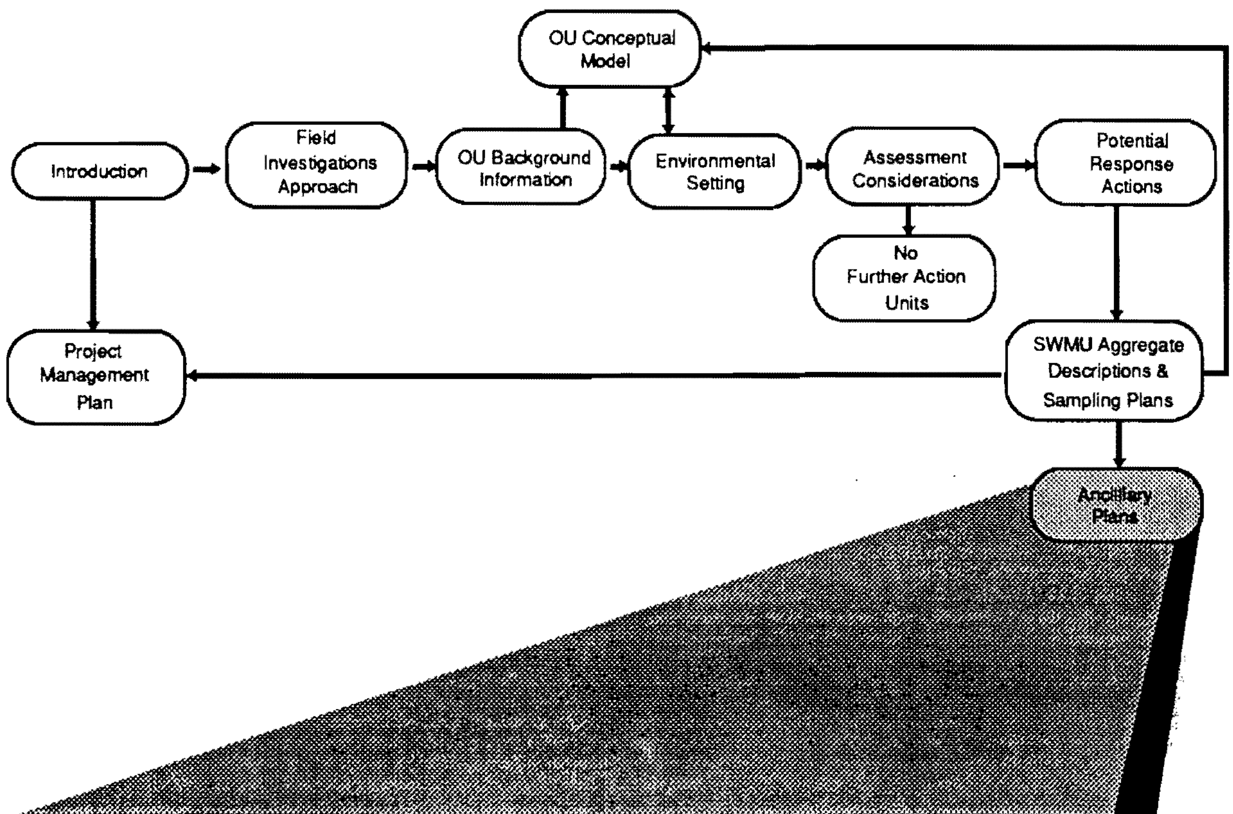
7.0 Coordination with the Community Relations Program

RCRA and CERCLA require that records be made available to the public. Two complementary approaches are being implemented: hard copy and electronic access. A reading room allows public access to hard copies of key documents. A work station and necessary data links are being prepared to allow public access to the FIMAD data base.

Annex IV Reference

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

Annex V



Community Relations Project Plan

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ANNEX V: COMMUNITY RELATIONS PLAN FOR OPERABLE UNIT 1144 (TECHNICAL AREA 49)

1.0 Overview of Community Relations Plan

The Community Relations Plan specific to Operable Unit (OU) 1144 (technical Area 49, or TA-49)follows the directives, goals, and regulatory requirements set forth in the Community Relations Program Plan in Annex V, Volume 1 of the Installation Work Plan (IWP) (LANL 1991, 0553) for Environmental Restoration (ER). This annex details the community relations activities for OU during the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI). The activities are based on current knowledge of public information needs and resources available to the Los Alamos National Laboratory (Laboratory) ER Program Staff.

As shown in Figure V-1, public participation is required by regulation during the corrective measures study (CMS); therefore, the Laboratory will provide opportunities for public participation during the five-year RFI process as detailed in this annex and illustrated in Figure V-2. The Hazardous and Solid Waste Amendments (HSWA) module of the Laboratory's RCRA Facility Permit requires that the following specific items be addressed in the Community Relations Plan:

- Establishing a mailing list of interested parties;
- News releases, fact sheets, approved RFI Workplans, RFI final reports, Special Permit Conditions Reports and publicly available quarterly progress reports that explain the progress and conclusions of the RFI;
- Creation of a public information repository and reading room with updates of available material;
- Informal meetings between the public and local officials, including briefings and workshops as appropriate;
- Public tours and briefings to address individual concerns and questions;
- Quarterly technical progress reports during the RFI process for the Administrative Authority; and

FigureV-1. Regulatorily Mandated Opportunities for Public Participation During the RCRA Corrective Action Process

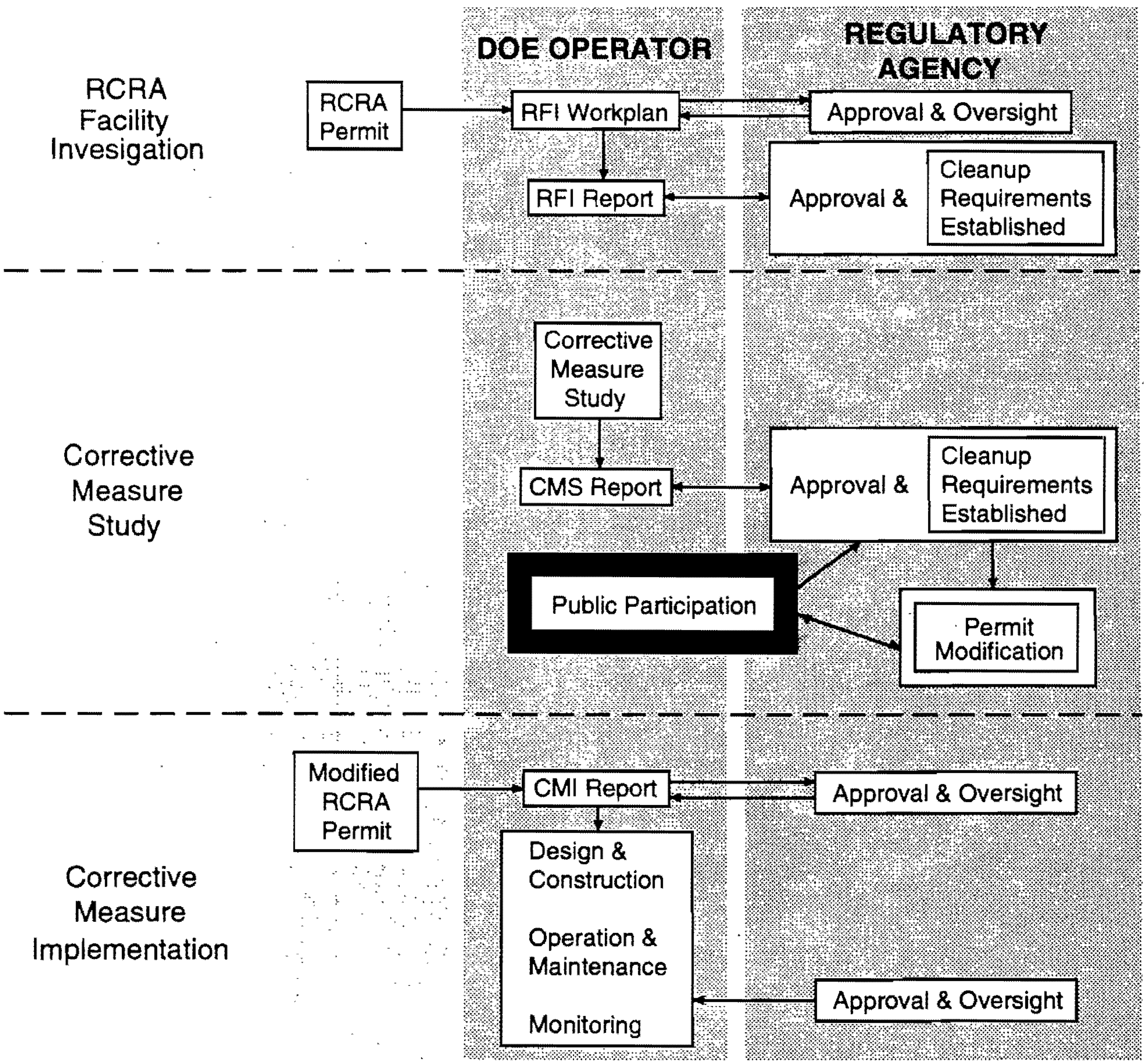
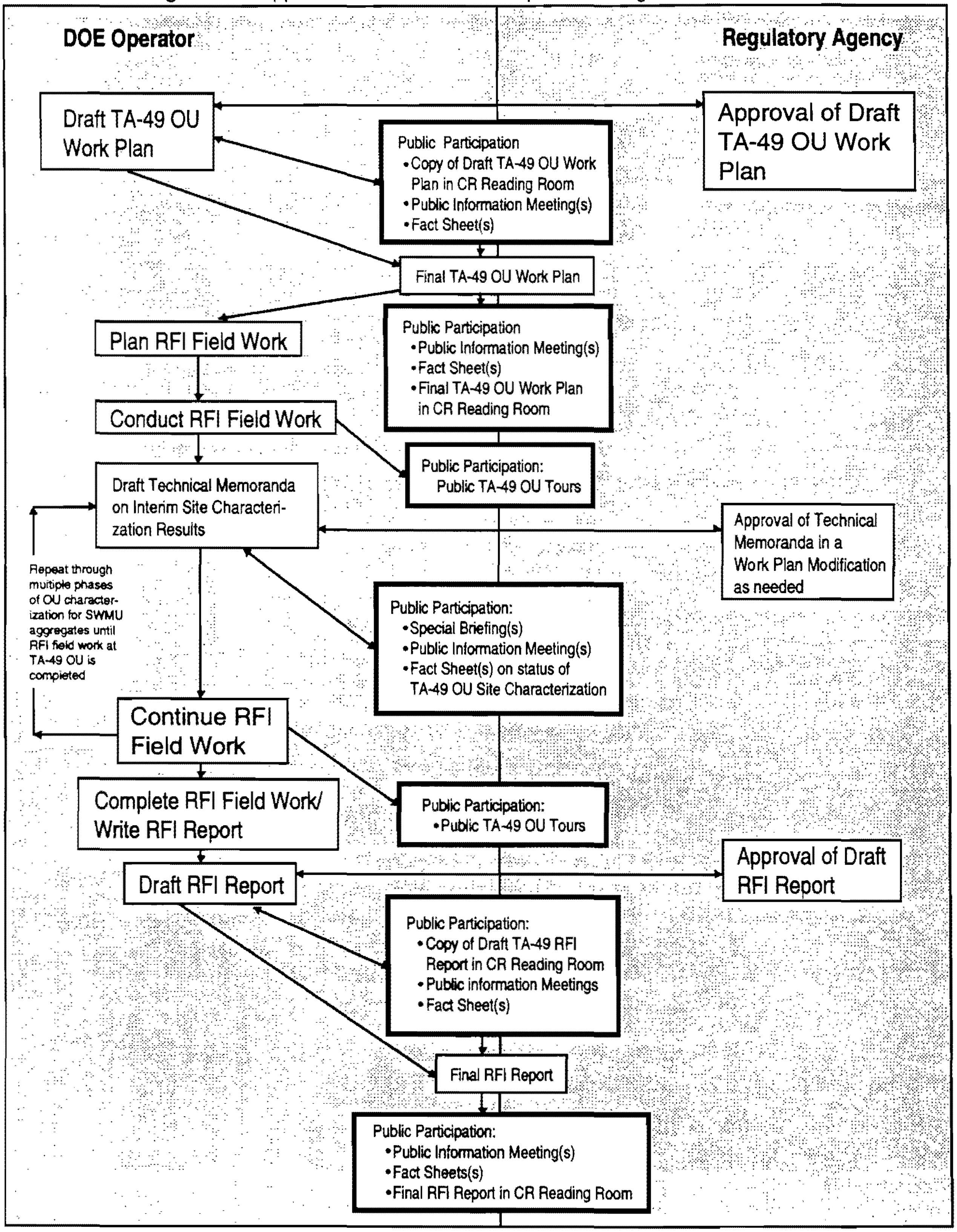


Figure V-2. Opportunities for Public Participation During the TA-49 OU RFI



- Procedures for immediate notification of the San Idelfonso Pueblo or other neighboring affected parties in the event of a newly-discovered off-site release which could potentially affect them.

These items are addressed in Sections 2.1 through 2.6 of this plan.

All information concerning ER program activities at OU 1144 will originate with or be provided to the public through the community relations project leader as follows:

Community Relations Project Leader
Environmental Restoration Program
Los Alamos National Laboratory
2101 Trinity Drive, Suite 20
Los Alamos, New Mexico 87545
(505) 665-2127

2.0 Community Relations Activities

The following is a brief description of community relations activities to be conducted during RFI activities at the TA-49 OU. These activities are designed to address key concerns identified by the TA-49 OU team and IWP. The scope of each activity is flexible and can be tailored to respond to public information needs.

Because of the proximity of TA-49 to Bandelier National Monument, the importance of keeping management at Bandelier informed of the status of activities is specifically acknowledged.

2.1 Mailing List

Community Relations will enhance the ER Program mailing list to include former workers at TA-49 and current Bandelier management to keep them informed of meetings, activities, and schedules pertaining to the TA-49 OU. Furthermore, an informal dialogue will be maintained with the management at Bandelier National Monument to complement the mailings and provide a faster means of response.

2.2 Fact Sheets

The Community Relations Office developed a fact sheet that shows the TA-49 OU and the location of its SWMUs, and that summarizes site history and use, known contaminant's of concern, and planned activities (see Attachment 1 to this Annex). The initial fact sheet was distributed in June 1991 and revised in May 1992. Updated fact sheets will be developed as public information needs change and progress is made. A map showing SWMU locations at TA-49 will be available for public review in the ER Program's Public Reading Room.

2.3 ER Community Reading Room

As they are developed, documents and data associated with the TA-49 OU, such as the RFI Work Plan, quarterly technical progress reports, the RFI report, and other reports, will be available to the public at the ER Community Reading Room at TriSquare, 2101 Trinity Drive, Suite 20, in downtown Los Alamos, from 9 a.m. to 4 p.m. on Laboratory business days. A copy of the TA-49 OU RFI Draft Work Plan will be available at the reading room in May 1992.

2.4 Public Information Meetings, Briefings, Tours and Responses to, Inquiries

Once initial information has been gathered and a specific mailing list developed, there will be public information meetings held in Los Alamos to introduce the public to forthcoming activities described in the work plan for the TA-49 OU. The TA-49 OU Project Leader, with the assistance of the Community Relations Project Leader, will present information and respond to questions and concerns raised by the public. The Laboratory and Department of Energy plan to hold quarterly public information meetings to discuss specific activities and significant milestones during the RFI. Tours will be conducted for interested parties upon request.

If a limited interest issue of concern is raised at a public information meeting, it may be necessary to hold a special briefing or to respond on a one-to-one basis to the inquiry. These inquiries will be coordinated by the Community Relations Project Leader and the TA-49 OU Project Leader.

2.5 Quarterly Technical Progress Reports

As the TA-49 OU RFI is implemented, the Laboratory will summarize technical progress in quarterly technical progress reports, as required by the HSWA module of the Laboratory's RCRA Facility Permit (Task V, C, page 46). These reports will be available at the ER Community Reading Room.

2.6 Informal Public Review and Comment on the Draft OU 1144 RFI Work Plan

The Laboratory will encourage public input regarding the field sampling proposed in the draft TA-49 OU RFI Work Plan after U.S. Environmental Protection Agency (EPA) formal approval of this document following its submittal to EPA in May 1992. Public input regarding numbers of samples, types of samples, and quality assurance samples (e.g., duplicate samples) will be incorporated, as appropriate, into the final Work Plan.

References for Annex V

EPA (US Environmental Protection Agency), April 10, 1990. Module VIII of RCRA Permit No. NM0890010515, EPA Region VI, issued to Los Alamos National Laboratory, Los Alamos, New Mexico, effective May 23, 1990, EPA Region VI, Hazardous Waste Management Division, Dallas, Texas. (EPA 1990, 0306)

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

Attachment 1

LOS ALAMOS NATIONAL LABORATORY ENVIRONMENTAL RESTORATION PROGRAM FACT SHEET FOR OPERABLE UNIT 1144 (TECHNICAL AREA 49)

TA-49:

- Experiments involving radioactive/hazardous materials were conducted in underground shafts at TA-49 from late 1959 to mid 1961.

- Portions of TA-49 currently are used for microwave research, the Laboratory's Hazardous Devices Team activities, and other low-impact uses. Additional activities, generally not involving hazardous materials, have continued intermittently at TA-49 since 1961.

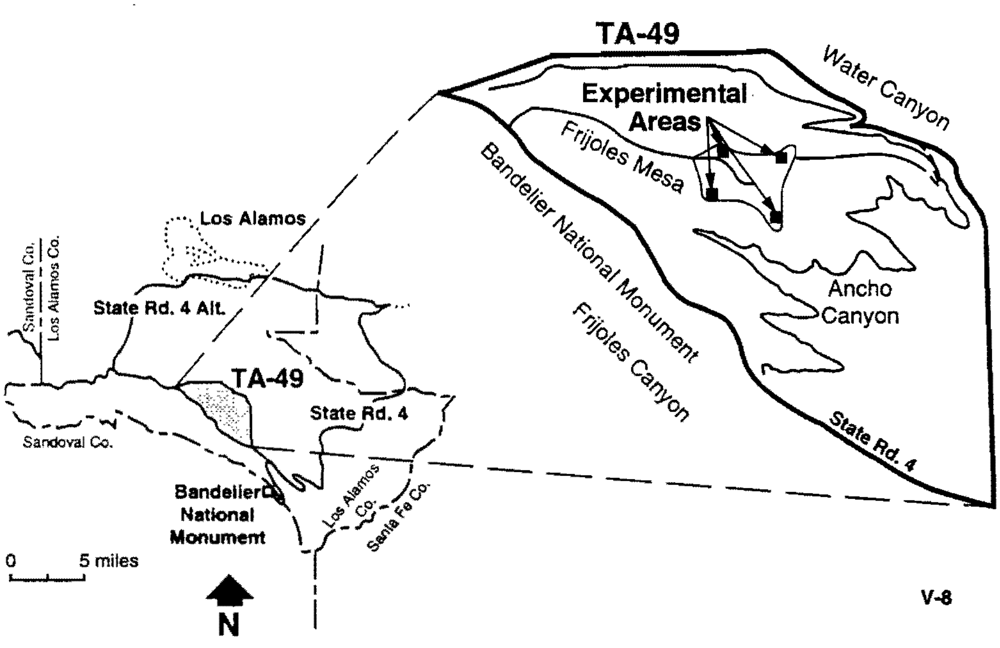
- Hazardous and radioactive materials, including multi-kilogram quantities of beryllium, lead, plutonium, and uranium are present in shafts at TA-49. Trace quantities of fission products, heavy metals, tritium, high explosives, and organics also may be present.

- Laboratory environmental monitoring data for ground and surface water and soil samples indicate that TA-49 contaminants have not moved beyond the boundaries of TA-49 or into the main aquifer. Groundwater contamination is highly unlikely because the main aquifer is about 1200 feet below the site.

- Safety at TA-49 has been enhanced by implementing strict access restrictions, drilling controls, and stabilization procedures.

- In May 1992, the Laboratory submitted to the U.S. EPA and the New Mexico Environment Department a work plan to determine the amounts and areas of contamination at TA-49. These studies will form the basis for corrective measures decisions for the TA-49 Operable Unit. Site characterization studies are scheduled to begin in October 1992 and extend into 1997.

TA-49 Locator Map



PURPOSE OF TECHNICAL AREA 49

From late 1959 to mid 1961, TA-49 was the site of underground experiments related to the safety of nuclear weapons. Underground experiments were carried out beneath four areas indicated on the map on the reverse side of this fact sheet. A number of supporting facilities, including shafts, radiochemical facilities, sumps, and a landfill, also were used. Since these experiments ceased in 1961, the site has been used periodically for a variety of other uses that have not resulted in any significant additional contamination. Currently, parts of the site are used on a limited basis by the Laboratory's high-power microwave group, the Hazardous Devices Team, and other Laboratory personnel.

WASTES PRESENT AT TECHNICAL AREA 49

Twenty potentially contaminated sites (Solid Waste Management Units, or SWMUs) have been identified at TA-49 and have been aggregated as the TA-49 Operable Unit. The experimental shafts (combined as Materials Disposal Area AB) contain 40 kilograms of plutonium, about 260 kilograms of uranium, 11 kilograms of beryllium, perhaps 90,000 kilograms or more of lead, and nonhazardous wastes (such as steel and cables) within the original shafts at depths of 31-108 feet.

Known or suspected contamination at the remaining TA-49 SWMUs involves trace soil contamination by heavy metals, radionuclides, organics, and other chemicals associated with facilities supporting the underground experiments.

Groundwater, surface water, and soil samples have been monitored frequently since 1960. No evidence of any migration of contaminants from these potential sources has been found beyond TA-49 boundaries or into the main aquifer.

PREVIOUS CLEAN-UP AT TECHNICAL AREA 49

Surface contamination at TA-49 has been stabilized with asphalt, concrete, and natural vegetative covers. The largest known accidental contamination release involved small levels of radioactive materials during a 1960 drilling operation at one test shaft. Contaminated materials were returned to the shaft and the area over and around the shaft was capped with clean soil and an asphalt cover. Other shafts have been sealed with concrete plugs and natural vegetative covers. After experiments were completed in 1961, some surface equipment and structures were removed or decontaminated. A second cleanup campaign was completed in 1971. The La Mesa forest fire in 1977 destroyed most remaining wooden structures. Further cleanup of uncontaminated building debris was conducted in 1984. A landfill at the northwest section of TA-49 was used for disposing of nonhazardous debris during all three cleanups.

FUTURE ACTION AND PROPOSED TIME FRAME

Future action is focused on further assessment of the extent of contamination and the selection of possible remedial actions. Remedial alternatives range from capping (accompanied by long-term monitoring, maintenance, and institutional controls) to excavation and disposal of contaminated soils. This process is guided by the Hazardous and Solid Waste Amendment (HSWA) module of the Laboratory's Resource Conservation Recovery Act (RCRA) operating permit, which specifies the sequence of events by which potentially contaminated areas are identified, characterized, and remediated.

The RCRA Facility Investigation (RFI) Work Plan that describes the characterization activities was submitted to the U.S. Environmental Protection Agency in May 1992. Actual RFI characterization activities are scheduled to be initiated in October 1992 and will require about 5 years to complete.

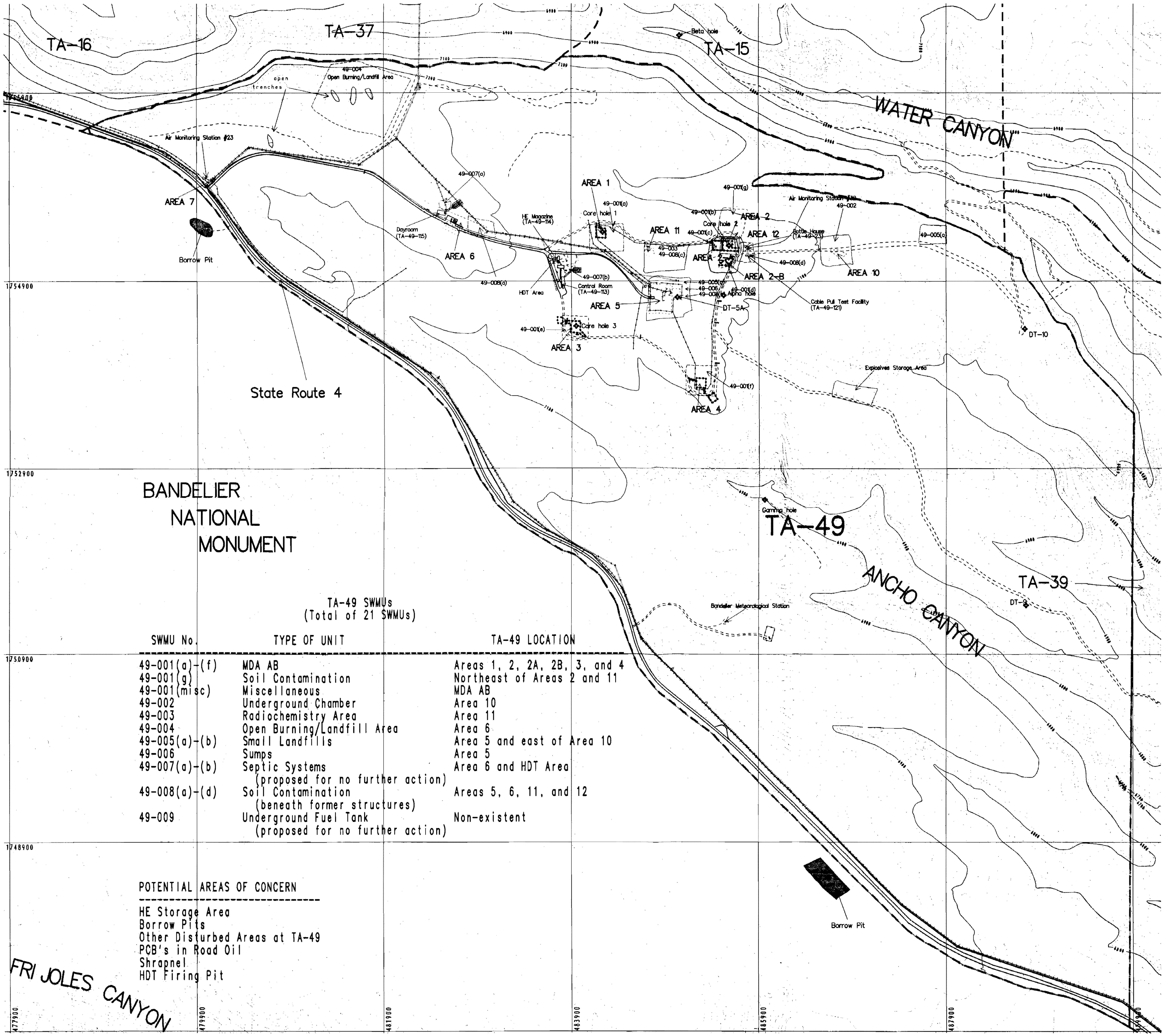
CONCLUSION

Ensuring the safe management of past, present, and future waste requires the cooperation of government, industry, and the public. The Laboratory is committed to provide the public with information such as this fact sheet. The Laboratory will continue to provide information concerning actions taken during investigation and throughout the entire cleanup process. If you have additional questions about TA-49 or about the Laboratory's Environmental Restoration Program, please do not hesitate to call or write:

Community Relations Project Leader
Environmental Restoration Program
Los Alamos National Laboratory
Box 1663, Mail Stop M314
Los Alamos, NM 87545
(505) 665-2127

APPENDIX A
TOPOGRAPHIC MAP OF TA-49
MAY 1992

OU 1144



TA-49 SWMUs
(Total of 21 SWMUs)

SWMU No.	TYPE OF UNIT	TA-49 LOCATION
49-001(a)-(f)	MDA AB	Areas 1, 2, 2A, 2B, 3, and 4
49-001(g)	Soil Contamination	Northeast of Areas 2 and 11
49-001(misc)	Miscellaneous	MDA AB
49-002	Underground Chamber	Area 10
49-003	Radiochemistry Area	Area 11
49-004	Open Burning/Landfill Area	Area 6
49-005(a)-(b)	Small Landfills	Area 5 and east of Area 10
49-006	Sumps	Area 5
49-007(a)-(b)	Septic Systems (proposed for no further action)	Area 6 and HDT Area
49-008(a)-(d)	Soil Contamination (beneath former structures)	Areas 5, 6, 11, and 12
49-009	Underground Fuel Tank (proposed for no further action)	Non-existent

POTENTIAL AREAS OF CONCERN

- HE Storage Area
- Borrow Pits
- Other Disturbed Areas at TA-49
- PCB's in Road Oil
- Shrapnel
- HDT Firing Pit

LEGEND

- Boundary, OU
- Boundary, TA
- Contours, 10 foot
- Contours, 100 foot
- Electrical >13.2 kV
- Fence, Industrial
- Gas Line
- Gate
- Material Disposal Area (MDA AB)
- Roads, Dirt
- Roads, Paved
- Road/Trail
- Sewer Line
- Storm Drain/Culvert
- SWMU, Probable
- SWMU, Possible
- Telephone Line
- Water Line

NORTH, NM State Plane

Grid provides NMSP coordinates, in feet

Grid interval, in feet: 2000

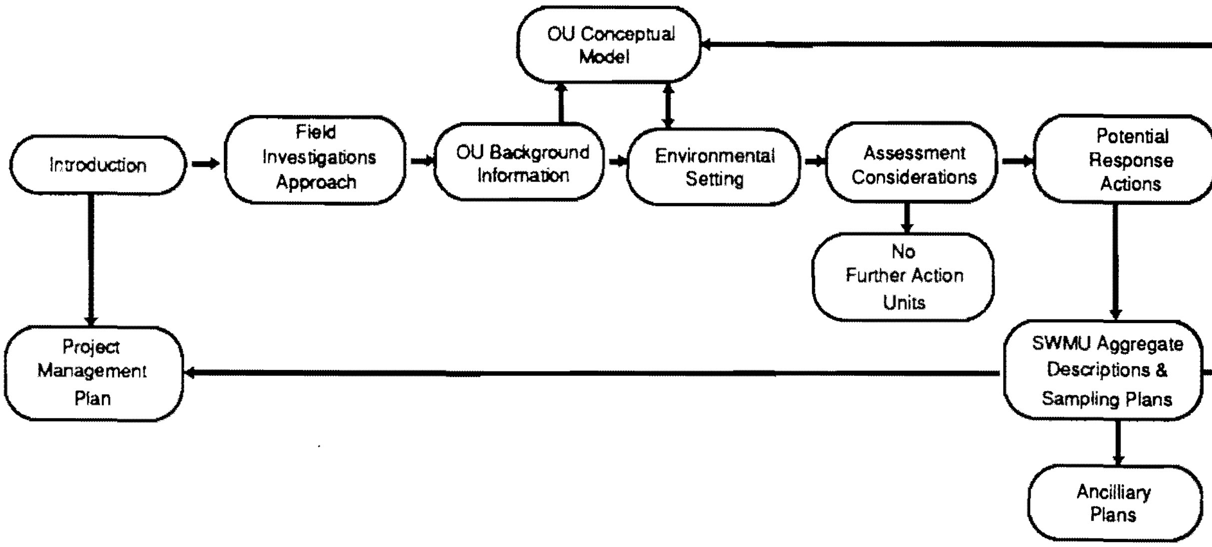
0 600 1200 1800 FEET ON GROUND

NOTICE: Information on this map is provisional and has not been checked for accuracy

University of California
Los Alamos National Laboratory
Earth & Environmental Sciences Division
FIMAD Facility for Information Management, Analysis and Display

Produced by: Marcia Jones
Date: 92-05-07

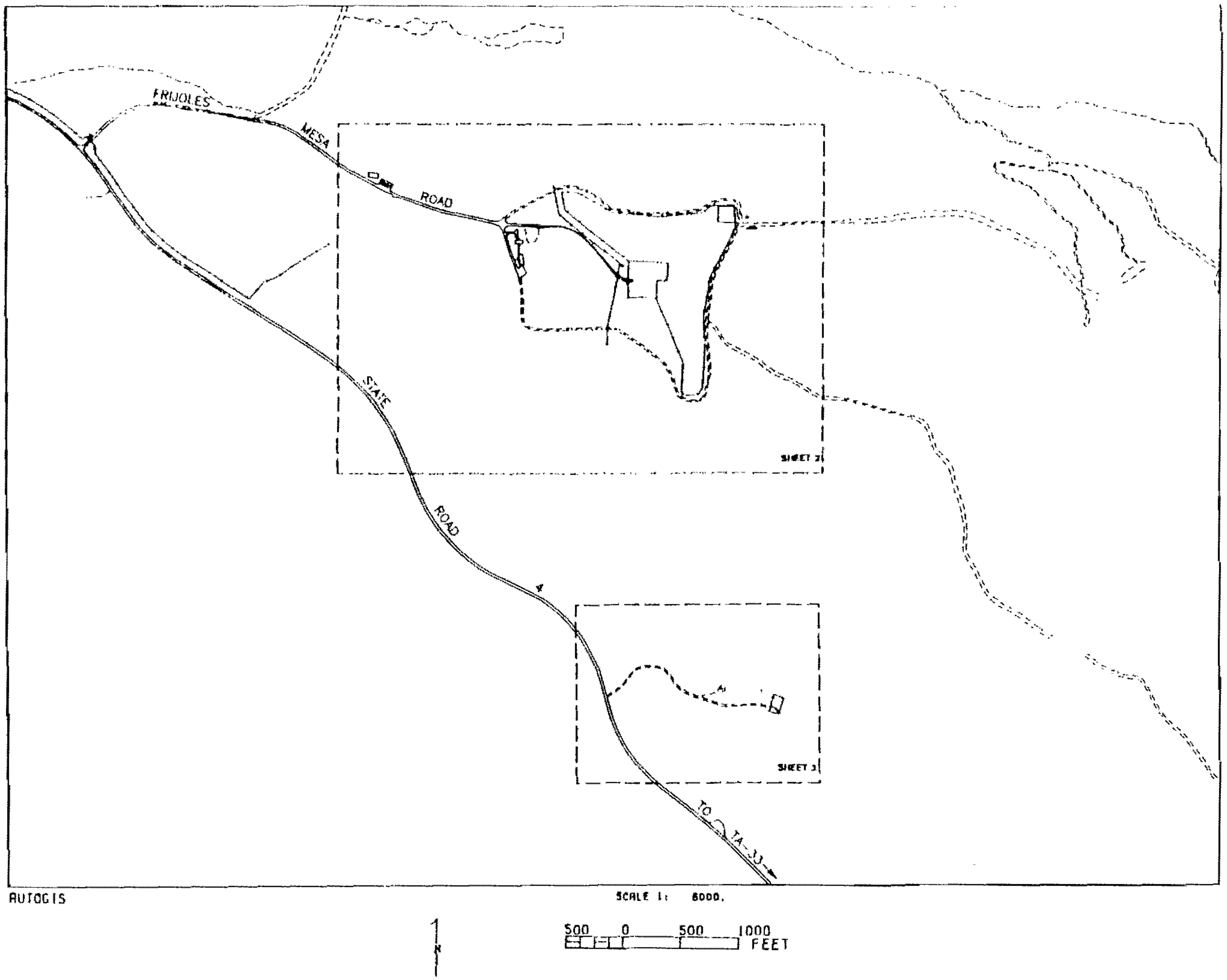
APPENDIX B



TA-49 Engineering Drawings

INDEX TO FIGURES IN APPENDIX B

TA-49



STRUCTURE NUMBER INDEX

STRUCTURE TA-NUMBER	STRUCTURE DESIGNATION	STRUCTURE NOMENCLATURE	STRUCTURE LOCATOR SHEET NO.	STRUCTURE LOCATOR MAP KEY
49- 23	FM- 23	BOTTLE HOUSE	2	F-2
49-101	FM-101	TEST WELL NO. 5	2	E-3
49-113	FM-113	HOT TRAINING FACILITY	2	C-3
49-114	FM-114	EXPLOSIVES MAGAZINE	2	C-2
49-115	FM-115	ANTENNA TEST FACILITY	2	A-1
49-121	49-121	CABLE BUILDING	2	F-2
49-122	49-122	TRAILER, STORAGE	3	F-4
47-123	49-123	ANTENNA	3	E-3
49-124	49-124	INSTRUMENT TRAILER	3	F-4
49-128	49-128	TRAILER, STORAGE	2	A-2
49-129	49-129	TRAILER, STORAGE	2	A-2
49-130	49-130	TRAILER, STORAGE	2	A-2
49-131	49-131	TRAILER, STORAGE	2	A-2
49-132	49-132	TRAILER, STORAGE	2	A-2

REV	DATE	REVISION	BY	CKD	APP
11	04-09-90	REDRAWN & REVISED TO STATUS OF 04-09-90			
10	07-12-89	REDRAWN & REVISED TO STATUS OF 07-07-89			

UNIVERSITY OF CALIFORNIA
Los Alamos — Los Alamos National Laboratory, Los Alamos New Mexico 87545
FACILITIES ENGINEERING DIVISION
STRUCTURE LOCATION MAP
TA-49 FRIJOLES MESA SITE
SEC CLASSIFICATION — CLASS U — REVIEWER — DATE 7-24-89
SUBMITTED — RECOMMENDED — APPROVED
DRAWN C. SANDOVAL — CHECKED B. COMER — DATE 07-12-89 — SHEET NO. 1 of 3 — DRAWING NO. ENG-R 5126

Figure B-1 TA-49 structure location map (7/12/89).

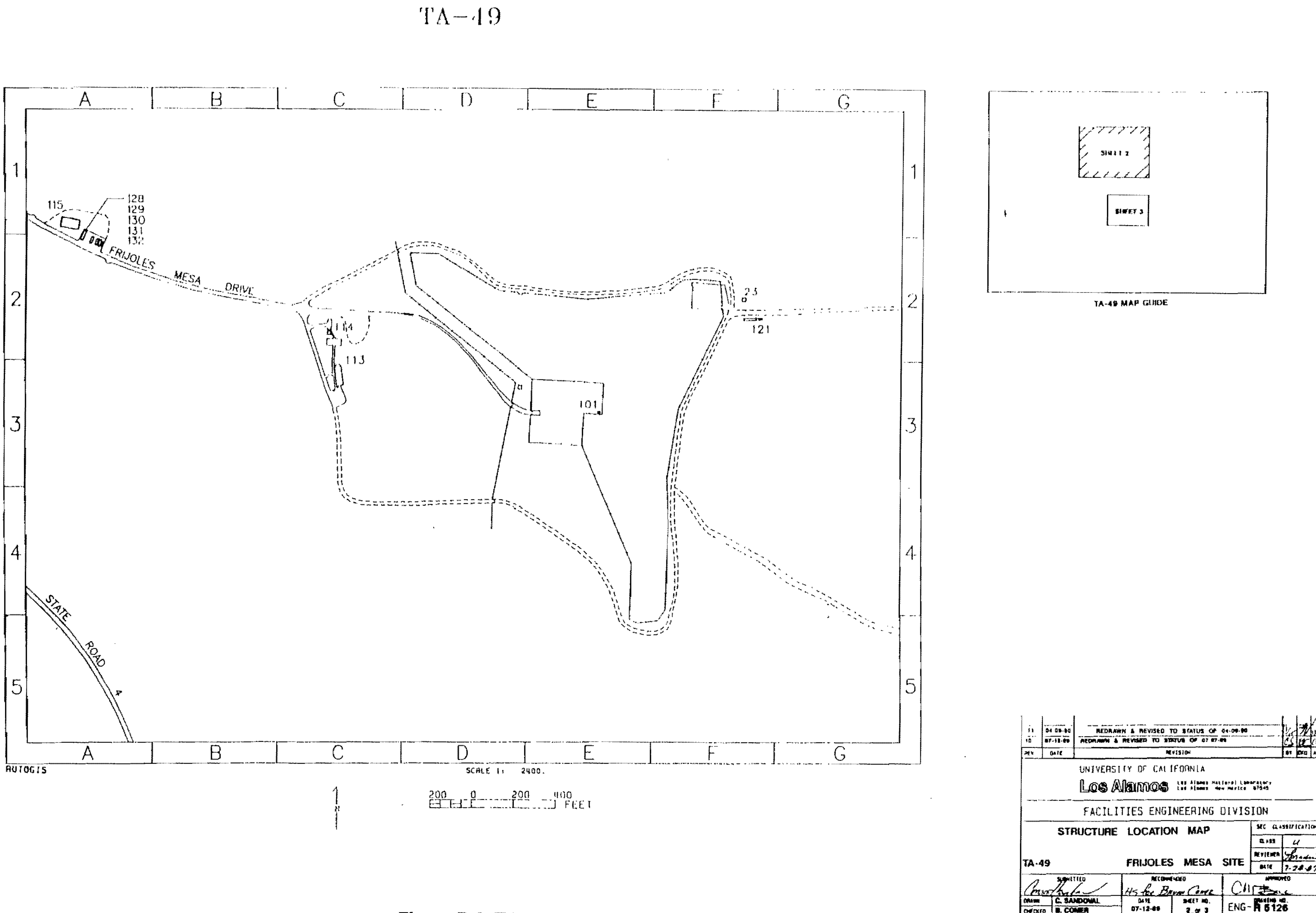


Figure B-2 TA-49 structure location map (7/12/89).

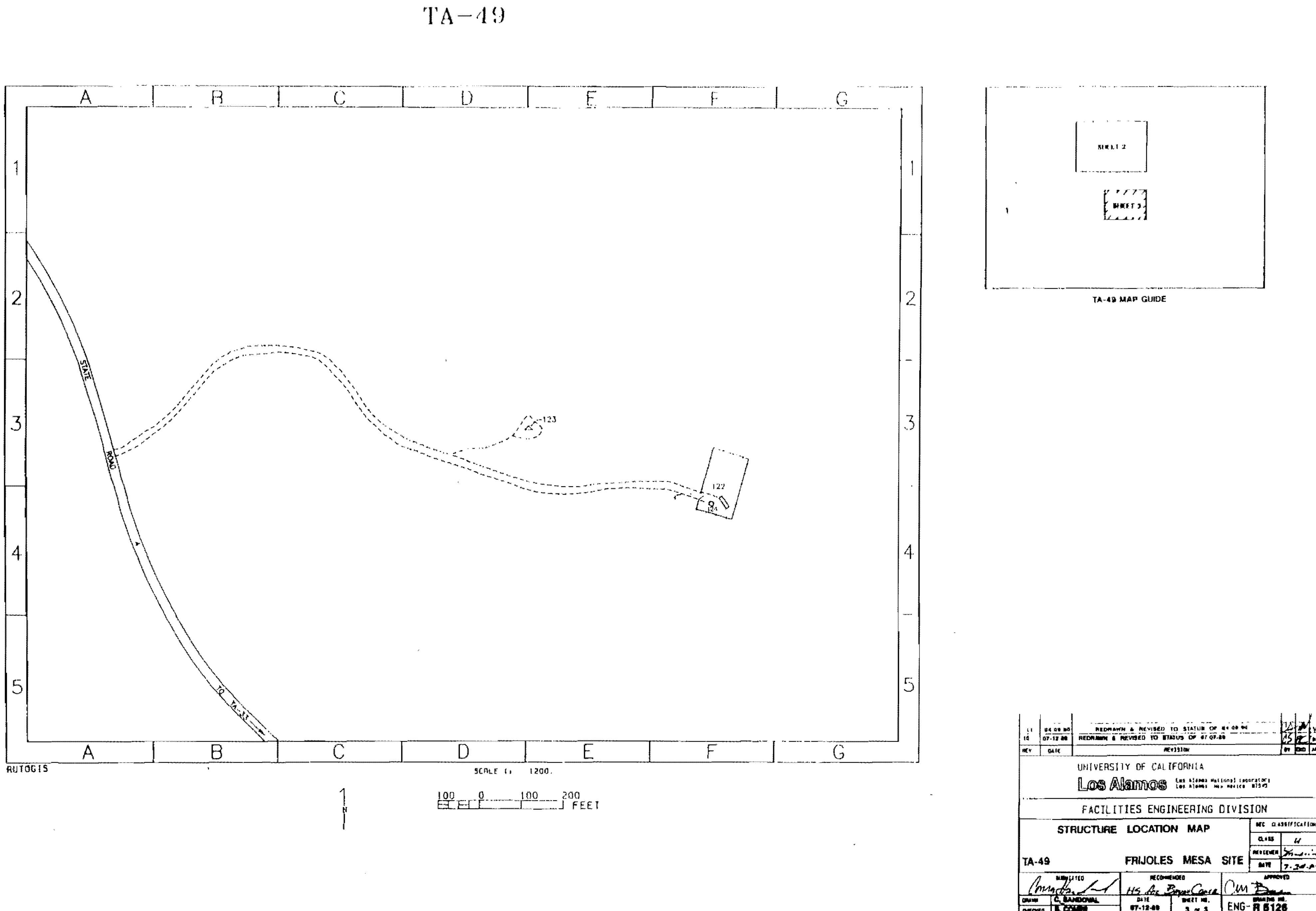


Figure B-3 TA-49 structure location map (7/12/89).

STRUCTURE NUMBER	STRUCTURE DESIGNATION	STRUCTURE NOMENCLATURE	REMARKS
TA-49-1	FM-1	GUARD HOUSE	AREA 7 STATION 638
TA-49-2	FM-2	OFFICE BUILDING	AREA 8
TA-49-3	FM-3	CRAFT SHACK	AREA 5
TA-49-4	FM-4	CRAFT SHACK	REMOVED 1960
TA-49-5	FM-5	CRAFT SHACK	AREA 6
TA-49-6	FM-6	CRAFT SHACK	AREA 3
TA-49-7	FM-7	GUARD HOUSE	AREA 5 STATION 637
TA-49-8	FM-8	THE SHED	AREA 5
TA-49-9	FM-9	POWER PANEL	AREA 1 ELECTRICAL
TA-49-10	FM-10	POWER PANEL	AREA 2 ELECTRICAL
TA-49-11	FM-11	POWER PANEL	AREA 4 ELECTRICAL
TA-49-12	FM-12	POWER PANEL	AREA 3 ELECTRICAL
TA-49-13	FM-13	SIREN	NEAR ROAD JUNCTION
TA-49-14	FM-14	TRANSFORMER STATION	AREA 3
TA-49-15	FM-15	CHANGE HOUSE	AREA 11
TA-49-16	FM-16	BUTANE TANK	AREA 11
TA-49-17	FM-17	THE BARN	AREA 3
TA-49-18	FM-18	SIGNAL PANEL	AREA 1 ELECTRICAL
TA-49-19	FM-19	LATRINE	AREA 1
TA-49-20	FM-20	GRAY HOUSE NO. 1	AREA 1
TA-49-21	FM-21	LATRINE	AREA 12
TA-49-22	FM-22	EQUIPMENT BUILDING	AREA 12
TA-49-23	FM-23	BOTTLE HOUSE	AREA 12
TA-49-24	FM-24	MANHOLE	AREA 12 ELECTRICAL
TA-49-25	FM-25	TRANSFORMER	AREA 12
TA-49-26	FM-26	POWER PANEL	AREA 12 ELECTRICAL
TA-49-27	FM-27	MANHOLE	AREA 12 ELECTRICAL
TA-49-28	FM-28	PERSONNEL SHELTER	AREA 2
TA-49-29	FM-29	BLUE SHACK NO 2	AREA 2-B
TA-49-30	FM-30	RED SHACK NO. 2	AREA 3
TA-49-31	FM-31	GRAY HOUSE NO 2	AREA 2-B
TA-49-32	FM-32	GREEN SHACK NO. 1	AREA 4
TA-49-33	FM-33	PORTABLE SHIELD	AREA 2-A
TA-49-34	FM-34	PORTABLE GENERATOR	AREA 10
TA-49-35	FM-35	GRAY HOUSE NO 3	AREA 12
TA-49-36	FM-36	SIGNAL PANEL	AREA 3 ELECTRICAL
TA-49-37	FM-37	SIGNAL PANEL	AREA 2 ELECTRICAL
TA-49-38	FM-38	MANHOLE	AREA 2-B ELECTRICAL
TA-49-39	FM-39	MANHOLE	AREA 2 ELECTRICAL
TA-49-40	FM-40	GRAY HOUSE NO. 6	DESTROYED 1960
TA-49-41	FM-41	ROAD BLOCK	AREA 12
TA-49-42	FM-42	CABLE BUILDING	AREA 3
TA-49-43	FM-43	RED SHACK NO 3	AREA 1
TA-49-44	FM-44	LATRINE	AREA 3
TA-49-45	FM-45	SIGNAL PANEL	AREA 3 ELECTRICAL
TA-49-46	FM-46	LATRINE	AREA 4
TA-49-47	FM-47	CABLE BUILDING	AREA 4
TA-49-48	FM-48	SIGNAL PANEL	AREA 4 ELECTRICAL
TA-49-49	FM-49	RED SHACK NO. 1	AREA 4
TA-49-50	FM-50	BLUE SHACK NO 1	AREA 4
TA-49-51	FM-51	GRAY HOUSE NO 4	AREA 4
TA-49-52	FM-52	PERSONNEL SHELTER	AREA 4
TA-49-53	FM-53	LATRINE	AREA 11
TA-49-54	FM-54	LATRINE	AREA 11
TA-49-55	FM-55	STORAGE BUILDING	AREA 11
TA-49-56	FM-56	BUTANE TANK	AREA 11
TA-49-57	FM-57	LATRINE	AREA 10
TA-49-58	FM-58	EQUIPMENT BUILDING	AREA 10
TA-49-59	FM-59	POWER & SIGNAL PANEL	AREA 10 ELECTRICAL
TA-49-60	FM-60	MANHOLE	AREA 10 ELECTRICAL
TA-49-61	FM-61	PORTABLE SHIELD	AREA 10
TA-49-62	FM-62	ELEVATOR BUILDING	AREA 10
TA-49-63	FM-63	LATRINE	AREA 6
TA-49-64	FM-64	LATRINE	AREA 7
TA-49-65	FM-65	BUTANE TANK	AREA 5
TA-49-66	FM-66	WATER TANK	AREA 5
TA-49-67	FM-67	U.G. COUNTING ROOM	AREA 5
TA-49-68	FM-68	OFFICE BUILDING	AREA 3
TA-49-69	FM-69	LATRINE	AREA 5
TA-49-70	FM-70	LATRINE	AREA 5
TA-49-71	FM-71	MANHOLE (PORTABLE)	AREA 5 ELECTRICAL
TA-49-72	FM-72	MANHOLE (PORTABLE)	AREA 5 ELECTRICAL
TA-49-73	FM-73	MANHOLE (PORTABLE)	AREA 5 ELECTRICAL
TA-49-74	FM-74	MANHOLE (PORTABLE)	AREA 5 ELECTRICAL
TA-49-75	FM-75	MANHOLE (PORTABLE)	AREA 5 ELECTRICAL
TA-49-76	FM-76	MANHOLE (PORTABLE)	AREA 5 ELECTRICAL
TA-49-77	FM-77	MANHOLE (PORTABLE)	AREA 5 ELECTRICAL
TA-49-78	FM-78	MANHOLE (PORTABLE)	AREA 5 ELECTRICAL
TA-49-79	FM-79	MANHOLE (PORTABLE)	AREA 5 ELECTRICAL
TA-49-80	FM-80	MANHOLE (PORTABLE)	AREA 5 ELECTRICAL
TA-49-81	FM-81	MANHOLE (PORTABLE)	AREA 5 ELECTRICAL
TA-49-82	FM-82	CRAFT SHACK	AREA 8
TA-49-83	FM-83	CARPENTRY & ELECTRICIAN SHED	AREA 8
TA-49-84	FM-84	TOOL BUILDING	AREA 8
TA-49-85	FM-85	STORAGE BUILDING	AREA 8
TA-49-86	FM-86	STORAGE BUILDING	AREA 8
TA-49-87	FM-87	ROAD BLOCK	NEAR ROAD JUNCTION
TA-49-88	FM-88	POWER PANEL A	AREA 5 ELECTRICAL
TA-49-89	FM-89	POWER PANEL B	AREA 5 ELECTRICAL
TA-49-90	FM-90	POWER PANEL C	AREA 5 ELECTRICAL
TA-49-91	FM-91	POWER PANEL D	AREA 5 ELECTRICAL
TA-49-92	FM-92	SIGNAL PANEL W	AREA 5 ELECTRICAL
TA-49-93	FM-93	SIGNAL PANEL X	AREA 5 ELECTRICAL
TA-49-94	FM-94	SIGNAL PANEL Y	AREA 5 ELECTRICAL
TA-49-95	FM-95	SIGNAL PANEL Z	AREA 5 ELECTRICAL
TA-49-96	FM-96	PHOTO TOWER	AREA 5
TA-49-97	FM-97	PORTABLE SHIELD	AREA 2-B

STRUCTURE NUMBER	STRUCTURE DESIGNATION	STRUCTURE NOMENCLATURE	REMARKS
TA-49-98	FM-98	PORTABLE SHIELD	AREA 2-B
TA-49-99	FM-99	POWER PANEL	AREA 8 ELECTRICAL
TA-49-100	FM-100	TEST WELL NO 10	
TA-49-101	FM-101	TEST WELL NO 5	
TA-49-102	FM-102	TEST WELL NO 9	
TA-49-103	FM-103	POWER PANEL	AREA 8 ELECTRICAL

STRUCTURE NUMBER	STRUCTURE DESIGNATION	STRUCTURE NOMENCLATURE	REMARKS

NO.	DATE	REVISIONS	BY	CHKD	APPD
1		[illegible]			

AUTHORIZED FOR: HEALTH | SAFETY | FIRE PROT | SEC

LOS ALAMOS SCIENTIFIC LABORATORY
ENGINEERING DEPARTMENT
UNIVERSITY OF CALIFORNIA LOS ALAMOS NEW MEXICO

INDEX SHEET
STRUCTURE LOCATION PLAN
TA-49 FRIJOLES MESA SITE

CHECKED	RECOMMENDED	APPROVED
DESIGNED / DRAWN N BYERS / SCALE NONE	DATE 8-15-61 / SHEET 1 OF 4	DRAWING NO. ENG-R 2484

Figure B-4 Index sheet for TA-49 structure location maps (8/15/61).

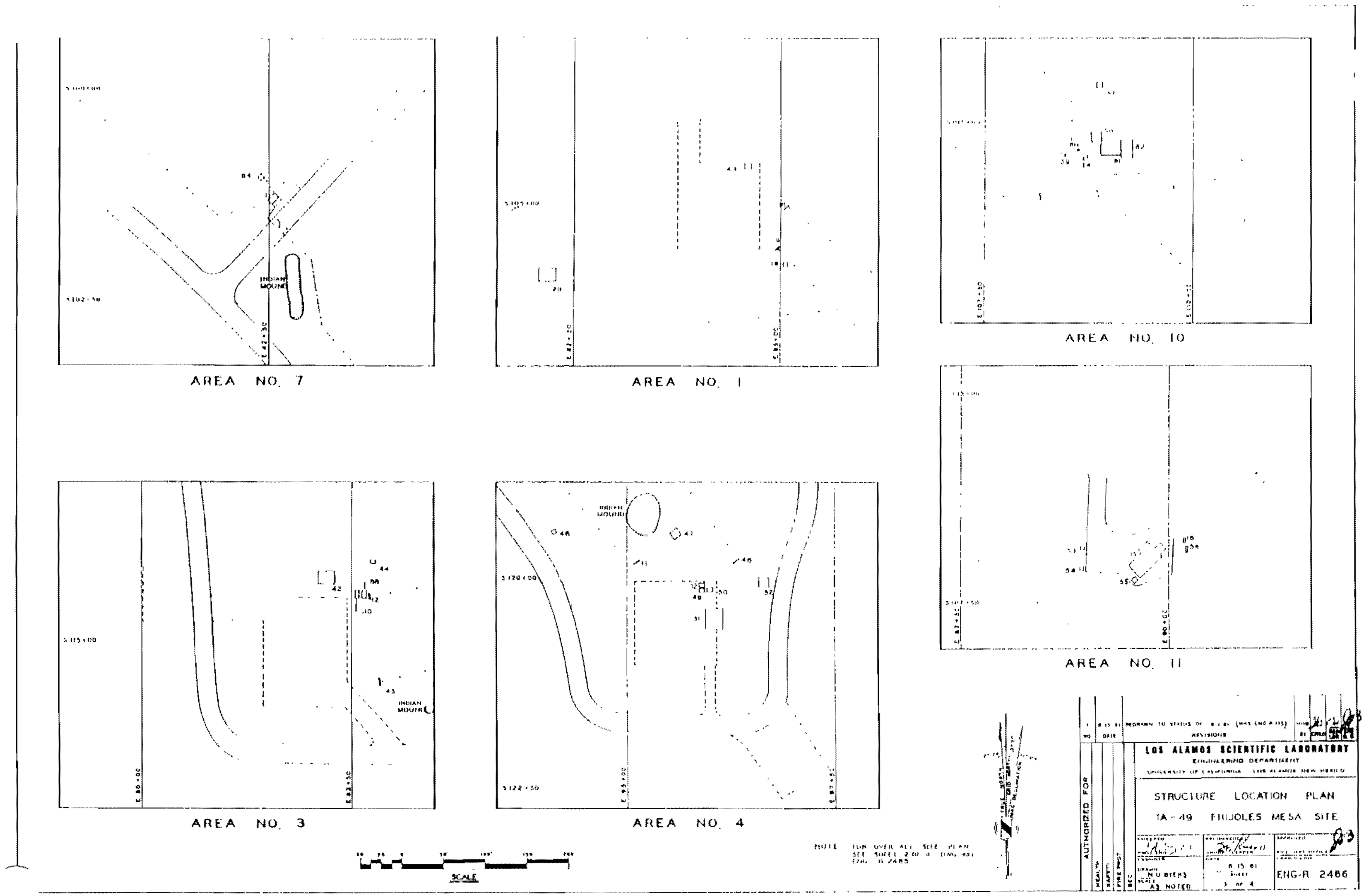


Figure B-5 TA-49 structure location map (8/15/61).

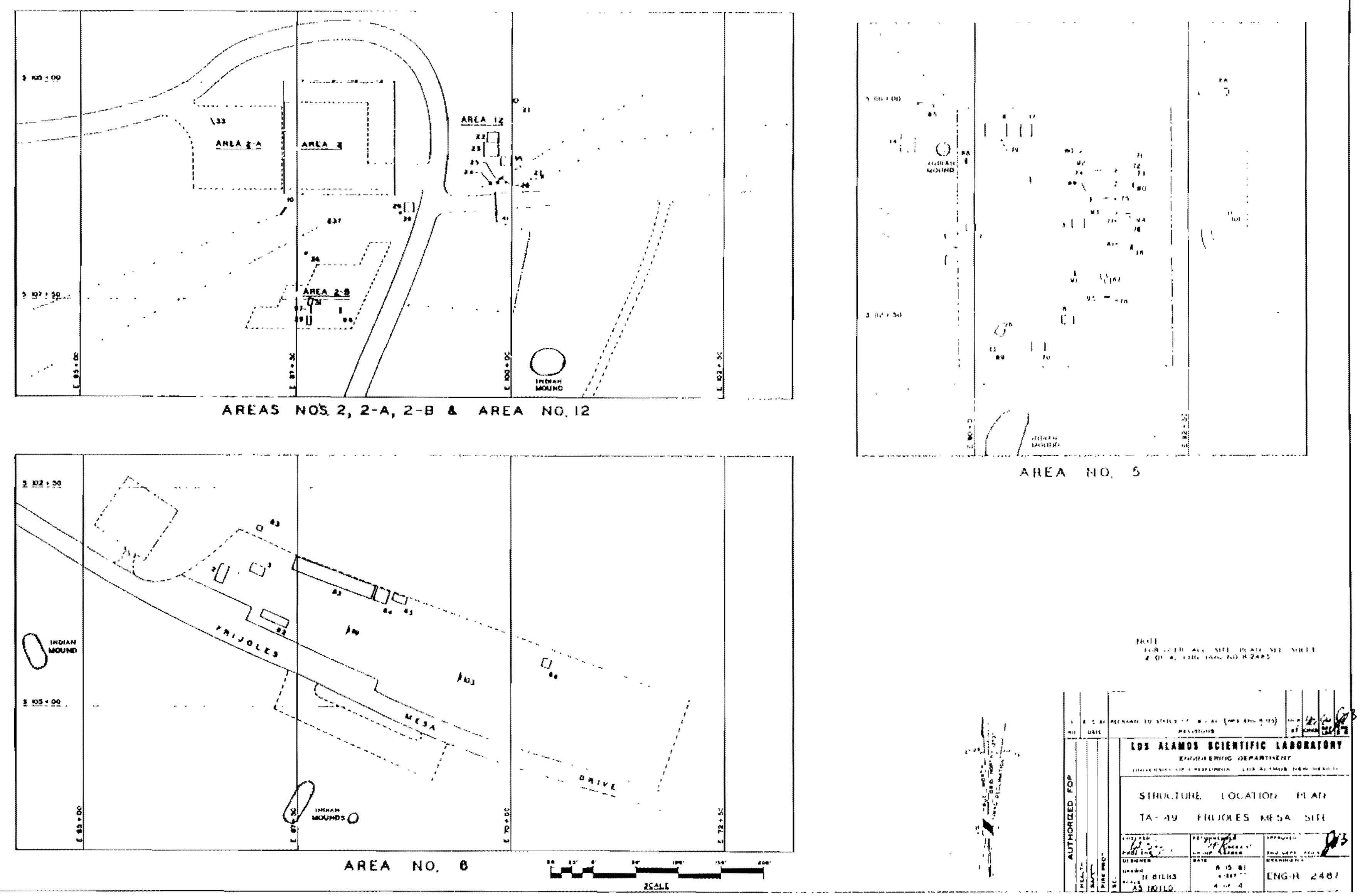


Figure B-6 TA-49 structure location map (8/15/61).

Figure B-7 TA-49 benchmark locations.

B-9

Missing

/mc.

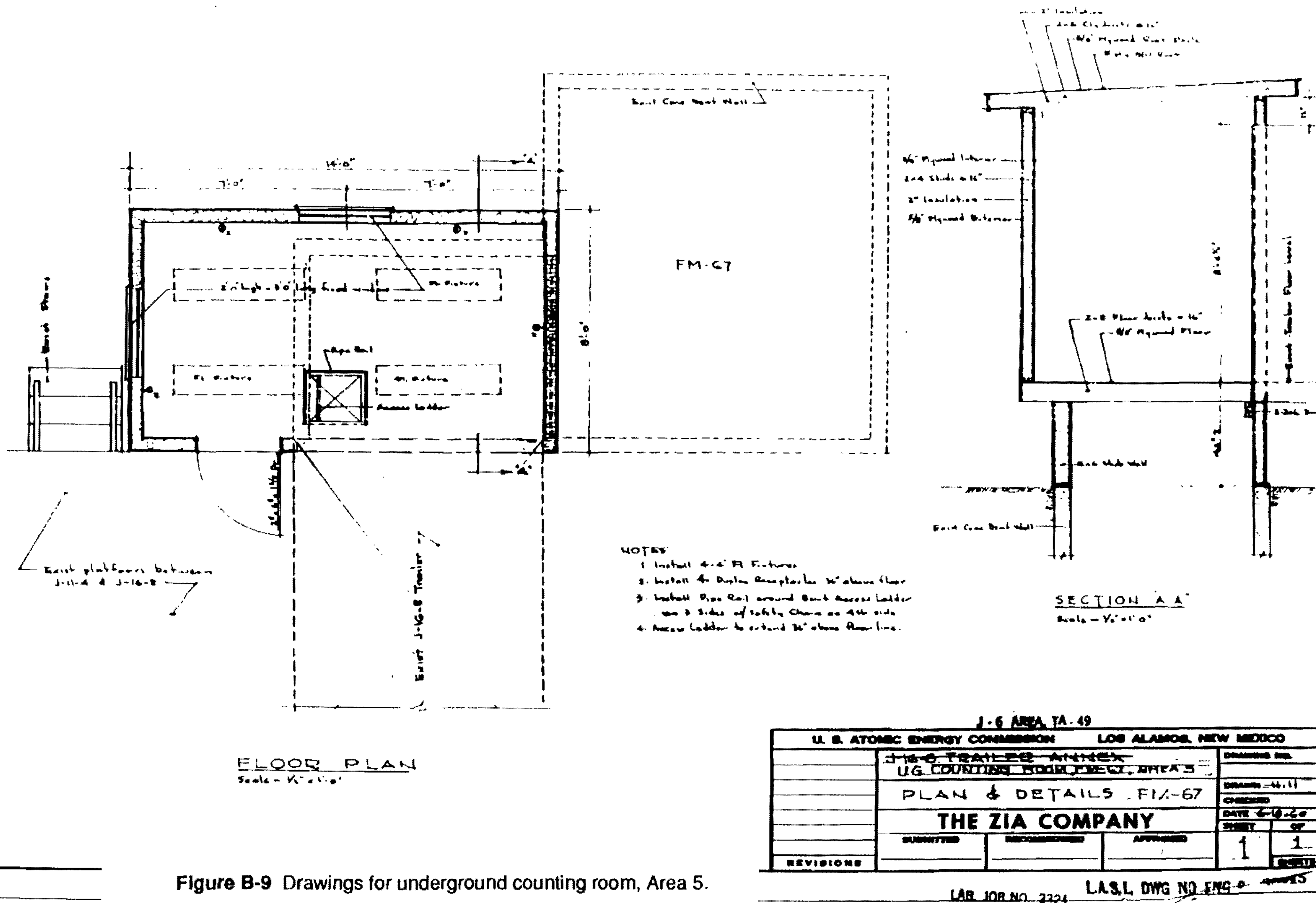


Figure B-9 Drawings for underground counting room, Area 5.

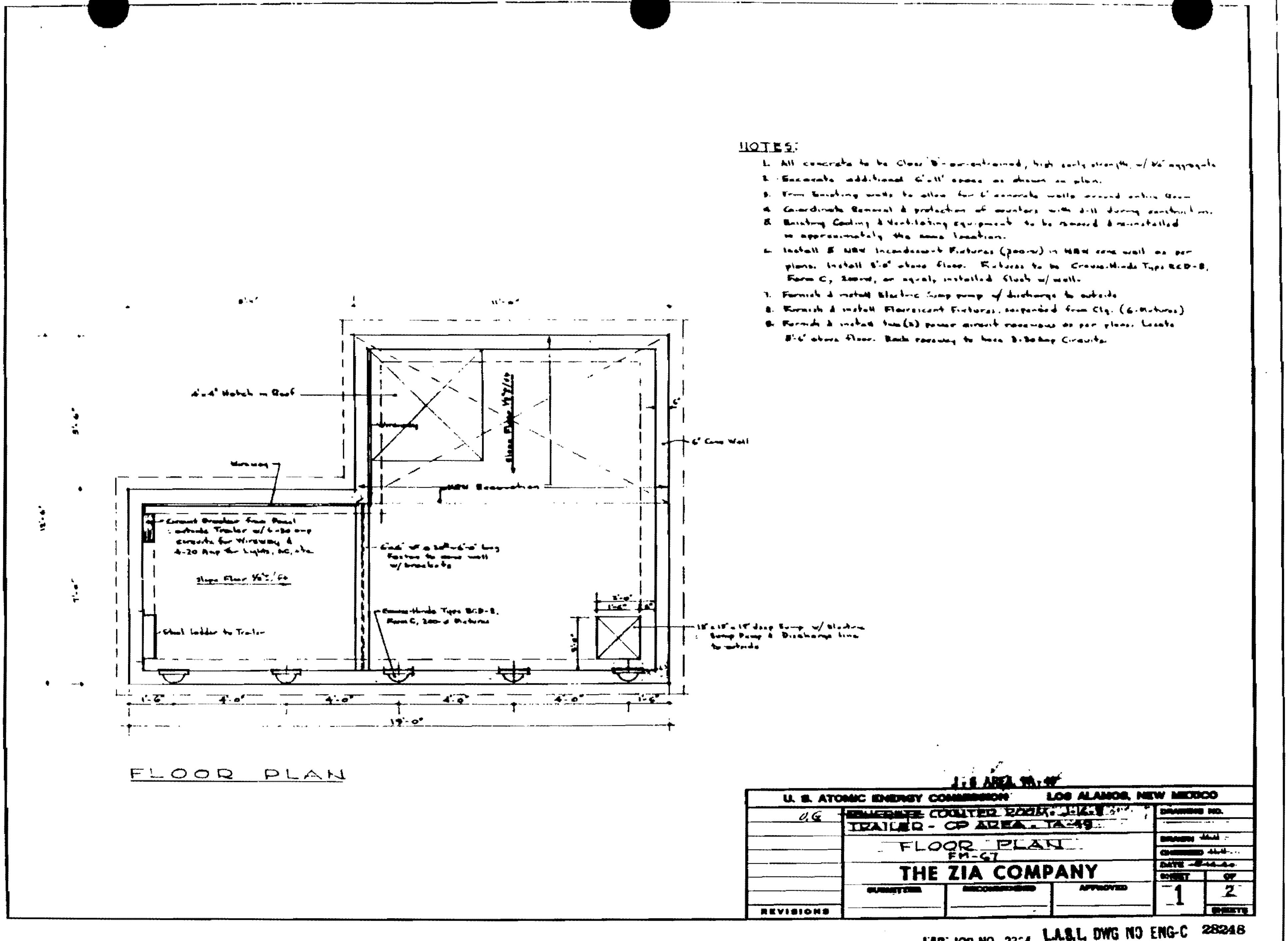


Figure B-10 Underground counting room floor plan and sump location, Area 5.

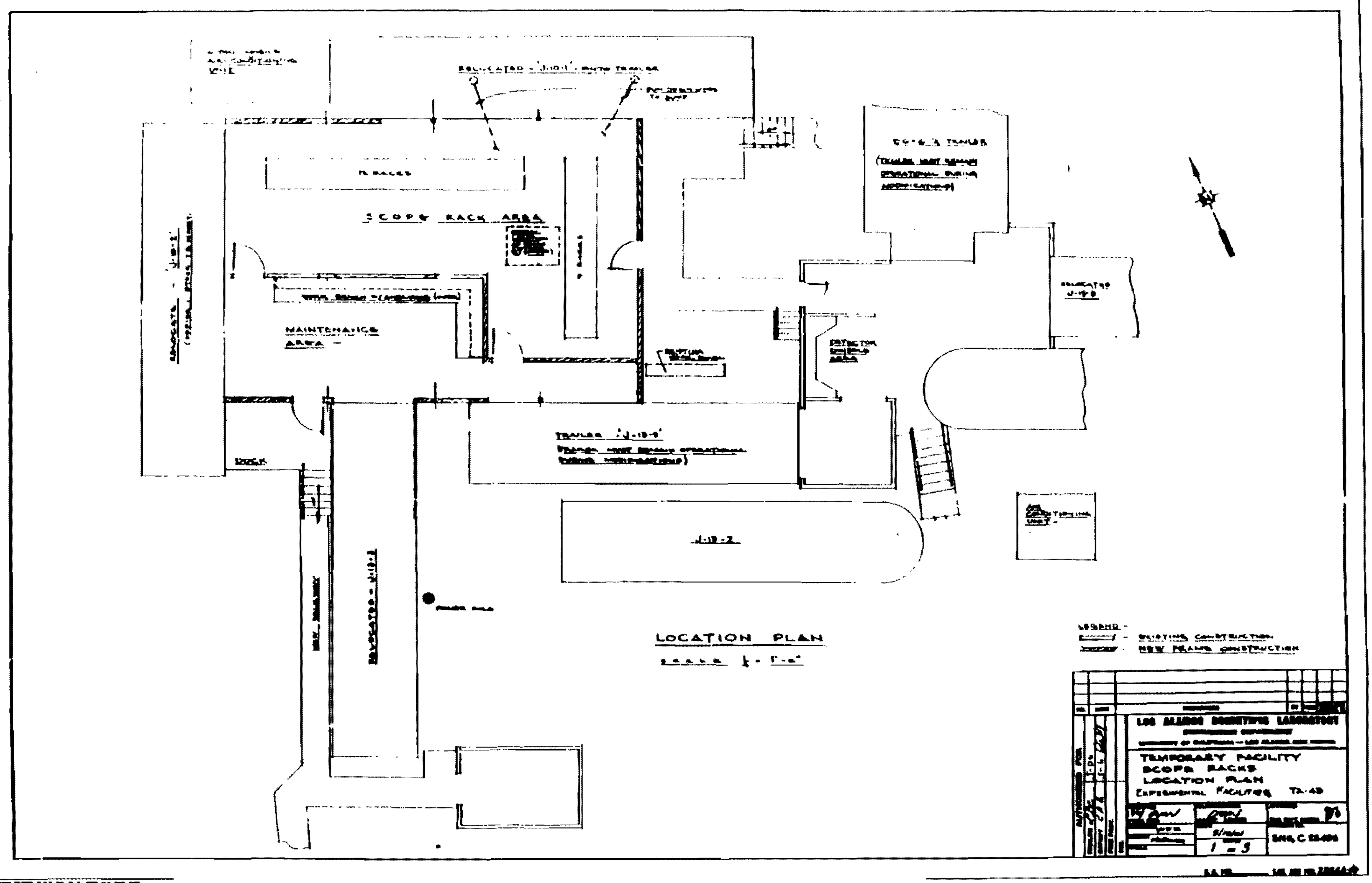


Figure B-11 Location of scope racks, photo trailer and drain lines, Area 5.

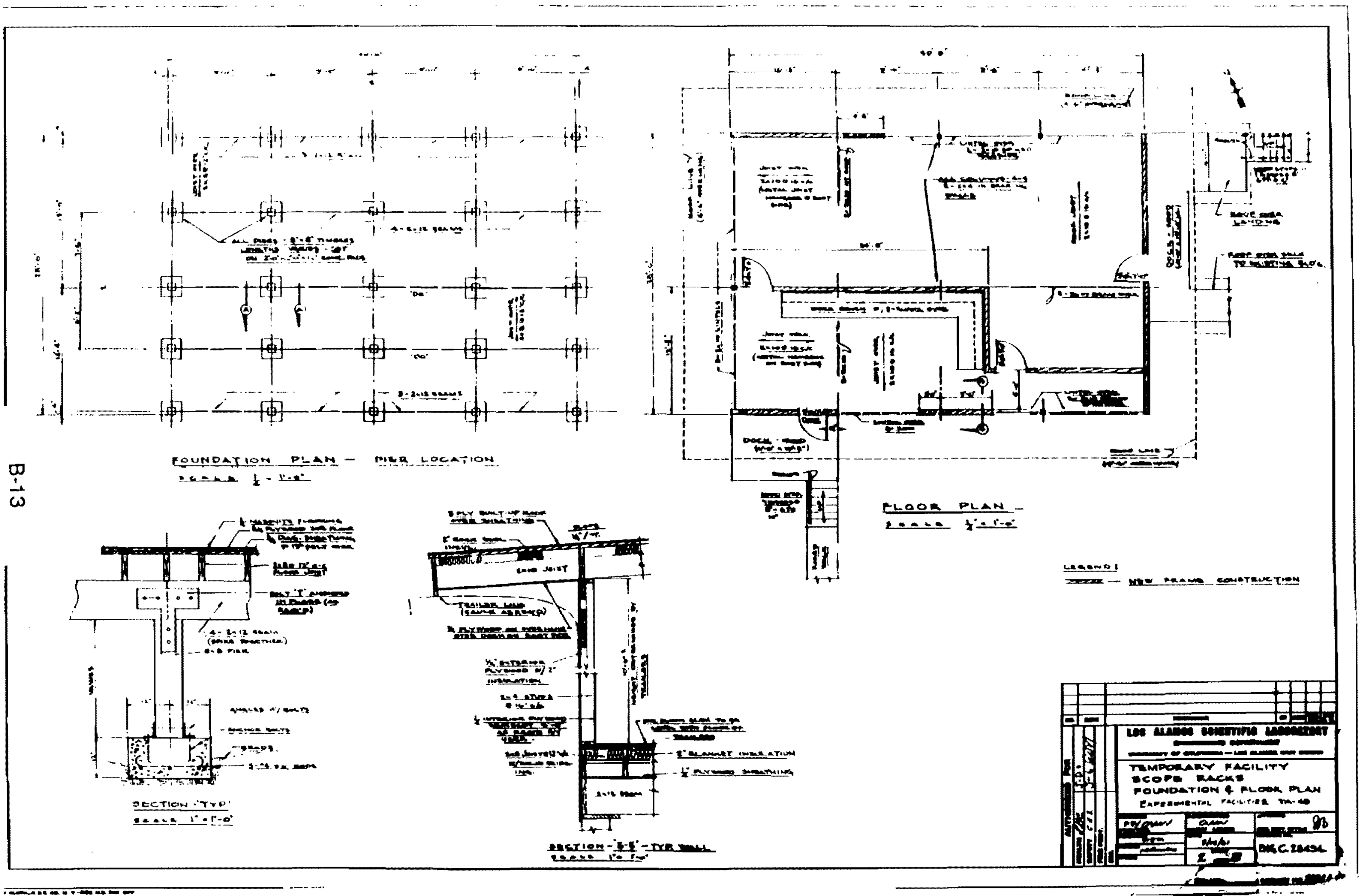


Figure B-12 Scope racks foundation and floor plan, Area 5.

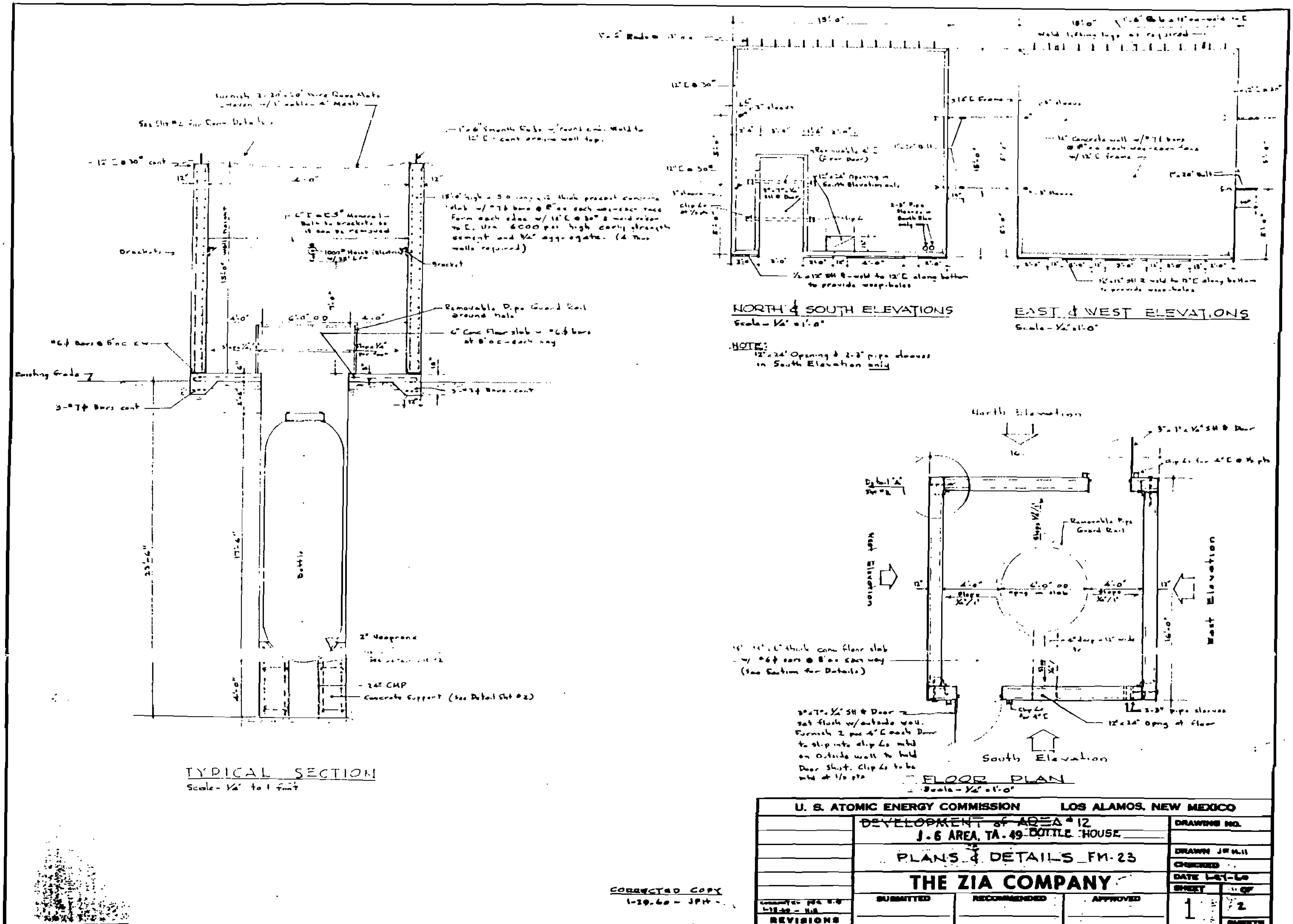


Figure B-13 Drawings for the Bottle House, Area 12.

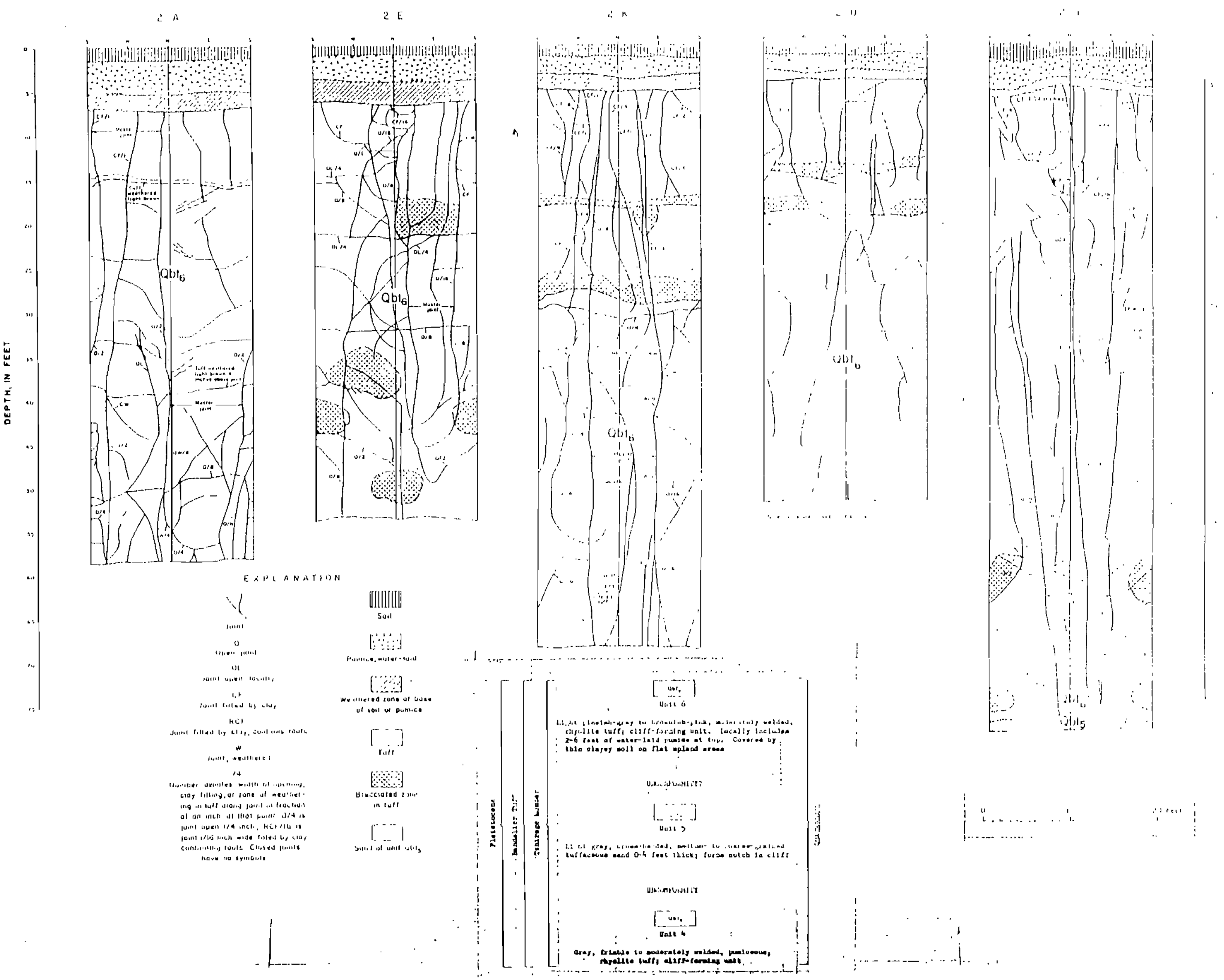


Figure B-14 Maps of walls of selected large-diameter holes in Area 2 (from Weir and Purtymun, 1962).

AREA 1

HOLE NO	GRID LOCATION	TYPE & CLASS	DATE DRILLED	HOLE DIA	HOLE DEPTH	DRIFT DIA	DRIFT LENGTH	DATE COVERED	REMARKS
USGS CH-1	S104+[illegible] E84+37	CORE HOLE	[illegible]	2"	501'				
1-A	S104+47 E83+78	SHOT	11-05-59	6'	58'		NONE	*	
1-B	S104+47 E84+00	SHOT	APRIL 61	3'	31'		NONE	5-12-61	60 TH SHOT 5-11-61
1-C	S104+47 E84+25	SHOT	11-17-58	4'	51'	4'X7'	14'	11-28-58	4 TH SHOT 11-20-58 * * *
1-D	S104+47 E84+50	SHOT	APRIL 61	3'	31'		NONE	6-22-61	62 ND SHOT 6-16-61
1-E	S104+47 E84+75	SHOT	10-21-59	3'-6"	50'		NONE		NOT USED BACKFILLED W/SAND NOV 59
1-F	S104+72 E83+75	GAS EXPANSION	10-16-59	3'	80'		NONE		30" CASING SET 10-23-59 & CAPPED 48" ABOVE GRADE
1-G	S104+72 E84+00	SHOT	APRIL 61	3'	31'		NONE	4-28-61	67 TH SHOT 4-28-61
1-H	S104+72 E84+25								NOT DRILLED
1-I	S104+72 E84+50	SHOT	MAY 61	3'	31'		NONE	6-16-61	66 TH SHOT 6-15-61
1-J	S104+72 E84+75	SHOT	MARCH 60	6'	58'		NONE	*	
1-K	S104+97 E83+75	SHOT	10-17-58	4'&3'	50'&80'		NONE	11-28-58	1 ST SHOT 10-29-58 * * *
1-L	S104+97 E84+00	SHOT	4-[illegible]-61	3'	31'		NONE	4-20-61	[illegible] TH SHOT 4-20-61
1-M	S104+97 E84+25	SHOT	2-24-61	3'	31'		NONE	3-18-61	48 TH SHOT 3-16-61
1-N	S104+97 E84+50	SHOT	4-5-61	3'	31'		NONE	4-14-61	64 TH SHOT 4-13-61
1-O	S104+97 E84+75	SHOT	10-31-58	4'&3'	50'&80'		NONE	11-28-58	2 ND SHOT 11-4-58 * * *
1-P	S105+22 E83+75	SHOT	MARCH 60	6'	58'		NONE	*	
1-Q	S105+22 E84+00	SHOT	2-24-61	3'	31'		NONE	4-3-61	51 ST SHOT 3-31-61
1-R	S105+22 E84+25	SHOT	4-3-61	3'	31'		NONE	4-11-61	63 RD SHOT 4-6-61
1-S	S105+22 E84+50	SHOT	2-24-61	3'	31'		NONE	4-3-61	50 TH SHOT 3-23-61
1-T	S105+22 E84+75	SHOT	MARCH 60	6	58'		NONE	*	
1-U	S105+47 E83+75	SHOT	11-24-59	6	58'		NONE	12-3-59	5 TH SHOT 11-25-59 * * *
1-V	S105+47 E84+00								NOT DRILLED
1-W	S105+47 E84+25	SHOT	MARCH 60	6	58'		NONE	*	
1-X	S105+47 E84+50								NOT DRILLED
1-Y	S105+47 E84+75	SHOT	11-12-59	4'&3'	50'&80'		NONE	11-18-59	3 RD SHOT 11-16-59 * * *

AREA 2 * *

HOLE NO	GRID LOCATION	TYPE & CLASS	DATE DRILLED	HOLE DIA	HOLE DEPTH	DRIFT DIA	DRIFT LENGTH	DATE COVERED	REMARKS
USGS CH-2	S105+72 E97+[illegible]	CORE HOLE	11-30-59	4 1/2"	5003'			1-5-60	
2-A	S105+22 E97+33	SHOT	11-25-59	6'	54'		NONE	12-4-59	6 TH SHOT 12-3-59
2-B	S105+22 E97+58	GAS EXPANSION	3-8-60	4'&3'	10'&35'				
2-C	S105+22 E97+83	PIPE DUMP HOLE	2-11-60	3'	30'		NONE		
2-D	S105+22 E98+08	SHOT	DEC 59	6'	57'	14"	7'	1-23-60	14 TH SHOT 1-15-60
2-E	S105+22 E98+33	SHOT	11-20-59	6'	53'-4"		NONE	12-17-59	7 TH SHOT 12-9-59
2-F	S105+47 E97+33	SHOT	12-22-59	6'	57'	14"	5'	JAN 60	13 TH SHOT 1-12-60
2-G	S105+47 E97+58								NOT DRILLED
2-H	S105+47 E97+83	SHOT	JAN 60	6'	57'	24"	7'	1-30-60	16 TH SHOT 1-29-60
2-I	S105+47 E98+08	SHOT	2-8-60	6'	37	24"	7'	3-14-60	28 TH SHOT 3-12-60
2-J	S105+47 E98+33	SHOT	JAN 60	6'	57	12"	7	2-3-60	19 TH SHOT 2-2-60
2-K	S105+72 E97+33	SHOT	11-29-59	6	68	14"	15'	12-17-59	9 TH SHOT 12-10-59
2-L	S105+72 E97+58	SHOT	3-7-60	6'	57'	24"	7'	4-2-60	32 ND SHOT 4-1-60
2-M	S105+72 E97+83	SHOT	10-11-60	6'	58	24"	7'		
2-N	S105+72 E98+08	SHOT	3-28-60	6'	37	24"	7'	9-29-60	58 TH SHOT 9-28-60
2-O	S105+72 E98+33	SHOT	JAN 60	6'	57	24"	7'	1-23-60	15 TH SHOT 1-19-60
2-P	S105+97 E97+33	SHOT	JAN 60	6'	57'	24"	7'	2-8-60	20 TH SHOT 2-5-60
2-Q	S105+97 E97+58	SHOT	FEB 60	6'	57'	24"	7'	3-5-60	24 TH SHOT 3-2-60
2-R	S105+97 E97+83								NOT DRILLED
2-S	S105+97 E98+08	SHOT	2-28-60	6'	57	24"	7	3-24-60	30 TH SHOT 3-24-60
2-T	S105+97 E98+33	SHOT	2-7-60	6'	57'	24"	7'	2-25-60	23 RD SHOT 2-24-60
2-U	S106+22 E97+33	SHOT	11-27-59	6'	58'	14"	15'	DEC 59	8 TH SHOT 12-11-59
2-V	S106+22 E97+58	SHOT	JAN 60	6	57'	24"	7	1-25-60	18 TH SHOT 1-22-60
2-W	S106+22 E97+83	SHOT	12-24-59	6'	57'	14"	7'	1-12-60	12 TH SHOT 1-8-60
2-X	S106+22 E98+08	SHOT	1-24-60	6'	57'	24"	7'	1-28-60	17 TH SHOT 1-27-60
2-Y	S106+22 E98+33	SHOT	12-21-59	6'	78	14"	5	12-22-59	10 TH SHOT 12-22-59
2-1	S106+22 E97+74	PIPE DUMP HOLE	JAN 60	3	30			1-5-60	
2-2	S106+22 E97+92	PIPE DUMP HOLE	JAN 60	3	30			1-5-60	
2-3	S106+22 E98+01	PIPE DUMP HOLE	JAN 60	3	30			1-5-60	
2-4	S105+22 E98+20	PIPE DUMP HOLE	JAN 60	3	30			1-5-60	

AREA 2A

HOLE NO	GRID LOCATION	TYPE & CLASS	DATE DRILLED	HOLE DIA	HOLE DEPTH	DRIFT DIA	DRIFT LENGTH	DATE COVERED	REMARKS
2A-C	S105+095 E96+98	SHOT	FEB 60	6	58'	24	7	3-18-60	[illegible]
2A-J	S106+345 E96+88	SHOT	3-30-60	6	58	24	7	11-27-60	[illegible]
2A-O	S105+595 E98+88	SHOT	12-8-60	6	58	24	7	*	
2A-T	S106+845 E98+98	SHOT	MARCH 60	6	58	24	7	[illegible]	[illegible]
2A-Y	S106+095 E98+98	SHOT	12-15-60	6	58	24'	7	*	
2A-Z	S106+345 E98+98	SHOT	MARCH 60	6	57	24'	7	[illegible]	[illegible]

AREA 2B

HOLE NO	GRID LOCATION	TYPE & CLASS	DATE DRILLED	HOLE DIA	HOLE DEPTH	DRIFT DIA	DRIFT LENGTH	DATE COVERED	REMARKS
2B-A	S106+82 E98+08	SHOT	9-21-60	6	58		NONE	10-7-60	59 TH SHOT [illegible]
2B-B	S106+82 E98+33	SHOT	1-20-61	6	58		NONE	4-[illegible]-61	52 ND SHOT 4-[illegible]-61
2B-C	S106+82 E98+58	SHOT	9-21-60	6	57		NONE	[illegible]	43 RD SHOT [illegible]
2B-D	S107+07 E97+72								NOT DRILLED
2B-E	S107+07 E97+97								NOT DRILLED
2B-F	S107+07 E98+22								NOT DRILLED
2B-G	S107+07 E98+47								NOT DRILLED
2B-H	S107+32 E97+38	SHOT	[illegible]	6	58	[illegible]	[illegible]	[illegible]	49 TH SHOT [illegible]
2B-I	S107+32 E97+61								NOT DRILLED
2B-J	S107+32 E97+86	SHOT	12-20-60	6	57	[illegible]	[illegible]	[illegible]	44 TH SHOT [illegible]
2B-K	S107+32 E98+11								NOT DRILLED
2B-L	S107+32 E98+36	SHOT	12-19-60	6	58	24	7	*	
2B-M	S107+57 E98+[illegible]								NOT DRILLED
2B-N	S107+57 E97+24								NOT DRILLED
2B-O	S107+57 E97+48								NOT DRILLED
2B-P	S107+57 E97+75								NOT DRILLED
2B-Q	S107+57 E97+99								NOT DRILLED
2B-R	S107+57 E98+24								NOT DRILLED
2B-S	S107+82 E98+[illegible]								NOT DRILLED
2B-T	S107+82 E96+88	SHOT	2-28-61	6	78	24	[illegible]	*	
2B-U	S107+82 E97+13								NOT DRILLED
2B-V	S107+82 E97+38	SHOT	1-10-61	6	58		NONE	*	
2B-W	S107+82 E97+63								NOT DRILLED
2B-X	S107+82 E97+88	SHOT	4-6-61	6	78		NONE	[illegible]	55 TH SHOT [illegible]
2B-Y	S107+82 E98+13	SHOT	AUG 61	6	58		NONE	*	
2B-Z	S107+17 E98+98	GAS EXPANSION	3-7-60	6&5	[illegible]				[illegible]
	S108+02 E94+13	PIPE DUMP HOLE						*	
	S108+02 E94+00	PIPE DUMP HOLE						*	

NOTE:

* COVERED [illegible] WITH SAND JAN 63

** ENTIRE AREA COVERED [illegible]

*** SHOT IN AREA [illegible]

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ENGINEERING DEPARTMENT
UNIVERSITY OF CALIFORNIA LOS ALAMOS NEW MEX

STATUS OF TEST AREAS
TA-49 FRIJOLES MESA SITE

AUTHORIZED FOR: HEALTH · SAFETY · FIRE PROT · J-DIV

DATE 6-10-63 · SCALE NONE · ENG C28506

Figure B-15 Status of MDA AB holes (6-10-63).

AREA 3

HOLE NO.	GRID LOCATION	TYPE & CLASS	DATE DRILLED	HOLE DIA	HOLE DEPTH	DRIFT DIA	DRIFT LENGTH	DATE COVERED	REMARKS
U6? CH-3	[illegible]	CORE HOLE	[illegible]	2"	300'				
3-A	[illegible]	SHOT	JAN 60	6'	[illegible]	[illegible]	[illegible]	MARCH 60	[illegible] SHOT [illegible]
3-B	[illegible]	SHOT	2-12-60	6'	[illegible]	24"	[illegible]	MAY 60	[illegible] SHOT [illegible]
3-C	[illegible]	SHOT	[illegible]	6'	[illegible]	24"	[illegible]	APRIL 60	[illegible] SHOT [illegible]
3-D	[illegible]	SHOT	MARCH 60	6'	[illegible]		NONE	JUNE 60	[illegible] SHOT [illegible]
3-E	[illegible]	SHOT	4-7-60	6'	[illegible]	24"	[illegible]	MAY 60	[illegible] SHOT [illegible]
3-F	[illegible]	SHOT	APRIL 60	6'	[illegible]	24"	[illegible]	1-3-61	[illegible] SHOT [illegible]
3-G	[illegible]	SHOT	7-14-61	6'	13?'		NONE	AUG 61	[illegible] SHOT 8-1-61
3-H	[illegible]								NOT DRILLED
3-I	[illegible]								NOT DRILLED
3-J	[illegible]	SHOT	5-26-61	3'	142'		NONE	7-26-61	66 TH SHOT 6-26-61
3-K	[illegible]	SHOT	6-25-61	3'	14?'		NONE	6-21-61	67 TH SHOT 6-15-61
3-L	[illegible]								NOT DRILLED
3-M	[illegible]								NOT DRILLED
3-N	[illegible]								NOT DRILLED
3-O	[illegible]								NOT DRILLED
3-P	[illegible]	SHOT	MARCH 60	6'	66'		NONE	JUNE 60	37 TH SHOT 6-22-60
3-Q	[illegible]								NOT DRILLED
3-R	[illegible]								NOT DRILLED
3-S	[illegible]								NOT DRILLED
3-T	[illegible]								NOT DRILLED
3-U	[illegible]	SHOT	2-13-60	6'	66'	24"	12'		34 TH SHOT 4-29-60
3-V	[illegible]	SHOT	2-13-60	6'	66'		NONE	*	
3-W	[illegible]								NOT DRILLED
3-X	[illegible]								NOT DRILLED
3-Y	[illegible]	SHOT	2-24-60	6'	108'	24"	12'	*	

AREA 4

HOLE NO.	GRID LOCATION	TYPE & CLASS	DATE DRILLED	HOLE DIA	HOLE DEPTH	DRIFT DIA	DRIFT LENGTH	DATE COVERED	REMARKS
U6? CH-4	S120+33 [illegible]	CORE HOLE	2-5-60	2"	303'				
4-A	[illegible]	SHOT	1-14-60	6'	66'	24"	11'	6-8-61	64 TH SHOT 6-7-61
4-B	[illegible]	SHOT	6-16-61	6'	101'		NONE	*	
4-C	[illegible]	SHOT	DEC. 59	6'	66'	14"	7'	JAN 60	11 TH SHOT 12-24-59
4-D	[illegible]	SHOT	SEPT 61	6'	106'		NONE	*	
4-E	[illegible]	SHOT	MARCH 60	6'	78'	24"	12'	JAN 61	45 TH SHOT 1-18-61
4-F	[illegible]	SHOT	7-19-61	6'	78'		NONE	7-28-61	71 ST SHOT 7-21-61
4-G	[illegible]								NOT DRILLED
4-H	[illegible]	SHOT	4-4-60	6'	66'	24"	12'	5-24-61	63 RD SHOT 5-23-61
4-I	[illegible]								NOT DRILLED
4-J	[illegible]	SHOT	6-2-61	6'	66'	24"	11'	6-22-61	73 RD SHOT 6-21-61
4-K	[illegible]	SHOT	5-31-61	6'	66'	24"	11'	7-13-61	76 TH SHOT 7-12-61
4-L	[illegible]								NOT DRILLED
4-M	[illegible]	SHOT	JAN 60	6'	66'	24"	6'	3-16-60	27 TH SHOT 3-15-60
4-N	[illegible]								NOT DRILLED
4-O	[illegible]	SHOT	3-8-60	6'	66'	24"	12'	3-23-60	28 TH SHOT 3-22-60
4-P	[illegible]	SHOT	6-6-61	6'	66'	24"	12'	*	
4-Q	[illegible]								NOT DRILLED
4-R	[illegible]	SHOT	3-28-60	6'	78'	24"	12'	5-8-61	58 TH SHOT 5-8-61
4-S	[illegible]								NOT DRILLED
4-T	[illegible]	SHOT	APRIL 60	6'	78'	24"	12'	3-6-61	47 TH SHOT 3-8-61
4-U	[illegible]	SHOT	12-29-59	6'	108'	24"	12'	NO	74 TH SHOT 6-30-61
4-V	[illegible]								NOT DRILLED
4-W	[illegible]	SHOT	3-3-60	6'	78'	24"	12'	3-5-60	25 TH SHOT 3-4-60
4-X	[illegible]								NOT DRILLED
4-Y	[illegible]	SHOT	2-8-60	6'	78'	24"	7'	2-12-60	21 ST SHOT 2-11-60
4-Z	[illegible]	GAS EXPANSION	2-5-60	6-5	31'-70'				15" PIPE CAPPED WITH BLIND FLANGE FLUSH W/GRADE
4-1	[illegible]	PIPE DUMP HOLE		36"	30'			*	
4-2	[illegible]	PIPE DUMP HOLE		36"	30'			*	
4-3	[illegible]	PIPE DUMP HOLE		36"	30'			*	
	[illegible]	CALIBRATION (FOR NTS)		[illegible] CASING					CAPPED W/STL PLATE - WELDED ON JAN 63
	[illegible]	CALIBRATION (FOR NTS)		[illegible] CASING					CAPPED W/STL PLATE - WELDED ON JAN 63
	[illegible]	CALIBRATION (FOR NTS)		[illegible] CASING					CAPPED W/STL PLATE - WELDED ON JAN 63
	[illegible]	CALIBRATION (FOR NTS)		[illegible] CASING					CAPPED W/STL PLATE - WELDED ON JAN 63
	S121+03 E95+27	CALIBRATION (FOR NTS)		[illegible] CASING					CAPPED W/STL PLATE - WELDED ON JAN 63
	S121+13 E95+27	CALIBRATION (FOR NTS)		[illegible] CASING					CAPPED W/STL PLATE - WELDED ON JAN 63

AREA 12

HOLE NO.	STRUCTURE NO	TYPE & CLASS	DATE DRILLED	HOLE DIA	HOLE DEPTH	DRIFT DIA	DRIFT LENGTH	DATE COVERED	REMARKS
BOTTLE HOUSE	TA-49-[illegible]	STEEL BOTTLE							59 TH SHOT 5-10-61
BOTTLE HOUSE	TA-49-[illegible]	STEEL BOTTLE							61 ST SHOT 5-19-61
BOTTLE HOUSE	TA 49-[illegible]	STEEL BOTTLE							65 TH SHOT 6-12-61
BOTTLE HOUSE	TA 49 23	STEEL BOTTLE							69 TH SHOT 6-28-61
BOTTLE HOUSE	TA 49 23	STEEL BOTTLE							75 TH SHOT 10-6-61 [illegible]

DEEP WELLS

WELL DESIGNATION	GRID LOCATION	DATE DRILLED	HOLE DIA	HOLE DEPTH	REMARKS
DT-5A	S111+47 E93+03	2-6-60	16"	1821'	12" CASING FROM SURFACE TO 520 TO MAINTAIN CIRCULATION
DT-9	S142+01 E131+27	2-19-60	16"	1501'	12" CASING FROM SURFACE TO 1360 ; 8" LINER TO QUIT IN
DT-10	S115+27 E129+84	3-13-60	14"	1409'	12" CASING FROM SURFACE TO 1125 ; 8" LINER TO BOTTOM

EXPLORATORY LARGE-DIAMETLR AUGER HOLES

HOLE DESIGNATION	GRID LOCATION	DATE DRILLED	HOLE DIA	HOLE DEPTH	REMARKS
ALPHA	S111+16 E97+54	2-6-60	24"	189'	DRILLED TO OBTAIN GEOLOGIC INFORMATION HOLE WAS DRY
BETA	S93+65 E91+89	2-25-60	24"	180'	DRILLED TO OBTAIN GEOLOGIC INFORMATION HOLE WAS DRY

NOTE

* BACKFILLED WITH SAND JAN 63

AUTHORIZED FOR: J-[illegible], J-DO

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ENGINEERING DEPARTMENT
UNIVERSITY OF CALIFORNIA LOS ALAMOS NEW MEXICO

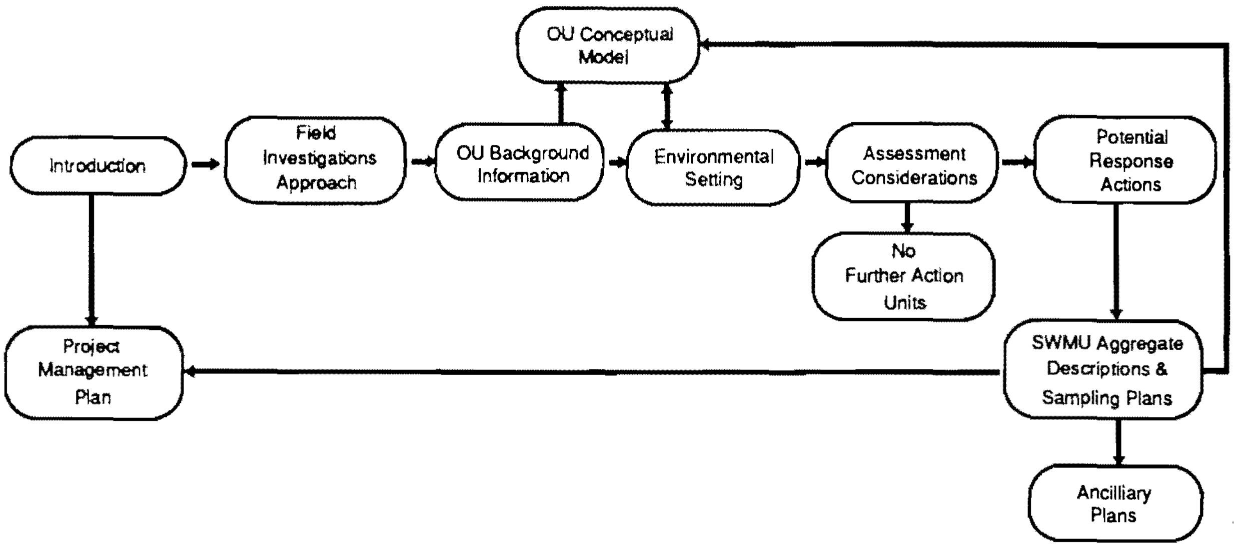
STATUS OF TEST AREAS
TA-49 FRIJOLES MESA SITE

J-DIV — DRAWN GDL — SCALE NONE — DATE 6-10-63 — SHEET 2 OF 2 — DRAWING NO ENG-C28507

LAB JOB NO 2324

Figure B-16 Status of MDA AB holes (6-10-63).

APPENDIX C



Field and Laboratory Investigation Methods

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LIST OF TABLES

APPENDIX C

Field and Laboratory Investigation Methods

C.1 Introduction

C.1.1 Approach

This chapter has been prepared to describe, in one place, the common elements that apply to the conduct of field investigations at all TA-49 SWMUs The objectives and technical approach for investigations at the TA-49 OU are described in Chapters 1-8 of this work plan. Key concepts presented there include:

1. OU-wide investigations which focus on general environmental characteristics and ambient levels of contaminant indicators. These investigations provide the framework within which SWMU-specific data will be evaluated.

2. SWMU-specific characterization which focuses on the nature and extent of contamination and the potential for future migration of wastes.

3. Identification and planning of explicit phases of investigation.

4. Evaluation of analytical data and reassessment of data needs at intermediate stages (according to the decision analysis and observational approaches).

Listed below are several general concepts that apply to the TA-49 field investigation.

1. Radiological contamination is a general characteristic of TA-49 and a primary focus of SWMU-specific investigations.

2. For all TA-49 SWMUs, release of any hazardous constituents would have been associated with the release of radioactive materials.

3. Field surveys and field screening of samples can be used to identify gross contamination and can serve as Level I/II data.

4. Field laboratory analyses can be used to quickly provide Level II/III data to help guide field operations.

C.1.2 Field Operations

This appendix identifies aspects of the Laboratory's implementation of the RFI that are not duplicated in the SWMU-specific field sampling plans. Such aspects include standard activities that will be used to support field operations as follows:

- health and safety of field operations,
- Laboratory-required preliminary activities and support procedures
- identification and documentation of sampling locations,
- sample handling and laboratory coordination procedures,
- equipment decontamination procedures, and
- management of wastes generated by sampling activities.

C.1.3 Investigation Methods

TA-49 field investigation methods are addressed in Section C.5 (Field Sampling Methods) of this appendix and are tiered to the Laboratory's Installation Work Plan (IWP) (LANL 1991, 0553). SOPs for methods to be used during the TA-49 RFI are summarized in Annex I of this OU work plan. The methods presented in this chapter are specific examples of the options identified in the IWP. In addition, this chapter references the Laboratory's ER Program Standard Operating Procedures (SOPs) (LANL 1991. 0411). Each of the brief method descriptions given herein refers to the applicable SOPs for detailed methodology. The methods described in Sections C.4 through C.8 in this chapter include

- sampling methods;
- field sample screening methods to identify grossly contaminated samples at the point of collection (Level I/II);
- in situ field survey methods to identify gross contamination areas (Level I/II/III);
- field laboratory measurement methods to provide rapid quantitative or semi-quantitative sample analyses (Level II/III); and
- offsite analytical laboratory methods (Level III).

The method descriptions are brief and provide some specific information that defines the application. More specific information is provided by the individual field sampling plan (such as sampling location or target depth of a borehole). The method descriptions presented here are not intended to supplant or reduce the importance of the Quality Assurance Project Plan (Annex II of this OU work plan) and the governing SOPs (LANL 1991, 0411).

C.1.4 Data Analysis

Section C.10 of this chapter gives a general discussion of data analysis concepts that will be applied in assessing the meaning of collected information. These concepts include:

- comparisons of sample contaminant levels, to background, action and screening levels;
- decisions to conduct additional sampling or to stop sampling;
- role of the decision analysis and observational approaches; and
- statistical methods.

C.2 Field Operations

As indicated in the project schedule (Annex I of this OU work plan), several investigations may be conducted concurrently at TA-49. Field investigation teams will have individual responsibilities for health and safety, sample identification, sample handling and chain of custody, and related activities. Other operations may be shared across field teams, such as the field laboratory or an equipment decontamination facility.

A field laboratory will be operated to perform all field laboratory analyses required by the site characterization plans described in Chapters 6 and 7. The field laboratory will be managed independently to assure rigorous QA/QC.

In this section, several aspects of field operations are described that are part of many TA-49 OU field operations. The applicability of this assumption to each sampling plan in Chapters 6 and 7 is implied and is not restated elsewhere in this OU work plan.

C.2.1 Health and Safety

Annex III of this OU work plan presents the Health and Safety Plan for the TA-49 RFI field activities. The plan gives SWMU-specific information regarding known or suspected contaminants and personnel protection required for different activities. All samples acquired under this work plan will be screened at the point of collection to detect gross contamination or conditions that may pose a threat to the health and safety of field personnel. The techniques listed in Section C.6 of this appendix, Field Sample Screening, will be used. In particular, gross alpha, gross beta, and gross gamma radiation surveys will be conducted routinely. Applicable SOPs are contained in Chapter 2 of the ER Program SOP document (LANL 1991, 0411) and are referenced in Annex I of this OU work plan.

C.2.2 Archaeological, Cultural, and Ecological Evaluations

Prior to initiation of field work as part of the Laboratory's ES&H Questionnaire process, archaeological and ecological evaluations will be performed in all areas where the surface is to be disturbed, vegetation is to be removed, or invasive sampling is to be performed. Following the archaeological and ecological evaluations, a DOE Environmental Checklist (DEC) will be issued. It is anticipated that the DEC will lead to a recommendation for a categorical exclusion before RFI field work begins at TA-49.

C.2.3 Support Services

Physical services support during the field investigation will be provided by Laboratory support groups ENG-3, ENG-5, Johnson Controls, or contractors. Existing job ticket procedures will be used. The services these groups will provide include, but are not limited to, back-hoe and front-end loader excavations, moving pallets of drummed auger cuttings and decontamination solutions, and setting up signs and other warning notices around the perimeter of the working area.

C.2.4 Excavation Permits

As part of the ES&H Questionnaire process, excavation permits are required by the Laboratory prior to any excavation, drilling, or other invasive activity. Acquisition of the permits will be coordinated with HSE-3 and Johnson Controls. Acquisition of excavation permits will be scheduled as appropriate for each phase of field work. All areas intended for excavation, drilling, or sampling deeper than 18 in. will be marked in the field for formal clearance prior to the work.

C.2.5 Sample Control and Documentation

Guidance for sample handling is provided in Section 13 of Annex II of the IWP. Sample packaging, handling, chain of custody, and documentation procedures are provided in the ER Program SOPs as follows:

- General Instructions for Field Personnel
- Containers, Sampling and Preservation
- Guide to Handling, Packaging and Shipping of Samples
- Sample Control and Documentation

C.2.6 Sample Coordination

A Sample Coordination Facility has been established by the ER Program in Laboratory group EM-9 to provide consistency for all investigations. The operation of this facility is detailed in Appendix N of the IWP. The applicable SOP is:

- Sample Control and Documentation

C.2.7 Quality Assurance Samples

Field quality assurance (QA) samples of several types are collected during the course of a field investigation. The definition for each kind of sample and the purpose it is intended to fulfill are given in Annex II, Quality Assurance Project

TABLE C.3-1

EXAMPLE OF A SAMPLE SCREENING AND ANALYSIS TABLE

Sample Type	Sampling Location	Interval	Sample Identification	Field Screening: Gross Alpha	Gross Beta	Gross Gamma	Field or Off-Site Laboratory Measurements: Gross Alpha/Beta	Gamma Spectrometry	Total Uranium	Isotopic Plutonium	SVOC (SW 8240)	RCRA Metals (SW 6010)	PCB (SW 8080)
Surface Soil													
	1	0.0 - 6.0 In		X	X	X	X	X	X	X		X	
	2	0.0 - 6.0 In		X	X	X	X	X	X	X		X	
	3	0.0 - 6.0 In		X	X	X	X	X	X	X		X	
	4	0.0 - 6.0 In		X	X	X	X	X	X	X		X	
	5	0.0 - 6.0 In		X	X	X	X	X	X	X		X	
	6	0.0 - 6.0 In		X	X	X	X	X	X	X		X	
	7	0.0 - 6.0 In		X	X	X	X	X	X	X		X	
	8	0.0 - 6.0 In		X	X	X	X	X	X	X		X	
	9	0.0 - 6.0 In		X	X	X	X	X	X	X		X	
	10	0.0 - 6.0 In		X	X	X	X	X	X	X		X	
	11	0.0 - 6.0 In		X	X	X	X	X	X	X		X	
	12	0.0 - 6.0 In		X	X	X	X	X	X	X		X	
	13	0.0 - 6.0 In		X	X	X	X	X	X	X		X	
	14	0.0 - 6.0 In		X	X	X	X	X	X	X		X	
	15	0.0 - 6.0 In		X	X	X	X	X	X	X		X	
	16	0.0 - 6.0 In		X	X	X	X	X	X	X		X	
	17	0.0 - 6.0 In		X	X	X	X	X	X	X		X	X
	18	0.0 - 6.0 In		X	X	X	X	X	X	X	X	X	X
	19	0.0 - 6.0 In		X	X	X	X	X	X	X	X	X	X
	20	0.0 - 6.0 In		X	X	X	X	X	X	X	X	X	X
QA/QC (Soil)													
Rinsate blank		0.0 - 6.0 In		X	X	X	X	X	X	X	X	X	X
Field duplicate		0.0 - 6.0 In		X	X	X	X	X	X	X	X	X	X
Field blank		0.0 - 6.0 In		X	X	X	X	X	X	X	X	X	X
Total number of screenings and analyses:				23	23	23	23	23	23	23	6	23	7

Plan (QAPjP) of this OU work plan. The frequency with which each type of field QA sample is to be collected also is detailed in the field sampling plans in Chapters 6-7.

C.2.8 Equipment Decontamination

Decontamination is performed as a quality assurance measure and as a safety precaution. It prevents cross contamination among samples and helps maintain a clean working environment for the safety of personnel. Sampling tools are decontaminated by washing, rinsing, and drying. The effectiveness of the decontamination process is documented through rinsate blanks submitted for laboratory analysis. Steam cleaning is used for large machinery, vehicles, auger flights, and coring tools used in borehole sampling. Decontamination fluids, including steam cleaning fluids, are considered wastes and must be collected and contained for proper disposal. The applicable SOP is:

- General Equipment Decontamination

C.2.9 Waste Management

This discussion is based on the guidance provided in Appendix B of the IWP. Wastes produced during characterization sampling activities may include borehole auger cuttings, excess sample, excavated soil from trenching, decontamination and steam-cleaning fluids, and disposable materials such as wipes, protective clothing, and spoiled sample bottles. In different areas of TA-49, several of the following waste categories have the potential to be encountered: hazardous wastes, low-level radioactive wastes, transuranic waste, and mixed waste (either low-level or transuranic mixed waste). Requirements for segregating, containing, characterizing, treating, and disposing of each type and category of waste are provided in the applicable SOP:

- RFI-Generated Waste Management

C.3 Standard Survey, Screening, and Analytical Tables

For all sampling plans of this RFI work plan, a standard table has been developed which identifies certain field operations and sample analytical requirements. These tables are contained in Appendix E and will be referred to in several remaining sections of this chapter. Table C.3-1 is an example of one of these tables.

C.3.1 Samples and Sampling Methods

The four columns on the left side of Table C.3-1 identify the type of sampling to be conducted, the sampling location, and the depth interval (as appropriate), and provide a space for the sample identification number (to be identified when the sample is collected). The sampling methods or activities identified in the first column are defined later in Section C.5 (Field Sampling Methods) of this appendix.

C.3.2 Survey, Screening and Analysis Methods

Consistent language has been adopted in this work plan to refer to five categories of measurements as defined below, to avoid confusion regarding the type of measurement being discussed.

1. Field Surveys (or "surveys"). Direct reading or recording instruments are used to scan the land surface to make measurements of in situ conditions. Typically, surveys provide Level I or II data. Gamma radioactivity is a common target of field surveys. Land surveys, geophysical surveys and borehole logging also are included in this category.

2. Field Screening ("field sample screening" or "screening"). Instruments or observations are applied to samples at the point of collection to measure the presence of gross contamination or to determine other properties of the sample. Usually, screening provides Level I data. Alpha radioactivity is a common target of field screening. Lithological logging of core samples also is included in this category.

3. Field Laboratory Measurements (or "field laboratory analyses"). These are sample analysis methods that require minimal sample preparation and are readily adaptable to mobile laboratory analytical equipment. These methods measure contaminants or other sample properties at better detection limits, with better precision, or for different contaminants than can be obtained with field screening techniques. Level II data are common, although Level I and Level III procedures also are used. Gross alpha/beta and gamma spectrometry measurements on dried soil samples is a typical example.

4. Offsite Analytical Laboratory Analysis. This category represents the primary analysis for which samples are collected, preserved, and sealed. Level III or IV data usually result. Analysis for RCRA metals is a typical application.

5. Special Analysis. This category represents analyses which require special methods such as, low-level isotopic plutonium.

In Table C.3-1, for each category of measurements, several measurement techniques are identified by vertical columns. These represent the techniques that will be used most commonly for TA-49 RFI samples. The individual measurement techniques represented by each vertical column are identified in the following sections of this appendix: Section C.4, Field Surveys; Section C.6, Field Sample Screening; Section C.7, Field Laboratory Measurements; and Section C.8, Offsite Laboratory Analysis.

C.3.3 Use of the Standard Screening and Analysis Table

The standard survey, screening, and analysis tables serves two major purposes. First, the tables clearly and concisely summarize the details of each sampling plan. These give sampling locations, indicates methods and intervals, and identifies the survey, screening, and analysis measurements for each sample as detailed in Chapters 6 and 7. The tables explicitly identify the collection and analysis of field quality assurance samples. The tables also provide much of the detail needed to estimate the costs of the investigation.

As used in the individual sampling plans given in Chapters 6 and 7, the table identifies three types of sample selections defined below:

- X. Specifically planned sample screening and analyses are marked with an X at the intersection of the sample row with the analysis column.
- E. An example selection of samples is marked with an E in the table. This is used for cases where a plan allows an option or provides guidance to field personnel for selecting the particular samples to be submitted for analysis. The particular samples selected in the field may differ from those indicated by an E, but the number selected should be the same as the number marked. Where a sample marked E has an associated field QA sampling requirement, the QA requirement will be applied to the actual sample selected.
- C. A C is marked in the table for sample analyses that are provided by theplan as a contingency against foreseeable uncertainties that may be encountered in the field. For example, the drilling of boreholes will continue beyond the nominal depth set in the plan if contaminants are still detectable in cores. The fraction of the boreholes in which this will occur is unknown . Explicit inclusion of contingency samples to account for such occurrences has been used in some of the plans. While the contingency samples are usually marked in conjunction with particular boreholes, they may be used as needed in any portion of the plan.

C.3.4 Indicator Analytes

In most of the TA-49 SWMU sampling plans, the following limited set of analytes will be used to indicate the presence or absence of contaminants:

- gamma spectrometry (includes americium-241, cesium-137, and gross gamma radioactivity levels)
- gross alpha/beta radioactivity
- total uranium

- isotopic plutonium
- RCRA metals

The specific analytical methods are defined in Section C.8, Laboratory Analysis.

C.3.5 Additional Analyses

For certain SWMUs, additional analyses are appropriate beyond those listed above. Some of the common additional analyses are shown in Table C.3-l and are detailed in Section C.8 and in other sections of this chapter, as well as in Chapters 6 and 7. Blank columns are provided in Table C.3-1 for listing other additional analyses required at particular SWMUs.

C.4 Field Surveys

Field surveys (defined above in Section C.3.2) typically are scans of the land surface using direct reading or recording instruments. For this OU work plan, these surveys include radiological and geophysical surveys to identify and refine locations as indicated by other information and to identify the presence or absence of contaminants or structures in the field. In some plans, these techniques are used to identify locations for judgemental sampling. In other plans, they are used for preliminary assessment of areas where contaminants are not expected. While negative field survey results are not necessarily conclusive evidence of the absence of contaminants, they can greatly minimize the probability that gross contamination has been overlooked and can allow timely redirection of field sampling.

C.4.1 Radiological Surveys

Radiological survey methods are address in Appendix F of this OU work plan.

C.4.2 Electromagnetic Surveys

Field surveys will be performed with an electromagnetic instrument to confirm the location of buried structures such as shafts and landfills and to trace the path of buried metallic material such as piping. The selected geophysical instrument will be able to detect all types of metal (ferrous and nonferrous) and will be capable of detecting a 2-in. diameter metal line buried at a depth of 5 ft. The A geophysical survey to locate buried metal lines is typically performed by continuously observing the instrument meter response while walking along traverse lines that cross at a right angle over the suspected trend of the buried line. A typical spacing of the parallel traverse lines is 20 ft. A geoplysical survey to locate buried metal structures is typically performed by taking measurements on a grid established over the suspected locations of the structure. The spacing for measurements is determined by the size of the structure; the required spacing my be as close as measurements taken at nodes on a 2.5 ft by 2.5 ft. grid. The applicable SOP is:

- General Surface Geophysics

C.4.3 Land Surveys

Land surveys will be used to document all sampling locations and to locate either former or buried structures (when needed). Because sampling location surveys will be done for all sampling points, it is not specifically identified in the analytical table. In all cases, the minimum precision requirements for the surveys are the same: plus or minus 1-ft horizontal and vertical. The conventional survey procedures used are documented by Laboratory Facilities Engineering organizations.

C.5 Field Sampling Methods

C.5.1 Introduction

For the field sampling plans used in this work plan, a suite of specific sampling methods has been selected, and the details of their use and application in the field have been defined. For example, a "surface soil sample" in this document is specifically defined as representing a 0- to 6-in. layer of soil collected by a hand scoop (see Subsection C.5.2), and a "core sample" is generally defined as a 5-ft core interval of a specified length (see Subsection C.5.3).

Setting these common definitions and using them uniformly in all of the TA-49 OU field sampling plans provides several benefits: consistency of field operations, comparability of sample analysis results from location to location, and the ability to have each sampling plan refer to a method defined in this chapter without reproducing the information in each plan. For each method identified below, the specifically defined portion is detailed. However, complete specification of the method requires additional information that is referenced to the applicable SOP or provided in the field sampling plan (e.g., nominal or target depth for a borehole).

C.5.2 Soil Sampling Methods

C.5.2.1 Surface Soil Sample

Surface soil samples are defined as samples taken from the first 6 in. of soil. This type of soil sample will be gathered using a stainless steel or Teflon scoop.

Care will be used to take the sample to a full 6 in. depth and to cut the sides of the hole vertically to ensure that equal volumes of soil are taken over the full 6-in. depth. The applicable SOP is:

- Spade and Scoop Method

C.5.2.2 Near-Surface Soil Sample

To obtain near surface soil samples to depths of about 30 in., the spade-and scoop method will be used. Spades and shovels are used to remove surficial material to the required depth and a stainless steel or Teflon scoop is used to collect the sample. Care will be used to take the sample to a full 6-in. depth and to cut the sides of the hole vertically to ensure equal volumes of soil are taken over the full 6-in. depth. Unless otherwise specified, the sample interval will be 6 in. Devices plated with chrome or other materials are not acceptable for sample collection. The applicable SOP is:

- Spade and Scoop Method

C.5.2.3 Undisturbed Surface Soil Sample

Undisturbed soil samples will be gathered from the first 6 in. of soil using the ring sampler method. This method involves driving a 4-in.-diameter stainless steel tube (ring sampler) vertically into the area to be sampled. The soil around the ring sampler is then excavated so that the tube can be removed. An undisturbed core sample is obtained by pushing out the soil in the ring sampler. The applicable SOP is:

- Stainless Steel Surface Soil Sampler

C.5.2.4 Manual Shallow Core Sample

Small volume soil samples can be recovered from depths approaching 10 ft with a hand auger or with a thin-wall tube sampler. The thin-wall tube sampler provides a less disturbed sample than that obtained with a hand auger. However, it may not be possible to force the thin-wall tube sampler through some soil or tuff, and sampling with the hand auger may be the more viable alternative. Usually it is not practical to use a hand auger or thin-wall sampler at depths below 10 ft. The applicable SOP is:

- Hand Auger and Thin-Wall Sampler

C.5.3 Core Sampling Methods and Borehole Stopping Criteria

Split-barrel core sampling will be accomplished using an auger rig that drives a

4.25-in. internal diameter hollow-stem auger with 7.5-in. outer diameter auger flights. Soil samples will be collected using a 3.125-in. internal diameter, 5-ft continuous, split-barrel sampler. In each sampling plan, a nominal depth for each borehole is given. The borehole will be sampled to at least the nominal depth. If contamination is detected by field screening or field laboratory measurements in either of the last two core intervals above the nominal depth, drilling will continue until background concentrations are detected or the limits of detection are reached in two successive sample intervals. This stopping criterion will be applied as a means of ensuring that the maximum information on contaminant depth is acquired. Each sampling plan specifies an analytical plan for cores down to the nominal depth. The pattern set by the analytical plan will be followed for the complete depth of the borehole as determined by the stopping criterion.

C.5.3.1 Shallow Boreholes

Several TA-49 sampling plans call for core samples to be collected from shallow boreholes limited to depths of about 30 ft where minimal penetration of contaminants is expected. For ease of setup and rapid drilling of shallow boreholes, the use of a light-weight drilling rig may be preferred over other methods.

The stopping criterion described in Section C.5.3 will be used as appropriate and the applicable SOP for shallow boreholes is:

- Hollow-Stem Auger

C.5.3.2 Vertical Boreholes

For boreholes to a maximum depth of 15 ft, the standard hollow-stem auger, split-barrel core sampling method will be used. A 5-ft core interval is specified as the standard sample. Drilling equipment and stopping criterion described above in Section C.5.3 will be used. The applicable SOP is:

- Hollow-Stem Auger

C.5.3.3 Angled Boreholes

Angle drilling is employed to acquire horizontal contaminant information at MDA AB. As for vertical core sampling, a 5-ft core interval is specified as the standard sample. The auger rig used in this type of investigation should have mechanical specifications comparable to a Failing F-10 or CME-85 unit, with angle drilling capability. In setting up for angle drilling, the drill rig will begin a borehole at a location specified in the sampling plan. The drilling angle and direction specified in the sampling plan will direct the auger string beneath the area to be investigated at the desired depth. The stopping criterion described in SectionC.5.3 will be used. For angled boreholes less than about 150 ft in length, the applicable SOP is:

- Hollow-Stem Auger

C.5.3.4 Deep Core Sampling

for tuff coring deeper than 150200 ft., a drilling rig is needed with capabilities of a greater than those used for the hollow stem uager rigs described above. Initial plans presented in Chapter 6 and 7 call for very few boreholes deeper than 200 ft. Section of rig and drilling method are matched to the goals of the investigation. For air rotary methods, the applicable SOP is:

- Air Rotary Drilling

C.5.3.5 Rock Coring

Rock samples can be recovered from indurated rock formations with the use of a diamond-studded bit. In this method, the diamond bit cuts a small diameter core of rock about 5 or 10 ft in length. As the rock is cut, it is pushed into an inner barrel of the drill string and is retrieved by a wire-line apparatus. This method works best in rock that is hard, relatively free of bedding planes, lithology changes, and fractures. The applicable SOPs are:

- Air Rotary Drilling
- Cable Tool Drilling

C.5.3.6 Shallow-Angled Boreholes

Investigations specific to MDA AB require core sampling of boreholes placed at shallow angles beneath the disposal pits. Such boreholes cannot be drilled with the standard hollow-stem auger rigs specified above. For these holes, air rotary drilling with continuous coring will be used and the stopping criterion described in Section C.5.3 will be used as appropriate. The applicable SOP is:

- Air Rotary Drilling

C.5.4 Swipe Sampling

Standard filter paper swipes routinely will be taken from an area of 100 cm2. When it is not possible to cover this area, an estimate of the surface area sampled will be made. Sufficient pressure should be used on the swipe to pick up loose contamination without tearing or separating the swipe. The applicable SOP is:

- Sampling for Removable Alpha Contamination

C.5.5 Surface Water Sampling Methods

A Geotech Model 0700 peristaltic pump, or its equivalent, will be used to collect surface water samples. The Geotech Model 0700 allows the union of the filtration assembly with the pump and the sample container so that collection of a representative sample is simplified and the possibility of sample contamination is reduced. In this method, surface samples are filtered and collected directly with minimal elapsed time.

An alternate method is to collect surface water as grab samples. This method involves dipping a beaker, flask, or some other transfer device into the surface water to retrieve samples. The water sample can also be collected directly by dipping the sample container into the water and filling, removing, and capping it. This method is less useful when sampling shallow waters such as seeps, springs, or shallow streams. The applicable SOP is:

- Surface Water Sampling

C.5.6 Groundwater Sampling

The sampling of the three existing groundwater wells at TA-49 is included in the general characterization of the OU. If perched water zones springs, or seeps are encountered at TA-49 OU, they also will be sampled. The applicable SOPs for groundwater sampling are:

- Purging of Wells for Representative Sampling of Ground Water
- Field Analytical Measurements on Ground Water Samples

C.6 Field Sample Screening

Field screening is defined earlier in Subsection 3.2. Screening measurements are applied to samples at the point of surface sample collection to assess conditions affecting the health or safety of field personnel. Application of screening for personnel health and safety is detailed in Annex III (Health and Safety Project Plan) of this OU work plan. Individual sampling plans may not explicitly identify the use or role of sample screening measurements. However, the standard analytical table for each investigation will indicate the measurement to be made. In general, every sample taken at TA-49 will be screened for gross alpha, beta, and gamma radioactivity. In addition, a noninstrumental form of sample screening, lithological logging, will be performed for all borehole samples.

In addition to the role of sample screening in monitoring for gross contamination or other health and safety concerns, some TA-49 OU sampling plans use the sample screening information explicitly as Level I data for making decisions on further sampling, or for selecting sample analysis options.

C.6.1 Radiological Screening

C.6.1.1 Gross Alpha

Field screening of samples for gross alpha contamination is conducted using a hand-held alpha detector and a ratemeter. The detector is held close to the sample and is capable of detecting approximately 100-200 counts per minute for an undried sample. The instrument cannot identify specific radionuclides. The applicable SOP is:

- Total Alpha Surface Contamination Measurements

C.6.1.2 Gross Gamma

Field screening of samples for gamma radioactivity will be done using a hand-held alpha detector probe and ratemeter as a gross indicator of potential contamination. The detector is held close to the sample and is capable of identifying elevated concentrations of certain radionuclides as an increased ratemeter reading above instrument background levels. The applicable SOP is:

- Measurement of Gamma Radiation Using a Sodium Iodide (NaI) Detector

C.6.2 Nonradioactive Screening

C.6.2.1 Organic Vapor Detectors

Organic vapor detectors may be used to screen specified borehole cores and soil samples at the point of collection. Two purposes are addressed: personnel safety and the identification of grossly contaminated samples. Two types of detectors, PID and FID, are used to detect a wide range of vapors.

PID. A Model PI 101 photoionization detector (PID) or its equivalent will be used as needed to detect organic vapors. This general survey instrument is capable of detecting real-time concentrations of many complex organic compounds and some inorganic compounds in air. The instrument can be calibrated to a particular compound. However, it cannot distinguish between detectable compounds in a mixture of gases. The applicable SOP is:

- Health and Safety Monitoring of Organic Vapors with a Photoionization Detector

FID. A Foxboro Model OVA-128, or its equivalent, will be used. This flame ionization detector (FID) can be used as a general screening instrument to detect the presence of many organic vapors. The instrumental response is relative to the response to a gas of known composition to which the instrument has been calibrated. The applicable SOP is:

- Health and Safety Monitoring of Organic Vapors with a Flame Ionization Detector

C.6.2.2 Combustible Gas/Oxygen Detectors

A Gastech Model 1314, or its equivalent, may be used to determine the potential for combustion or explosion of unknown atmospheres. A typical combustible gas indicator (CGI) determines the level of organic vapors and gases present in an atmosphere as a percentage of the lower explosive limit (LEL) or lower flammability limit (LFL). The Gastech Model 1314 also contains an oxygen detector to determine atmospheres that are deficient or enriched in oxygen. The applicable SOP is:

- Health and Safety Monitoring of Combustible Gas Levels

C.6.2.3 Lithologic Logging

Lithological logging of recovered core will be performed to describe the physical nature of borehole cores. Lithological logging will be performed by a geologist qualified to describe subsurface lithologies and differentiate the various strata of the Bandelier Tuff. The applicable SOP is:

- Lithological Logging of Borehole Cores

C.6.2.4 High Explosives

Field screening for high explosives (HES) will employ the spot test of (Baytos 1991, 0741).

C.7 Field Laboratory Measurements

The scope and nature of field laboratory measurements to be used in support of the TA-49 RFI are defined in this section. The field laboratory will provide fast turn-around analysis of samples for a limited number of analytical methods. The techniques used in the field laboratory can give primarily Level I, II, or III data, as noted below. The field laboratory methods provide better quality information or lower detection limits than can be obtained with field screening or survey. In some cases, they provide a type of information that cannot be obtained with field screening or survey techniques. The intended uses of the field laboratory results are:

1. Guidance to Field Operations. The use of a field laboratory can provide fast turn-around results to aid in directing the course of field work, thus increasing the efficiency of field operations. An example is the use of field laboratory measurements to determine when to cease borehole drilling.

2. Judgemental Sample Selection. Field laboratory analyses of knowledge-based (judgemental) samples can enhance the effectiveness of the investigation. Based on field laboratory analyses, additional samples having particular characteristics can be selected:

   - those with no detectable contaminants to define the edge of a plume;
   - those with the highest levels, to identify contaminants during source characterization.

3. Analytical Sample Load Reduction. Field laboratory provides the capability to relatively quickly and inexpensively assess samples for selected analytes. As a consequence, the submittal of a smaller number of samples to an off-site analytical laboratory can be justified by a base of lower quality measurements. This approach provides assurance that high quality measurements are representative and sufficient for decision making and can limit the number of samples that must be sent for more costly and time consuming analysis at an offsite analytical laboratory.

The selection of samples to be submitted to an offsite analytical laboratory, based on field laboratory results, is required in the TA-49 OU field investigation. The criteria to be used for making this selection depend on the focus and goals of the particular investigation, described in the SWMU-specific sampling plans (Chapters 6 and 7 of this OU work plan).

C.7.1 Radiologic Measurements

C.7.1.1 Gross Alpha and Gross Beta Radioactivity

Measurements of gross alpha and beta radioactivity can be used to assess the presence of plutonium, uranium, and americium in samples, although identification of the individual radionuclides is not possible by this method. These Level II measurements can be used to guide field operations or to bias sample selection. For example, the alpha emissions from plutonium-238 are indistinguishable from those of americium-241 by gross alpha counting.

The method uses a thin-walled Na I detector in dried soil samples in a fixed geometry. A measurement time of approximately 15 to 20 min is typical. Detection limits are approximately 4-10 pCi/g for alpha emitters and 5-12 pCi/g for beta emitters. Additional detail is given in Annex II of this OU work plan and in the ER Program Generic QA Plan. The applicable SOP is:

- Screening Soil Samples for Alpha Emitters

C.7.1.2 Gross Gamma Radioactivity

Gross gamma radioactivity will be determined by the gamma spectrometry method.

C.7.1.3 Tritium by Liquid Scintillation Counting

Overnight turn-around Level II tritium analysis of soil moisture or water samples can be obtained by liquid scintillation techniques. Distillation of soil moisture from soil samples is done in a ventilated hood in the field laboratory, as part of the process of drying soil samples for gross alpha measurements. Liquid scintillation measurements will be done using documented laboratory procedures for this measurement.

C.7.1.4 Gamma Spectrometry

Gamma spectrometry can be used to quantify gamma-emitting radionuclides in soil samples. Rapid turn-around analysis can be Level II or Level III quality using personal computer-based, multichannel analyzers (MCA) and NaI or germanium photon detectors. An example is a Canberra MCA with a Ludlum 44-10 NaI detector, although many equivalent instruments are available. Dried soil samples in fixed geometries can be analyzed in approximately 20 to 30 min with a detection limit of about 5 pCi/g for radionuclides such as 137Cs (detection limits are isotope-specific). The applicable SOP is:

- Use of Gamma Spectrometry Systems as a Screen for Gamma Ray-Emmitting Radionuclides in Soil Samples

C.7.2 Organic Chemical Measurements

C.7.2.1 Volatile Organic Compounds

To guide field operations, rapid turn-around Level II analysis might be needed to identify and quantify volatile organic compounds (VOCs). The Laboratory's transportable purge-and trap GC/MS can provide qualitative and quantitative analyses of most VOCs with boiling points below 200 degrees C that exhibit low or slight solubility in water. Volatile water-soluble compounds also can be detected with higher detection limits. The applicable SOP is:

- Portable Gas Chromotography for Field Screening of Volatile Organic Compounds

C.7.2.2 PCBs

The extent and variability of PCB contamination at TA-49 is expected to be limited or non-existent. An inexpensive, fast turn-around measurement technique with a detection limit less than the regulatory limit (25 ppm) will be used to define the areal extent of contamination to minimize analytical laboratory analyses. A 10 ppm detection level is achievable with available analytical techniques that provide quick turnaround in a field laboratory. A DEXSIL L2000 PCB/Chloride Analyzer or an alternative method with suitable detection limit can be used. The L2000 uses a chloride-specific electrode to quantify PCBs in oil or soils. Sample preparation involves extracting the PCBs from the soil and reacting the sample with a sodium reagent to transform the PCBs into chloride, which can be quantified by the instrument. Oil samples take about 5 min to prepare and soils about 10 min. Documented field laboratory procedures for measurement of PCBs in soil will be used.

C.7.2.3 High Explosives

Laboratory analysis for HEs will be conducted according to the USATHAMA High Performance Liquid Chromatography method.

C.8 Offsite Laboratory Analysis

In Subsection C.3.2, laboratory analysis levels are defined as they are used in this OU work plan. Offsite laboratory analysis are intended to provide the highest quality (Level III/IV) data required. As described in Subsection C.2.6, samples to be submitted to an offsite analytical laboratory will be coordinated, handled, and tracked by the ER Program Sample Coordination Facility. The standard list of analytes and quantification limits is given in Annex II of this OU work plan and in the ER Program Generic QA plan. Standard commercial laboratory procedures will be modified as described in Section C.7.1 and Annex II of this OU work plan.

Some TA-49 OU sampling plans rely on Level III data to support their objectives. Other plans use Level I/II data for field guidance and use the higher quality results for limited purposes. As discussed earlier in Section C.3, the standard survey, screening and analysis tables identify the analyses for which each sample is submitted. Identification of methods frequently listed in the standard table follows.

Gamma Spectrometry. Radionuclides are quantified by measurement of gamma ray photon emissions. Pertinent to this OU work plan, this method yields the levels of gross gamma radioactivity, cesium-137, and americium-241.

Tritium. Tritium in water samples or in moisture distilled from soil is quantified by measuring the low energy beta emission with liquid scintillation counting.

Total Uranium. Analysis will be done by LANL HSE-9 methods following sample digestion using EPA method 3050.

Isotopic Plutonium. Radiochemical methods are used to separate plutonium from soil, followed by alpha spectrometry to quantify each isotope of plutonium. Special radiochemical separation methods and counting techniques employing advanced instrumentation may be used to provide plutonium isotopic data in soil and sediment at low activity levels (Level V data).

Semivolatile Organics (SVOCs). The EPA standard method (SW 8270) will be used to quantify semivolatile organic compounds.

RCRA Metals. The EPA standard method (SW 6010) will be used to quantify metals.

The following analyses will be used in the TA-49 RFI, but are not part of the common suite of analyses in the SWMU-specific sampling plans:

- PCBs. The EPA standard method (SW 8080) will be used to quantify PCBs.
- Isotopic Uranium. Radiochemical separation of uranium from soil is followed by alpha spectrometry to quantify each isotope of uranium.

C.9 Geohydrologic Characterization of Boreholes and Recovered Co

Methods used for geohydrologic characterization of boreholes during the TA-49 RFI are described in the following discussion.

C.9.1 Hydrogeologic Measurements on Recovered Core

Gravimetric water content in intact core samples will be measured quantitatively by weighing moisture loss due to oven drying by ASTM method D-4531-86 (ASTM 1946, 0743). This procedure also yields bulk density, dry density, and porosity.

Porosity (He Injection) will be measured quantitatively using intact core samples by American Petroleum Institute Method API 40, Section 3.58.

Saturated hydraulic conductivity will be measured using intact core samples by ASTM method ASTM D-2434-68 (ASTM 1946, 0743).

Moisture characteristic curves will be measured using intact core samples to characterize wetting and drying cycles, with verification at the dry end with the psychrometer method, by the American Society of Agronomy method (Chapter 24).

Air/water relative permeability will be determined by the method of van Genuchten, using data from saturated hydraulic conductivity tests and moisture characteristic curves.

C.9.2 Geochemical Measurements

Standard X-ray diffraction procedures will be applied to powdered rock and soil samples to characterize the type and relative abundance of mineral phases as follows.

- Clay mineralogy. Kaolinite, illite, and montmorillonite.
- Zeolite mineralogy.
- Matrix mineralogy. Silica polymorphs, alkali feldspars, and volcanic glass.
- Carbonate mineralogy.
- Iron and manganese mineralogy.
- Total organic carbon. Total organic carbon in crushed rock samples will be measured by combustion in a muffle furnace by ASTM method D-2974 (ASTM 1946).

Other geochemical measurements are as follows:

- Cation exchange capacity. Cation ion exchange capacity will be measured on crushed core samples by sodium absorption using EPA method 9080 (EPA 2985, 0409).
- Slurry pH. The ph of slurries of crushed core samples leached with deionized water will be measured using ASTM method DG657 (ASTM 1946).

C.9.3 Environmental Isotopes Measurements

Chlorine-35/chlorine-37. This isotope ratio will be measured by accelerator mass spectrometry on chloride samples obtained by leaching crushed core samples with deionized water.

Carbon-12/carbon-13. This isotope ratio will be measured by mass spectrometry on water sample or pore water extracted under vacuum from crushed core samples.

Hydrogen/deuterium. This isotope ratio will be measured by mass spectrometry on water samples or pore water extracted from crushed core samples.

Oxygen-18/oxygen-16. This isotope will be ratio measured by mass spectrometry on water samples or pore water extracted under vacuum from crushed core samples.

Tritium. Tritium activity will be measured in water samples or pore water extracted under vacuum from crushed core samples by liquid scintillation counting methods.
Carbon-14. Carbon-14 age determinations will be carried out by accelerator mass spectrometry on pore water extracted from crushed rock samples.

Chlorine-36. Chlorine-36 age determinations will be carried out by accelerator mass spectrometry on water samples, or solutions obtained by leaching crushed core samples with deionized water.

C.9.4 Straddle Packer Tests

In situ air permeability tests will be performed over discrete depth intervals in open boreholes to measure in situ air permeability. The test is performed by vacuum extraction by the method of (Donahue and Erekian 1982, 0405).

Carbon-12/carbon-13 isotope ratio will be measured by mass spectrometry methods on in situ gas samples extracted from discrete depth intervals in open boreholes.

Relative humidity will be measured on in situ gas samples extracted from discrete depth intervals in open boreholes using the thermocouple psychrometry method described in Agronomy Monograph #9, Chapter 4.

C.9.5 Borehole Geophysics

Thermal neutron logs in open boreholes continuously measure rock properties that capture thermal neutrons. Neutron capture is directly related to moisture content in unsaturated rocks and to porosity in saturated rocks.

Gamma gamma density logs in open boreholes continuously measure rock properties that alter and scatter gamma radiation. The measured values are directly related to bulk density of the rock. The method typically uses a 100 mCi cesium-137 source.

Caliper logs continuously measure the diameter of an open borehole to identify zones of fractured rock.

Axial borehole video log provides a continuous television record of the walls of an open borehole. A wide angle lens provides a 360 degree view of the borehole wall. A compass mount provides directional orientation of discrete features such as fractures and joints.

Sidescan borehole video log provides a continuous television record of a segment of the wall of an open borehole. The sidescan lens is motor driven and will rotate 360 degrees to provide complete viewing. A compass mount provides directional orientation of discrete features such as fractures and joints.

Electromagnetic induction log continuously measures the electrical properties of the bulk rock medium in an open borehole. The measurement may be taken in unsaturated or saturated environments.

Magnetic susceptibility log continuously measures the magnetic susceptibility of the rock matrix in open boreholes. The log is used for stratigraphic correlation.

Natural gamma radiation log in open or cased boreholes continuously measures the natural gamma radiation emitted by the rock matrix. The log is used for stratigraphic correlation.

Spectral gamma radiation log in open or cased boreholes continuously measures the natural gamma radiation emitted by the rock matrix. The gamma radiation spectrum is divided into three separate energy "windows" to differentiate abundances of uranium, thorium, and potassium. The log is used for stratigraphic correlation and to evaluate the presence or absence of radioactive contamination.

Prompt fission neutron log in open boreholes continuously measures fissionable isotopes in the rock that may be related to radioactive contamination.

Geochemical (californium-252) log in open boreholes continuously measures the following suite of elements in the rock matrix: aluminum, calcium, iron, silicon, sulfur, titanium, carbon, oxygen, hydrogen, chloride, potassium, thorium, and uranium. The method measures gamma emissions that result from bombardment of the rock matrix by neutrons from a 252 Cf source.

C.10 Data Analysis

Several aspects of data analysis are integral to the use of the phased investigation and decision analysis approaches described in the IWP and in Chapter 2 of this OU work plan. An overview of several aspects of data analysis pertinent to the TA-49 OU is given below.

C.10.1 Phased Sampling

Phased sampling involves the collection of an initial set of samples, with the results of measurements from this set used to determine if additional sets of samples are required. Thus, results from the initial investigation guide the selection of subsequent sampling. Although unbiased estimates of population parameters can be based on a single set of samples, efficient and cost-effective data practice entails the use of the first set of samples to determine the number of additional samples and their optimum locations for the required accuracy of the estimates. Subsequent sampling is used to give a more detailed characterization of the area, if required, and to confirm the predictions and parameter estimates of the earlier stages.

The phased approach has been used to guide sample collection and chemical analysis for the TA-49 RFI to the extent possible. Analytical results for the first set of the samples collected will be evaluated to determine if further analysis is necessary and to provide guidance for minimizing required analyses on subsequent samples.

C.10.2 Approaches to Data Analysis

Use of Background Levels. As discussed in Section 5.1 of this OU work plan, the term background level refers to the natural or fallout levels of elements, chemicals, or radionuclides. Comparison of measured sample to background levels will be used to assess whether contaminant release has occurred at TA-49 SWMUs.

Use of Action Levels. The use of action levels in assessing TA-49 OU data will be in accordance with the usage described in Section 3.5 of the IWP and Section 5.1 of this OU work plan. The action level concept is based on the EPA's proposed 40 CFR 264, Subpart S, and available action levels that have been proposed are listed in Appendix F of the IWP. These and other action levels for contaminants of concem are discussed in Section 5.1 of this OU work plan. Action levels will be used in conjunction with background levels to assess the presence, magnitude, and importance of environmental contamination from individual SWMUs. The comparison of sample analysis results to action levels will comprise part of the assessment of options for further characterization or the need for remediation.

Decisions to Conduct Additional Sampling. Within some of the individual sampling plans, options are presented to expand the scope of sampling based on immediate information from field surveys, sample screening, and field laboratory measurements. These options allow the area covered by a sampling program to be adjusted.

After review and evaluation of analytical data from initial sampling, a decision to conduct subsequent investigations will be based on a need to further characterize contaminant concentrations, vertical and lateral extent, or migration along particular pathways, dependent upon objectives of the particular SWMU-specific investigation.

Decisions Not to Conduct Additional Sampling. Characterization investigations may be terminated on the basis of one of several criteria as follows:

1. At many SWMUs, contamination is unlikely to exist. In a number of these cases, initial results will be sufficient to determine that no significant contamination is present and that no further action is necessary.

2. In some cases, data from initial characterization may identify significant levels of contamination, but the nature and probable extent of contamination may indicate an easily remediated situation. A commonly encountered example is underground piping or soil hot spots. In such cases, it may be judged more appropriate to remove the contamination as a voluntary corrective action than to do further characterization.

3. Initial characterization may identify waste types or contaminant situations for which the most appropriate approach is the conduct of a pilot study to assess options for treatability or remedial alternatives.

4. Further characterization may be curtailed so that effective planning of a corrective measures study can provide additional guidance.

Decision Analysis Approach. In all of these situations, the decision analysis approach described in Appendix I of the IWP will be used to ensure that the decision-making process, with regard to additional characterization sampling, will be systematic. This will be documented by formal reports of data assessment.

References for Appendix C

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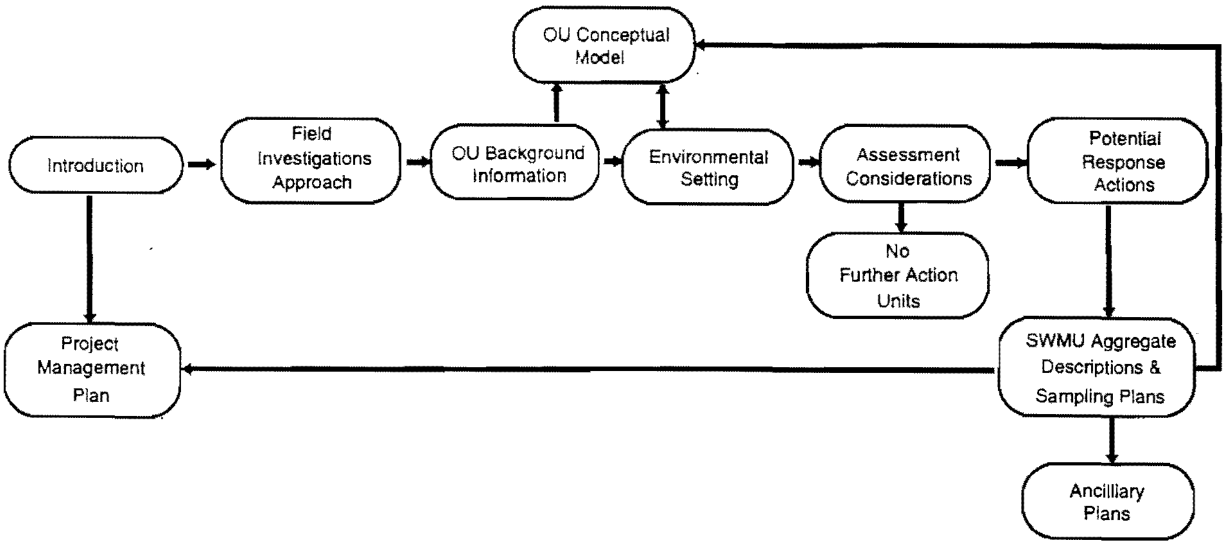
APPENDIX D



Tabulation of Data from Previous TA-49 Environmental Studies

Index for Figures and Tables in Appendix D

Transport of Radionuclides in Sediments from an Inactive Waste Management Area (TA-49). From 1959 to 1961, hydronuclear experiments were conducted in underground shafts at the Laboratory at TA-49. This technical area is located on Frijoles Mesa in the southwest corner of the Laboratory between TA-28 and TA-33 (Fig. 4). The experiments involved a combination of conventional (chemical) high explosives, usually in a nuclear weapons configuration. The quantity of fissile material was kept far below the amount required for a nuclear explosion (Purtymun 1987b). The underground shafts ranged in depth from 15 to 36 m (50 to 120 ft) beneath the surface of the mesa (Purtymun 1987b, ESG 1988).

Eleven stations were established in 1972 to monitor surface sediments in natural drainage from the experimental area. Another station was added in 1981 as the drainage changed (Fig. 21). Sediment samples from the 12 stations were analyzed for radiochemical and chemical constituents and for organic compounds.

Results of analyses of sediment samples for radiochemicals were compared with the statistically established levels for regional background (1977-1986 [Purtymun 1987a]) and no 1990 samples exceeded those background levels, as shown in Table G-41. Plutonium has often been found at levels exceeding background limits in previous monitoring. The plutonium reported is attributable to a surface contamination incident that occurred in 1960 (Purtymun 1987b, ESG 1988).

Sediments from the 12 stations were analyzed for chemical constituents. The results of the analyses indicated that constituents were below threshold limits for EPA's EP toxicity criteria concentrations (Table G-42). The great majority of results were below limits of analytical detection.

Samples of sediments from the 12 stations were analyzed for 68 volatile organic compounds, 71 semivolatile organic compounds, 19 pesticide compounds, two herbicide compounds, and four PCB compounds (Table G-43). The LOQs for the organic compounds are given in Appendix C. All samples were analyzed for these compounds. Only one target compound was detected at levels above the LOQ: 1,2,4-trimethylbenzene at levels between 6 and 10 μg/g in 10 of the 12 samples. This suggests sample contamination during collection or analysis because of the consistent levels in all samples. This compound was not among the ones noted last year, which also showed analytical difficulties. Because of the uncertainties in the analyses, additional samples will be collected next year for organic analyses.

Three deep test wells (DT-5A, DT-9, and DT-10) were used to monitor possible movement of contaminants from the shafts to the main aquifer (Fig. 16). The depth to the main aquifer is about 360 m (1 200 ft). No water is perched in beds between the surface of the mesa and the top of the main aquifer. The chemical and radiochemical quality of water from these wells indicated no contamination from activities at TA-49 (Sec. VI.C.4.a. and Tables G-22 and G-23).

Table D-1. Transport of Radionuclides in Sediments from an Inactive Waste Management Area (TA-49). Taken from the 1990 Environmental Surveillance Report. (ESG 1992, 0740)

Summary of Radiochemical Analyses of Sediments from TA-49

Station	^{3}H (10^{-6} µCi/mL)	^{137}Cs (pCi/g)	Total Uranium (mg/g)	^{238}Pu (pCi/g)	$^{239,240}Pu$ (pCi/g)	Gross Gamma (counts/min/L)
A-1	21.0 (2.0)	0.08 (0.09)	3.2 (0.3)	0.000 (0.001)	0.002 (0.001)	3.1 (0.5)
A-2	5.2 (0.6)	0.15 (0.12)	2.2 (0.2)	0.005 (0.001)	0.003 (0.001)	1.4 (0.4)
A-3	7.8 (0.9)	0.20 (0.09)	2.8 (0.3)	0.000 (0.001)	0.002 (0.001)	1.3 (0.4)
A-4	13.0 (1.0)	0.20 (0.12)	3.3 (0.3)	0.002 (0.001)	0.002 (0.001)	2.4 (0.5)
A-4A	8.1 (0.9)	0.08 (0.08)	3.8 (0.4)	0.000 (0.000)	0.002 (0.001)	2.1 (0.5)
A-5	36.0 (4.0)	0.14 (0.12)	2.0 (0.2)	0.001 (0.001)	0.001 (0.001)	0.5 (0.4)
A-6	10.0 (1.0)	0.16 (0.09)	2.5 (0.2)	0.000 (0.000)	0.004 (0.001)	1.7 (0.4)
A-7	9.0 (1.0)	0.20 (0.12)	2.4 (0.2)	0.001 (0.001)	0.003 (0.001)	1.5 (0.4)
A-8	10.0 (1.0)	0.11 (0.08)	2.7 (0.3)	0.003 (0.001)	0.002 (0.001)	2.1 (0.5)
A-9	16.0 (2.0)	0.21 (0.13)	2.0 (0.2)	0.001 (0.001)	0.003 (0.001)	1.8 (0.4)
A-10	2.8 (0.4)	0.03 (0.08)	3.8 (0.4)	0.002 (0.001)	0.002 (0.001)	3.4 (0.5)
A-11	6.6 (0.8)	0.23 (0.12)	3.4 (0.3)	0.000 (0.000)	0.004 (0.001)	2.9 (0.5)
Sediment background (1974—1986)[a]		0.44	4.4	0.006	0.023	

[a]See Purtymun (1987a).

Table D-2. Summary of Radiochemical Analyses of Sediments from TA-49. Taken from the 1990 Environmental Surveillance Report. (ESG 1992, 0740)

Trace Metals in Solution Extracted from Sediments at TA-49 (mg/L)

	Ag	As	Ba	Cd	Cr	Hg	Pb	Se	Be total mg/g	Ni CN mg/L	total mg/g
Extraction procedure toxic threshold	5.0	5.0	100	1.0	5.0	2.0	5.0	1.0	N/A	N/A	N/A
Limits of detection	0.005	0.002	0.5	0.01	0.04	0.002	0.05	0.001	0.01	0.01	0.01
Stations											
A-1	0.01	0.002	0.1	0.05	0.1	0.0002	1.0	0.001	0.0005	0.015	0.1
A-2	0.01	0.002	0.13	0.05	0.1	0.0002	1.0	0.001	0.0005	0.02	0.1
A-3	0.01	0.002	0.09	0.05	0.1	0.0002	1.0	0.001	0.0005	0.012	0.1
A-4	0.01	0.002	0.12	0.05	0.1	0.0002	1.0	0.003	0.0005	0.015	0.1
A-4A	0.01	0.002	0.09	0.05	0.1	0.0002	1.0	0.001	0.0005	0.015	0.1
A-5	0.01	0.002	0.08	0.05	0.1	0.0002	1.0	0.001	0.0005	0.015	0.1
A-6	0.01	0.002	0.1	0.05	0.1	0.0002	1.0	0.001	0.0005	0.015	0.1
A-7	0.01	0.002	0.12	0.05	0.1	0.0002	1.0	0.001	0.0005	0.012	0.1
A-8	0.01	0.002	0.09	0.05	0.1	0.0002	1.0	0.001	0.0005	0.015	0.1
A-9	0.01	0.002	0.08	0.05	0.1	0.0002	1.0	0.001	0.0005	0.01	0.1
A-10	0.01	0.002	0.15	0.05	0.1	0.0002	1.0	0.001	0.0005	0.015	0.1
A-11	0.01	0.002	0.1	0.05	0.1	0.0002	1.0	0.001	0.0005	0.015	0.1
Maximum	0.01	0.002	0.15	0.05	0.1	0.0002	1.0	0.001	0.0005	0.015	0.01

[a]BLD = below limits of detection.

Table D-3. Trace Metals in Solution Extracted from Sediments at TA-49. Taken from the 1990 Environmental Surveillance Report. (ESG 1992, 0740)

Number of Results above the Analytical LOQ for Organic Compounds in Sediments from TA-49

	Type of Organic Compound				
	Volatile	**Semivolatile**	**Pesticide**	**Herbicide**	**PCB**
Number of Compounds Analyzed	68	71	19	2	4
Stations					
A-1	1	0	0	0	0
A-2	1	0	0	0	0
A-3	1	0	0	0	
A-4	1	0	0	0	0
A-4A	1	0	0	0	0
A-5	1	0	0	0	0
A-6	1	0	0	0	0
A-7	1	0	0	0	0
A-8	0	0	0	0	0
A-9	1	0	0	0	0
A-10	1	0	0	0	0
A-11	1	0	0	0	0

Table D-4. Number of Results Above the Analytical LOQ for Organic Compounds in Sediments from TA-49. Taken from the 1990 Environmental Surveillance Report. (ESG 1992, 0740)

Table D-5. 1990 Airborne Contaminant Levels for TA-49.

	Total Air Volume (m^3)	No. of Monthly Samples	No. of Samples <MDL[a]	Maximum[b]	Minimum[b]	Mean[b]	Mean as a Percentage of Guide[c]
Tritiated water concentration (pCi/m^3[10^{-12} μCi/mL])	132.15	12	11	3.9 (0.9)	-0.5 (0.5)	1.1 (1.2)	<0.1
		No. of Quarterly Samples					
^{239,240}Pu concentrations (aCi/m^3[10^{-18} μCi/mL])	86,823	4	4	0.7 (0.5)	0.0 (0.4)	0.3 (0.3)	<0.1
^{238}Pu concentrations (aCi/m^3[10^{-18} μCi/mL])	86,823	4	4	0.8 (0.6)	0.2 (0.5)	0.5 (0.3)	<0.1
^{241}Am concentrations (aCi/m^3[10^{-18} μCi/mL])	41,927	2	2	1.8 (0.5)	1.7 (0.6)	1.7 (0.6)	<0.1
Uranium concentrations	86,823.30	4	0	44.5 (4.5)	14.3 (1.4)	27.2 (12.6)	<0.1

[a]Minimum detectable limit = 2×10^{-18} μCi/mL.

[b]Uncertainties are in parentheses.

[c]Controlled area DOE Derived Air Concentration = 2×10^{-5} μCi/mL.

Uncontrolled area Derived Concentration Guide = 1×10^{-7} μCi/mL.

Data taken from 1990 Environmental Surveillance Report. (ESG 1992, 0740)

Table D-6. Chemical Quality (mg/L) of Surface Waters and Groundwaters from On-Site Stations for four representative years.

Year	Station	SiO_2	Ca	Mg	K	Na	CO_3	HCO_3	P	SO_4	Cl	F	NO_3-N	TDS[b]	Total Hard-ness	pH[c]	Conduc-tivity (mS/m)
1990	DT-5A	65	13	2.7	1	12	5	68	0	2	1	0.2	0.3	64	44	8.2	9.6
	DT-9	73	14	3.2	1	13	5	57	0	3	1	0.3	0.4	274	48	8.4	9.68
	DT-10	53	15	3.9	1	13	5	67	0	2	2	0.3	0.3	200	53	8.7	10.4
	Beta	36	15	4.1	3.5	18.5	5	55	0.075	14.2	9	0.2	0.4	188	53	7.3	12.5
1983	DT-5A	71	8	2	1.8	11	0	66	0.1	1	1	0.2	0.9	131	31	7.8	11
	DT-9	56	-	-	-	-	-	-	-	0	-	0.7	1.2	116	-	7.9	11
	DT-10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Beta	48	22	6	7.7	67	0	126	17	30	40	0.6	43	335	77	7.5	48
1979	DT-5A	50	3	2	2.7	21	0	76	1	2	2	0.3	3	180	33	8.4	13
	DT-9	40	5	3	1	11	0	27	1	2	2	0.4	2	138	35	8.3	10
	DT-10	58	6	3	1.4	11	0	80	2.0	1	2	0.4	1	130	50	8.5	12
	Beta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1975	DT-5A	-	10	3	-	11	0	60	-	-	4	.7	1.6	142	38	7.6	12.5
	DT-9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	DT-10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Beta	-	10	1	-	19	0	52	-	-	10	.1	2.2	190	28	7.2	14

Data taken from:
(ESG 1992, 0740)
(ESG 1983)
(ESG 1980, 0406)
(Apt and Lee 1976, 0617)

Table D-7. Radiochemical Quality of Surface Waters and Groundwaters from On-Site Stations for four representative years.

Year	Station	^{3}H (10^{-6} µCi/mL)	^{137}Cs (10^{-9} µCi/mL)	Total Uranium (µg/L)	^{238}Pu (10^{-9} µCi/mL)	$^{239,240}Pu$ (10^{-9} µCi/mL)	Gross Gamma (counts/min/L)
1990	DT-5A	0.0 (0.3)	81 (71)	0.5 (0.1)	0.000 (0.010)	0.005 (0.010)	-50 (80)
	DT-9	0.3 (0.3)	126 (71)	0.3 (0.1)	0.004 (0.004)	0.000 (0.010)	160 (80)
	DT-10	0.0 (0.3)	172 (88)	0.1 (0.1)	0.008 (0.008)	0.012 (0.009)	800 (100)
	Beta	0.0 (0.3)	76 (94)	0.2 (0.1)	0.000 (0.010)	0.004 (0.009)	300 (80)
1983	DT-5A	1.5 (0.4)	-8 (48)	0.5 (1.0)	0.035 (0.034)	0.005 (0.024)	66 (36)
	DT-9	0.3 (0.2)	-27 (38)	0.0 (1.0)	0.006 (0.028)	0.040 (0.032)	123 (38)
	DT-10	-	-	-	-	-	-
	Beta	1.2 (0.6)	6 (100)	0.5 (0.8)	-	-	58 (36)
1979	DT-5A	0.4 (1.0)	5 (45)	1.6 (1.4)	-0.03 (0.03)	-0.02 (0.04)	-
	DT-9	0.2 (0.6)	-40 (46)	0.9 (0.8)	-0.01 (0.06)	-0.02 (0.04)	-
	DT-10	-0.1 (0.3)	-10 (40)	0.7 (0.8)	0.01 (0.06)	-0.02 (0.06)	-
	Beta	-0.1 (0.8)	10 (80)	0.0 (0.8)	0.01 (0.03)	0.01 (0.04)	-
1975	DT-5A	0.5 (0.8)	-	0.8 (2.1)	0.00 (0.01)	0.00 (0.01)	-
	DT-9	-	-	-	-	-	-
	DT-10	-	-	-	-	-	-
	Beta	1.3 (0.1)	-	0.0 (1.0)	-0.03 (0.04)	0.00 (0.04)	-

Counting uncertainties are in parenthesis.

Data taken from annual Environmental Surveillance Reports.
(ESG 1992, 0740)
(ESG 1983)
(ESG 1980, 0406)
(Apt and Lee 1976, 0617)

Table D-8. Results from the Environmental TLD network at Area G and ten inactive rad-waste MDAs.

Results from the Environmental TLD network at Area G and ten inactive rad-waste MDAs are summarized below. Above normal readings at Areas G and T are located near radioactive materials and wastes that are currently being stored above ground.

The above normal reading at Area W is unexplained. All other readings were at background levels for the Los Alamos environment.

Area X was discontinued from the Environmental TLD network since it is no longer identified as a rad-waste MDA.

Fourth quarter 1991 TLD rad-waste MDA results summary.

Technical Area	MDA	Mean (mrem)	C.V. (%)	Min. (mrem)	Max (mrem)
21	A	30	10	26	34
21	B	26	13	21	31
50	C	26	12	22	33
33	E	27	12	23	30
16	F	24	18	20	28
54	G	41	69	27	170
21	T	31	30	26	50
21	U	25	15	19	28
21	V	25	10	23	29
35	W	49	11	49	49
49	AB	26	3	24	27

Data taken from "Quarterly Report on Environmental Surveillance of Radioactive Waste Material Disposal Areas (MDAs) at LANL" by Keith Jacobson (Mar 25, 1992).

Table D-9. Log of Core Hole 2
Cored by rotary with air for carrier
Total depth of hole 501 feet
Completed November 30,1959
Altitude of land surface 7,137 feet

	Thickness (feet)	Depth (feet)
Bandelier Tuff		
Tshirege Member		
Unit 6:		
Tuff, very light gray to light pinkish gray, pumiceous;very fine grained ashy matrix; quartz crystals are clear with well developed faces and range from very fine grained to large granule size; zenoliths of light red dense igneous rock; pumice fragments up to 3/4 inch in length; limonite stains on fractures; 47.8 feet of core recovered.	78	78
Unit 5		
No recovery, interpretation from gamma ray log.	2	80
Unit 4		
Tuff, very light gray with slight lavender cast; very coarse to granule quartz and feldspar crystal fragments; devitrified pumice fragments up to 1 inch in length; zenoliths of light grayish green dense rock; 40 feet of core recovered.	56	136
Unit 3		
No recovery.	55	191

	Thickness (feet)	Depth (feet)
Unit 2		
Tuff, light purplish gray, dense, welded; quartz and sanidine crystals up to granule size; devitrified pumices up to 1/2 inch in length; zenoliths of dark gray rock fragments up to 1/2 inch in length; 67.9 feet of core recovered.	101	292

Table D-9 continued.

Unit 1B		
Tuff, light pinkish gray, pumiceous; quartz and sanidine crystals up to granule size; devitrified pumice 3/4 inch in length and 3/8 inch wide; 3.8 feet of core recovered.	195	487
Unit 1A		
No recovery	14	501

Correlation based on recovered core and gamma-ray logs

Data from Weir and Purtymun 1962.
(Weir and Purtymun 1962, 0228)

Table D-10. Sample log of Beta hole

Drilled by rotary bucket
Total depth 180 feet
Completed February 25,1960
Altitude of land surface 6,801 feet

	Thickness (feet)	Depth (feet)
Recent alluvium	8	8
Bandelier Tuff		
Tshirege Member		
Unit 1B:		
Tuff, light pinkish-tan to light-gray, pumiceous, friable; quartz and sanidine fragments and crystals up to granule size; mafic mineral stains and some mafic minerals; devitrified pumice fragments up to 1/2 inch in length; light yellowish pumice; gray glassy pumice; dark gray pumice fragments; samples from 61 to 81 feet are light red. Samples from 105 to 180 feet contain brown nodules of clay up to 6 inches in length; these appear to be large pumice fragments that altered to clay; the clay appears platy in places and near edge grades into highly altered cellular pumice; some gray rhyolite and light red latite fragments are found in this interval		
Drilling stopped at 180 feet in a rhyolite and latite tuff breccia, edges of fragments subrounded; ground mass a light brownish tan, pumiceous, friable tuff	172	180

Data from Weir and Purtymun 1962, 0228.

Table D-11. Sample log of Alpha hole
Drilled by rotary bucket
Total depth 189 feet; diameter 2 feet
Completed February 6,1960
Altitude of land surface 7,125 feet

	Thickness (feet)	Depth (feet)
Bandelier Tuff		
Tshirege Member		
Unit 6:		
Tuff, light-gray, moderately welded; contains fine to medium-size quartz and sanidine crystals and fragments; yellowish-tan to gray pumice and gray devitrified pumice fragments; light-red latite and gray rhyolite rock fragments in a fine-grained light-gray ash matrix. Hard layer was encountered at 54 feet	76	76
Unit 5:		
Sand, light-gray, friable; fine to coarse-size quartz and sanidine fragments subrounded; quartz has coating of yellow weathering stain; fragments of tuff and pumice	2	78
Unit 4:		
Tuff, light-gray; medium to coarse quartz and sanidine crystals and fragments; gray devitrified pumice; light-gray rhyolite fragments, subrounded; friable zone 78 to 85 feet; moderately welded 85 to 128 feet	50	128
Unit 3:		
Tuff, light-gray, friable; medium size quartz and sanidine crystals and fragments; gray and white devitrified pumice fragments up to 1/2 inch in length; gray rhyolite fragments, pebble size; coating of yellow weathering stain around quartz fragments; large amount of very light-gray pumice; samples from 166 to 189 feet are pinkish-gray and moderately welded	61	189

Data from Weir and Purtymun 1962, 0228.

Table D-12. Sample log of well DT-5A
Drilled by rotary with mud for carrier
Total depth 1,821 feet
Completed pilot hole January 25,1960
Altitude of land surface 7,143.78 feet

	Thickness (feet)	Depth (feet)
Bandelier Tuff		
Tshirege Member:		
Sidewall cores from hole DT-5A:		
Unit 1B		
Tuff, light pinkish-gray, highly friable; greenish glass shards; rhyolite rock fragments.		370
Unit 1A		
Tuff, light-gray to light-tan, pumiceous.		490
Tuff, light-gray to pinkish gray, pumiceous, apparently friable.		500
No samples recovered due to lack of circulation.	520	520
Unit 1A		
Tuff, light gray to pinkish gray; quartz and sanidine crystals and fragments; mafic minerals in fine grained ash matrix; light yellowish gray pumice with cellular structure; light red rhyolite rock fragments occur from 560 to 641 feet; light gray rhyolite rock fragments occur from 580 to 641 feet ; fragments of light gray siltstone occur from 610 to 615 feet.	121+	641
Otowi Member		
Tuff, light gray, pumiceous; quartz and sanidine crystals and fragments with minor amounts of mafic minerals in a fine grained ash matrix. Light red and dark gray rhyolite; light red and dark gray latite; white to light gray pumice fragments throughout member.	198	839
Guaje Member		
Pumice, light gray, contains some rhyolite and latite rock fragments.	91	930

Table D-12 continued

	Thickness (feet)	Depth (feet)
Santa Fe Group		
Puye Conglomerate		
Fangolomerate member		
Conglomerate composed of rhyolite, latites, andesite(?), and light colored igneous debris. Other rock fragments include light red sandstone, pumice, and light tan clays. Some gravels appear well rounded	237	1,167
Tschicoma Formation		
Undifferentiated latite and quartz latite:		
Lattite flow rock, light-gray to dark-gray; interflows of greenish-gray siltstone, rhyolite, and tuff fragments and clays occur from 1,221 to 1,225 feet and from 1,259 to 1,264 feet	126	1,293
Santa Fe Group		
Puye Conglomerate		
Fanglomerate member:		
Conglomerate composed of rhyolite, latites, andesites(?) and light colored igneous debris. Other rock fragments include light gray and greenish-grey sandstone. Some fragments appear well rounded. Light-Gray ash containing some of the above rock fragments occurs from 1,415 to1,431 feet	138	1,431
Tschicoma Formation		
Undifferentiated latite and quartz latite:		
Latite flow rock, dark-gray, some of appears glassy	26	1,457
Santa Fe Group		
Puye Conglomerate		
Fanglomerate member:		
Conglomerate consisting of rhyolite, latite, and other igneous debris; light-gray sandstone and brown clay	18	1,475

Table D-12 continued

	Thickness (feet)	Depth (feet)
Totavi Lentil:		
Conglomerate composed of bull quartz, quartzite, and much granitic debris. Also abundant volcanic rock debris; gray and brown sandstone fragments	52	1,527
Undifferentiated unit:		
Siltstone and snadstone, light-pinkish-gray, yellow and brown with lenses of conglomerate; arkosic is some zones but containing much volcanic debris. Light-gray and brown siltstones occur from 1,555 to 1,580 feet; pumiceous zones from 1,585 to 1,595 feet and 1,760 to 1,780 feet. Cuttings are finer from 1,775 to 1,820 feet	294	1,821

From Weir and Purtymun, 1962.
(Weir and Purtymun 1962, 0228)

Radiochemical and chemical analyses of water from deep test wells at

TA-49, Los Alamos County, N. Mex.

Results in parts per million and equivalents per million except as otherwise noted.

	Well DT-5A		Well DT-9		Well DT-10			
Analysis No.	3681		3688		3684[a]		4574	
Date of collection:	5-1-60		5-7-60		5-5-60		9-22-60	
Chemical components								
	ppm	epm	ppm	epm	ppm	epm	ppm	epm
SiO_2	76	-	69	-	65	-	65	-
Al	.2	-	.2	-	.1	-	-	-
Fe	.21	-	.4	-	.00	-	.01	-
Mn	.00	-	.00	-	.00	-	-	-
Ca	8.8	0.439	12	0.599	12	0.599	12	0.60
Mg	2.9	.238	1.2	.099	2.9	.238	2.9	.24
Na	14	.609	12	.522	11	.478	12	.52
K	1.8	.046	1.2	.031	1.2	.031	-	-
Cations (epm)	-	1.332	-	1.251	-	1.346	-	-
HCO_3	68	1.115	68	1.115	80	1.311	78	1.28
CO_3	0	.000	0	.000	0	.000	0	.00
SO_4	8.7	.181	3.7	.077	3.7	.077	-	-
Cl	.5	.014	2.0	.056	2.2	.062	-	-
F	.2	.011	.3	.016	.2	.011	.2	.01
NO_3	2.0	.032	.0	.000	1.0	.016	-	-
PO_4	.00	-	.28	-	.21	-	-	-
Anions (epm)	-	1.353	-	1.264	-	1.477	-	-
Difference:								
Cations - anions (epm)	-	-.021	-	-.013	-	-0.31	-	-

Physical characteristics and computed values

	Well DT-5A	Well DT-9	Well DT-10	
Dissolved solids (ppm)				
Res. on evap. at 180°C	147	136	138	-
Calculated	148	134	138	-
Suspended solids (ppm)				
Hardness as $CaCO_3$ (ppm)	34	35	42	42
Non-carbonate	0	0	0	0
Specific conductance				
(micromhos at 25°C)	132	125	135	131
pH	7.6	7.5	7.3	7.7
Color	0	0	0	-

Radiochemical data

	Well DT-5A	Well DT-9	Well DT-10
Alpha activity (μμc/l)	< 1.3	1.4 ± 0.7	< 0.8
as of	6-28-60	6-30-60	6-29-60
Beta activity (μμc/l)	7.3 ± 1.1	3.6 ± 0.5	8.7 ± 1.3
as of	6-20-60	6-21-60	6-21-60
Radium (Ra) (μμc/l)	< 0.1	0.1 ± 0.1	0.1 ± 0.1
Uranium (U) (μg/l)	0.9 ± 0.1	0.8 ± 0.1	1.0 ± 0.1

a/ Bailed.

Table D-13. Radiochemical and Chemical Analysis of Water from Deep Test Wells at TA-49. (Weir and Purtymun 1962, 0228)

Chemical analyses of the Tshirege member, Bandelier tuff at TA-49, Los Alamos County, N. Mex.

Hole designation	Depth (feet)	Stratigraphic unit	Constituents													Sum
			SiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O	K_2O	H_2O	TiO_2	P_2O_5	MnO	CO_2	
CH-1	38-40	Qbt_6	72.7	13.5	2.0	0.50	0.33	1.0	4.5	4.5	0.55	0.32	0.07	0.08	<0.05	100
CH-1[1]	38-40	Qbt_6	73.71	13.53	1.77	.75	.16	1.17	4.50[2]	4.49[2]	.11[3] .18	.14	.01	.01	-	100.52
2-H	30	Qbt_6	72.0	13.5	2.1	.24	.28	.67	3.7	4.3	2.8	.26	.06	.06	< .05	100
2-H	58	Qbt_6	73.6	13.1	1.9	.25	.32	.51	3.9	4.6	1.3	.26	.06	.06	< .05	100
2-U	52	Qbt_6	75.6	12.7	1.2	.34	.12	.59	4.0	4.6	.46	.18	.05	.04	< .05	100
2-Y	78	Qbt_5	78.2	11.2	1.4	.36	.12	.30	3.5	4.2	.32	.17	.03	.04	< .05	100
CH-2	130-132	Qbt_4	77.2	12.0	1.1	.28	.04	.41	4.1	4.4	.28	.14	.02	.06	< .05	100
3-C	58	Qbt_6	74.6	12.8	1.7	.21	.12	.53	4.2	4.7	.75	.22	.05	.06	< .05	100
3-Y	105	Qbt_4	74.8	12.7	1.5	.28	.16	.66	4.1	4.7	.51	.22	.04	.06	< .05	100
3-Y[1]	105	Qbt_4	74.78	12.51	1.50	.38	.04	.87	4.12[2]	4.70[2]	.41[3] .15	.21	-	.00	-	99.67
CH-3	46.5	Qbt_6	72.6	13.8	1.9	.48	.20	.61	4.3	4.5	1.2	.27	.06	.07	< .05	99.99
4-A	85	Qbt_4	77.0	12.1	1.2	.23	.02	.26	4.0	4.6	.44	.10	.02	.04	< .05	100
4-Y	78	Qbt_4	76.5	12.4	1.2	.25	.05	.26	4.2	4.6	.29	.14	.02	.06	< .05	100
CH-4	83	Qbt_4	76.6	12.4	1.2	.29	.09	.29	4.2	4.5	.42	.13	.02	.08	< .05	100.22

Except as otherwise noted, samples were analyzed by rapid methods similar to those described in USGS Bulletin 1036-C.

Analysts: Paul L. D. Elmore, Samuel D. Botts, Ivan H. Barlow, and Gillison Chloe.

1/ Rock analysis done by classical or conventional methods as described by Hillebrand (1900). Analyst: M. K. Carron.

2/ Determined by flame photometer by W. W. Brannock.

3/ Upper figure for H_2O^+, lower figure for H_2O^-. The H_2O^+ quantity for sample from hole 3-Y at 105 feet determined from loss on ignition minus H_2O^-.

Table D-14. Chemical Analyses of the Tshirege Member of the Bandelier Tuff at TA-49. (Weir and Purtymun 1962, 0228)

Results of semiquantitative spectrographic analyses of the Tshirege member of the Bandelier tuff at TA-49, Los Alamos County, N. Mex.

Hole designation	Strati-graphic unit in Tshirege member	Depth (feet)	Si	Al	Fe	Mg	Ca	Na	K	Ti	Mn	Ba	Be	Ce	Co	Cr	Cu	Ga	La	Mo	Nb	Nd	Ni	Pb	Sc	Sn	Sr	V	Y	Yb	Zr
			Constituents (percent)																												
CH-1	Qbt_6	38-40	M	M	1.5	0.3	0.7	3	3	0.15	0.07	0.07	0.00015	0.015	0.0003	0.0007	0.0007	0.003	0.007	d	0.003	0.007	0.0003	0.003	0.0007	0	0.015	0.0015	0.003	0.0003	0.03
2-M	Qbt_6	30	M	M	1.5	.3	.7	3	3	.15	.03	.03	.0003	.015	.0003	.0015	.0007	.003	.007	d	.003	.007	.0007	.003	.0007	d	.007	.0015	.003	.0003	.03
2-N	Qbt_6	58	M	M	1.5	.15	.3	3	3	.15	.03	.03	.0003	.015	0	.0007	.0003	.003	.007	d	.003	.007	.0003	.003	.0007	d	.007	.0015	.003	.0003	.03
2-U	Qbt_6	52	M	M	1.5	.07	.3	3	3	.15	.03	.03	.00015	.015	0	.0007	.0003	.003	.007	d	.003	.007	0	.003	0	0	.007	.0007	.003	.0003	.03
2-T	Qbt_5	78	M	7	1.5	.07	.15	3	3	.07	.03	.015	.0003	.015	0	.00015	.0003	.0015	.015	d	.007	.007	0	.003	0	0	.003	.0007	.007	.0007	.05
CH-2	Qbt_4	130-132	M	M	.7	.07	.3	3	3	.07	.07	.015	.0003	d	0	.00015	.00015	.003	.003	0	.003	0	0	.0015	0	0	.003	0	.003	.0003	.015
3-C	Qbt_6	58	M	M	1.5	.15	.3	3	3	.15	.03	.03	.0003	.05	0	.0007	.0003	.0015	.015	d	.003	.015	.0003	.003	.0007	d	.007	.0007	.007	.0007	.03
3-T	Qbt_4	105	M	M	1.5	.15	.3	3	3	.15	.03	.03	.0003	.015	0	.0003	.0003	.003	.007	d	.003	.007	.0003	.007	d	d	.007	.0007	.003	.0003	.03
4-A	Qbt_4	85	M	7	.7	.03	.15	3	3	.07	.03	.015	.0003	.015	0	d	.00015	.003	.007	d	.003	d	0	.003	0	0	.003	0	.003	.0003	.03
4-Y	Qbt_4	78	M	M	.7	.07	.3	3	3	.07	.03	.015	.0003	.015	0	d	.0003	.003	.007	0	.003	.007	0	.0015	0	d	.003	0	.003	.0003	.03

Analyst: R. G. Havens

Symbols used: M - Major constituent; i.e. greater than 10 percent.

0 - Constituent analyzed but not found.

d - Constituent barely detectible, concentration uncertain.

The following constituents were analyzed but not found: P, Ag, As, Au, B, Bi, Cd, Dy, Er, Eu, Gd, Ge, Hf, Hg, Ho, In, Ir, Li, Lu, Os, Pd, Pr, Pt, Re, Rh, Ru, Sb, Sm, Ta, Tb, Te, Th, Tl, Tm, U, W, Zn.

Approximate visual detection limits (Revised August 1956) for the elements determined by the semiquantitative spectrographic methods

Element	Percent	Element	Percent	Element	Percent	Element	Percent	Element	Percent	Element	Percent	Element	Percent	Element	Percent
Si	0.002	Al	0.001	Fe	0.0008	Mg	0.0005	Ca	0.005	Na 1/	0.05 (0.0005)	K 1/	0.7 (0.002)	Ti	0.000.
P	.2	Mn	.0002	Ag	.0001	As 1/	.1 (.01)	Au	.002	B	.002	Ba	.0002	Be	.0001
Bi	.001	Cd	.005	Ce	.02	Co	.0005	Cr	.0001	Cs 1/	2 (0.02)	Cu	.0001	Dy	.005
Er	.005	Eu	.05	Ga	.0002	Gd	.005	Ge	.001	Hf	.01	Hg 1/	1 (0.002)	Ho	.01
In	.001	Ir	.01	La	.002	Li 1/	.02 (0.00006)	Lu	.01	Mo	.0005	Nb	.001	Nd	.01
Ni	.0003	Os	.01	Pb	.001	Pd	.0003	Pr	.05	Pt	.003	Rb 1/	10. (0.006)	Re	.005
Rh	.005	Ru	.01	Sb	.01	Sc	.0005	Sn	.001	Sr	.0002	Sm	.01	Ta	.02
Tb	.1	Te 1/	.1 (.01)	Th	.02	Tl	.01	Tm	.01	U	.05	V	.001	W	.01
Y	.001	Yb	.0005	Zn	.02	Zr	.001								

1/ A different exposure is required for the detectabilities shown in parentheses.

Note: Some combinations of elements affect the detectabilities. Approximate values are given. In unusually favorable materials, concentrations somewhat lower than the values given may be detected. In unfavorable materials the given detectabilities may not be attained for some of the elements.

Table D-15. Results of Semiquantitative Spectrographic Analyses of the Tshirege Member of the Bandelier Tuff at TA-49. (Weir and Purtymun 1962, 0228)

Table D-16. Results of Hydrologic Laboratory Analyses of the Tshirege Member of the Bandelier Tuff at TA-49 (Weir and Purtymun 1962, 0228)

Table 17.—Results of hydrologic laboratory analyses of the Tshirege member of the Bandelier tuff at TA-49, Los Alamos County, N. Mex.

Laboratory sample No.	Field No.	Strati-graphic unit	Depth (feet)	Approxi-mate pH	Moisture content dry weight (percent)	Moisture content volume (percent)	Specific gravity	Dry unit weight (g per cc)	Specific retention (percent)	Porosity (percent)	Specific yield (percent)	Coefficient of permeability (gpd per square foot)
60-BM 11[c]	CH-1	Qbt_6	15	7.5			2.57	1.19	19.2	53.7	34.5	2
15[c]	CH-3	Qbt_6	20		1.5	1.9	2.58	1.24	27.3	51.9	24.6	.1
59-BM 197	2-W	Qbt_6	30		.6	.8	2.57	1.28	16.3	50.2	33.9	3
197[h]	2-W	Qbt_6	30		-	-	-	-	-	-	-	[a]3
60-BM 6	2-O	Qbt_6	30		1.0	1.1	2.58	1.17	16.2	54.7	38.5	6
6[h]	2-O	Qbt_6	30		-	-	-	-	-	-	-	[a]5
7	1-A	Qbt_6	30		.6	.8	2.58	1.26	17.7	51.2	33.5	4
7[h]	1-A	Qbt_6	30		-	-	-	-	-	-	-	[a]4
21	3-A	Qbt_6	30	7.8	3.9	4.7	2.58	1.21	23.0	55.1	30.1	.9
21[h]	3-A	Qbt_6	30									[a].2
18[c]	CH-4	Qbt_6	33	7.8			2.57	1.31	20.5	49.0	28.5	1
1	4-U	Qbt_6	40				2.53	1.35	20.0	46.6	26.6	2
1[h]	4-U	Qbt_6	40									[a]2
59-BM 196	2-D	Qbt_6	55		2.0	3.0	2.56	1.50	16.8	41.4	24.6	.1
196[h]	2-D	Qbt_6	55									[a]2
60-BM 9	2-F	Qbt_6	56		1.9	2.6	2.57	1.38	15.4	46.3	30.9	4
9[h]	2-F	Qbt_6	56									[a]3
8	1-A	Qbt_6	58		3.0	4.7	2.55	1.58	19.8	38.0	18.2	.9
8[h]	1-A	Qbt_6	58									[a]1
22	3-A	Qbt_6	58		.8	1.2	2.57	1.48	19.5	42.4	22.9	1
22[h]	3-A	Qbt_6	58									[a].8
2	4-U	Qbt_6	60				2.58	1.26	17.9	51.2	33.3	1
59-BM 198	4-A	Qbt_6	64		6.6	8.7	2.57	1.32	24.6	48.6	24.0	.9
198[h]	4-A	Qbt_5	64									[a]2
60-BM 10	4-U	Qbt_5	61				2.55	1.57				[b]59
59-BM 199	4-A	Qbt_5	66				2.58	1.47				[b]34
60-BM 3	4-U	Qbt_4	67		.3	.4	2.56	1.17	11.7	54.3	42.6	13
3[h]	4-U	Qbt_4	67									[a]13
5	4-U	Qbt_4	82		.3	.4	2.57	1.33	14.7	48.2	33.5	4
5[h]	4-U	Qbt_4	82									[a]4
23	3-A	Qbt_4	88	7.7	.5	.7	2.57	1.33	11.6	48.2	36.6	5
23[h]	3-A	Qbt_4	88									[a]8
4	4-U	Qbt_4	104		1.3	2.2	2.54	1.71	21.8	32.7	10.9	.3
4[h]	4-U	Qbt_4	104									[a].4
29	Alpha	Qbt_3	135	7.9	2.2	2.9	2.56	1.32	14.2	48.4	34.2	22
28	Alpha	Qbt_3	175		.2	.3						
16[c]	CH-3	Qbt_2	195		.1	.2	2.54	1.59	11.3	37.4	26.1	2
13[c]	CH-2	Qbt_2	197				2.55	1.83	12.3	28.2	15.9	.2
19[c]	CH-4	Qbt_2	202		.1	.2	2.54	2.05	17.3	19.5	2.0	.04
17[c]	CH-3	Qbt_2	203		.1	.2	2.55	2.02	20.2	20.8	.6	.08
31[c]	CH-2	Qbt_2	235		.1	.2	2.57	1.84	20.8	28.4	7.6	.2
12[c]	CH-1	Qbt_2	265	7.7			2.56	1.85	14.4			.2
14[c]	CH-2	Qbt_2	270				2.55	1.84	13.9	27.8	13.9	.3
20[c]	CH-4	Qbt_2	274	7.7	.1	.2	2.56	1.81	17.2	29.3	12.1	.2
32[c]	CH-2	Qbt_{1B}	295	7.9	.1	.2	2.56	1.81	17.3	29.3	12.0	.2
24	Beta	Qbt_{1B}	10		22.9	27.0						
25	Beta	Qbt_{1B}	65		14.1	13.3						
30	Beta	Qbt_{1B}	105		17.8		2.32					
26	Beta	Qbt_{1B}	135	7.7	43.2	36.3						[b]50
27	Beta	Qbt_{1B}	180		16.5	17.3						

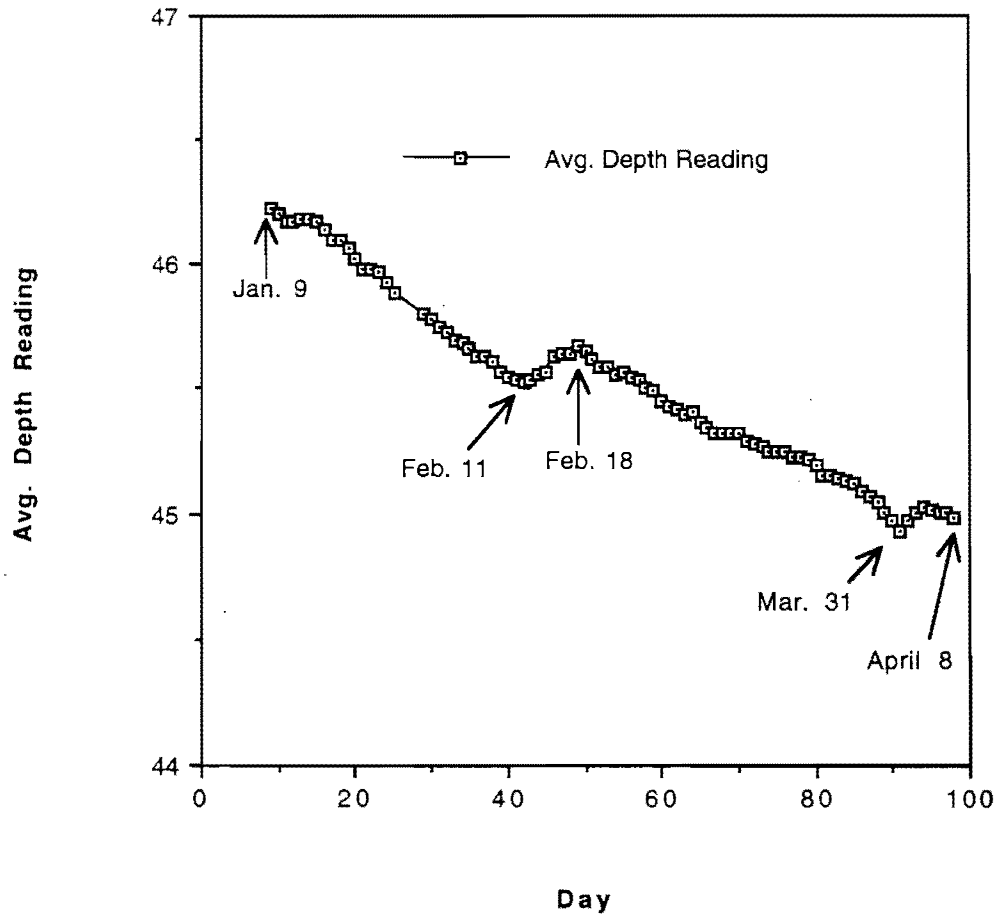
a Horizontal permeability parallel to axes of 6-inch sidewall cores.

b Repacked samples

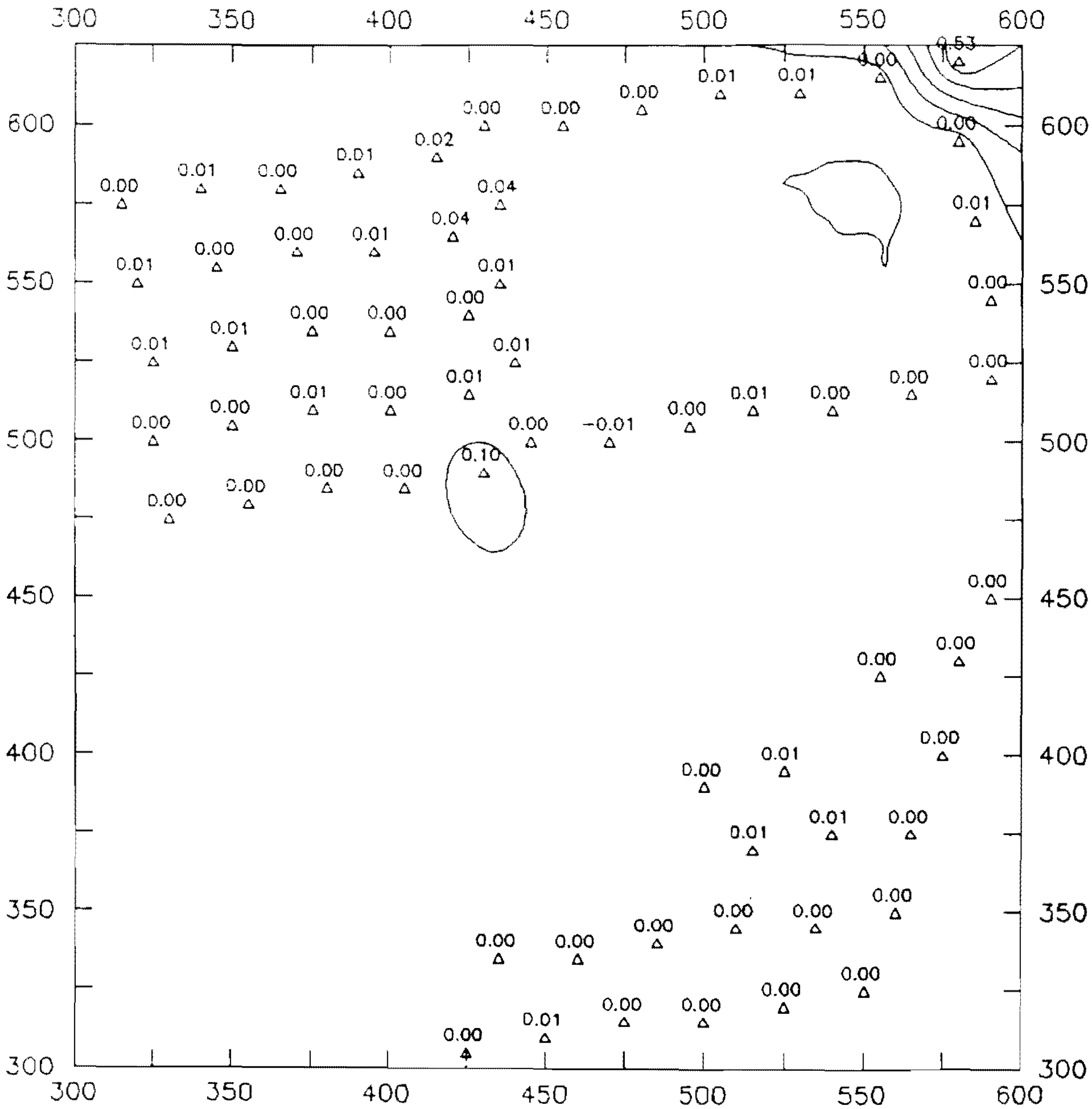
c Vertical cores

h Horizontal cores cut from larger samples

Figure D-1. Core Hole 2 Transducer Readings. 9 Jan - 8 April 1992.



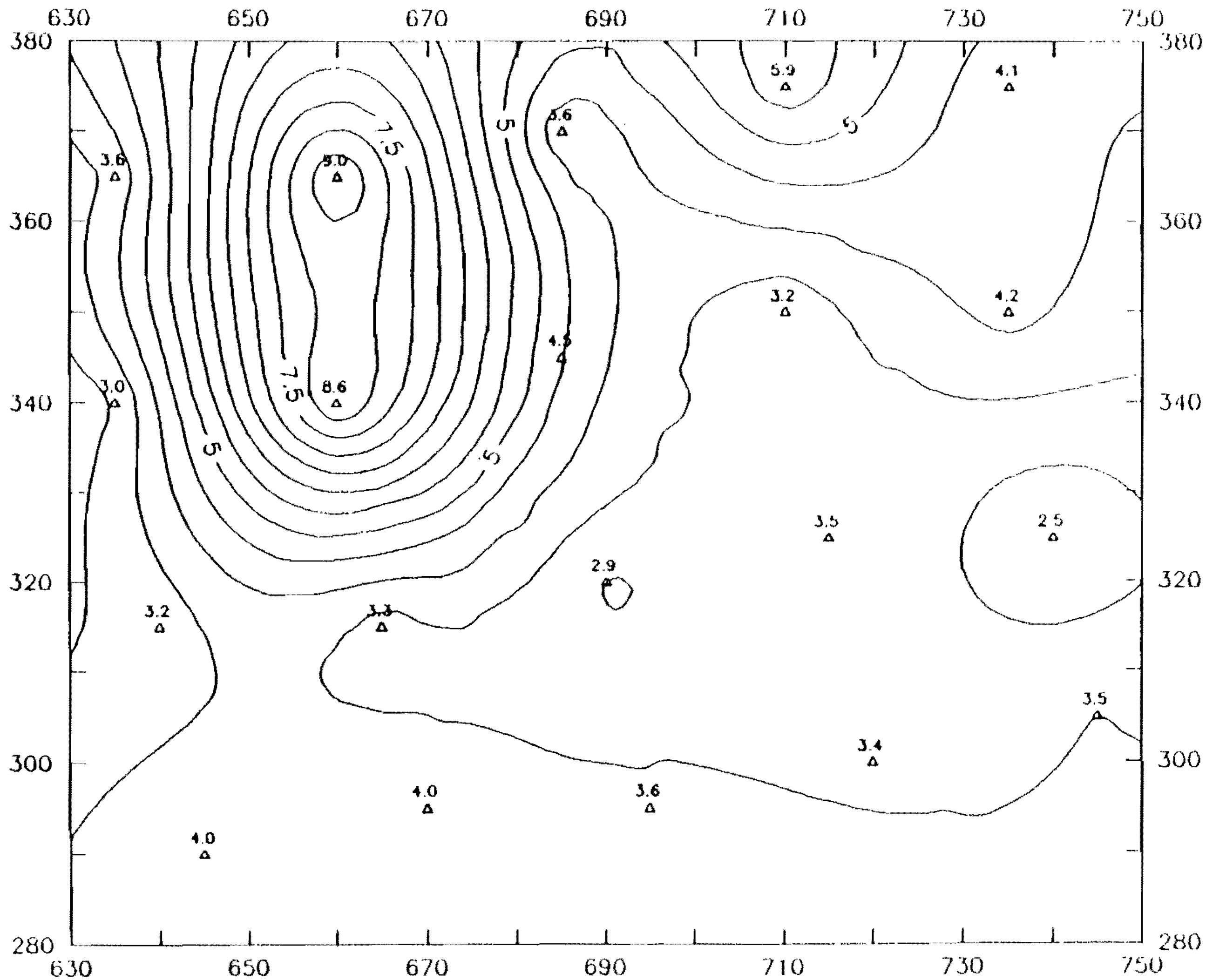
From unpublished EM-8 data.



Plutonium-238 (pCi/g) in soil from Areas 2, 2A, and 2B. Grid units are in feet relative to New Mexico State plane coordinates E485 000 and N1 755 000.

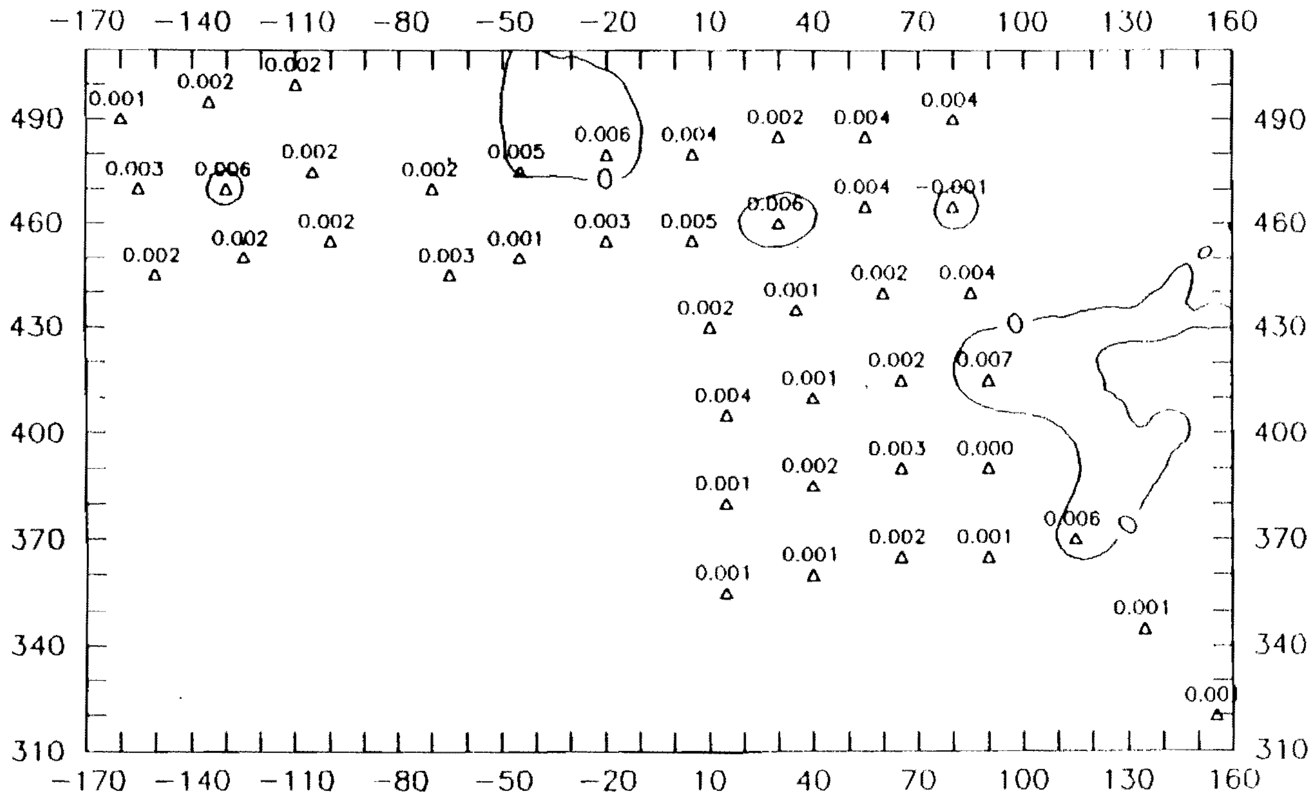
Figure D-2. Plutonium-238 in Soil from Areas 2, 2A, and 2B. (Soholt 1990, 0698)

Figure D-3. Uranium in Soil from Area 11. (Soholt 1990, 0698)



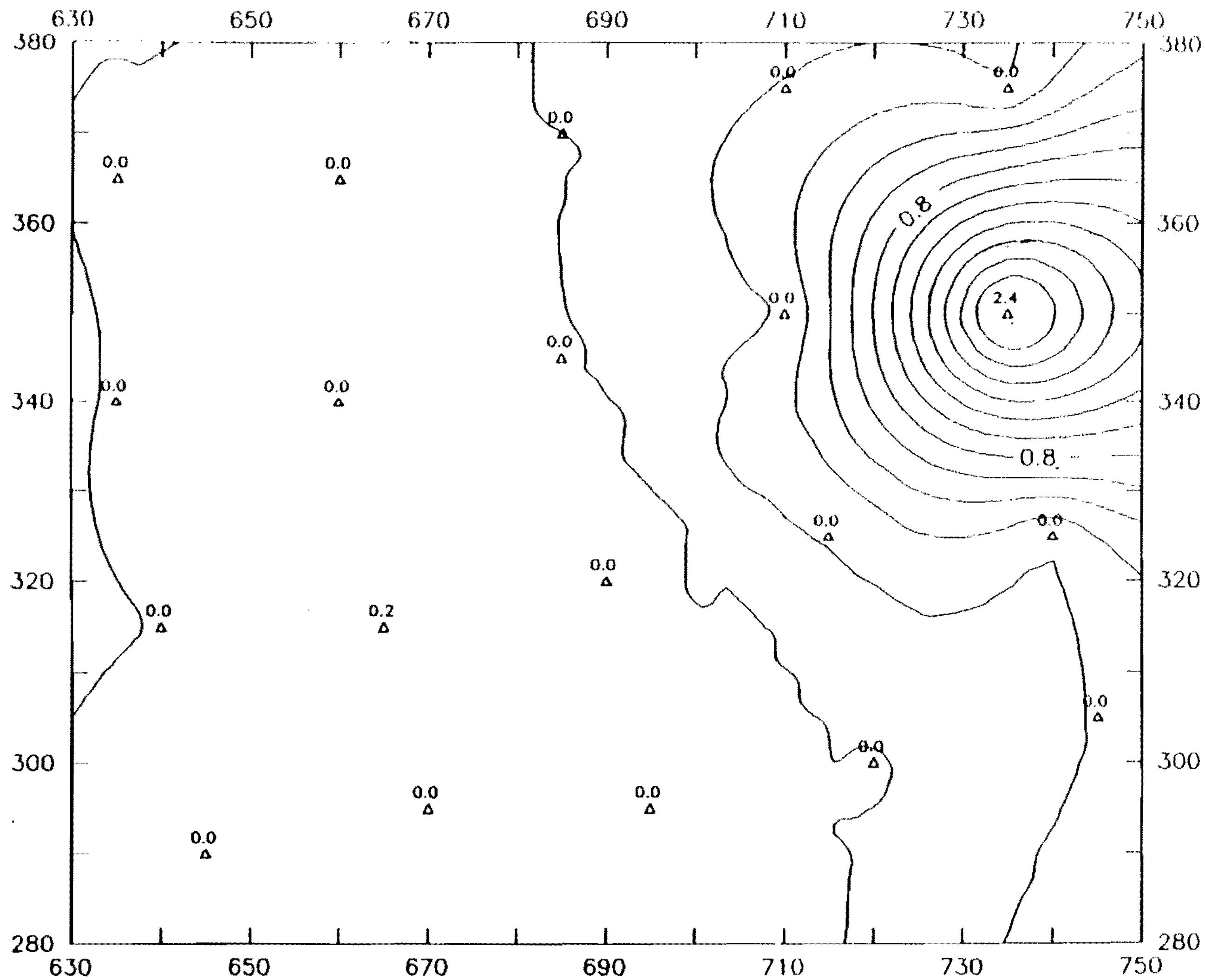
Uranium (µg/g) in soil from Area 11. Grid units are in feet relative to New Mexico State plane coordinates E484 000 and N1 755 000.

Figure D-4. Plutonium-238 in Soil from Area 3. (Soholt 1990, 0698)

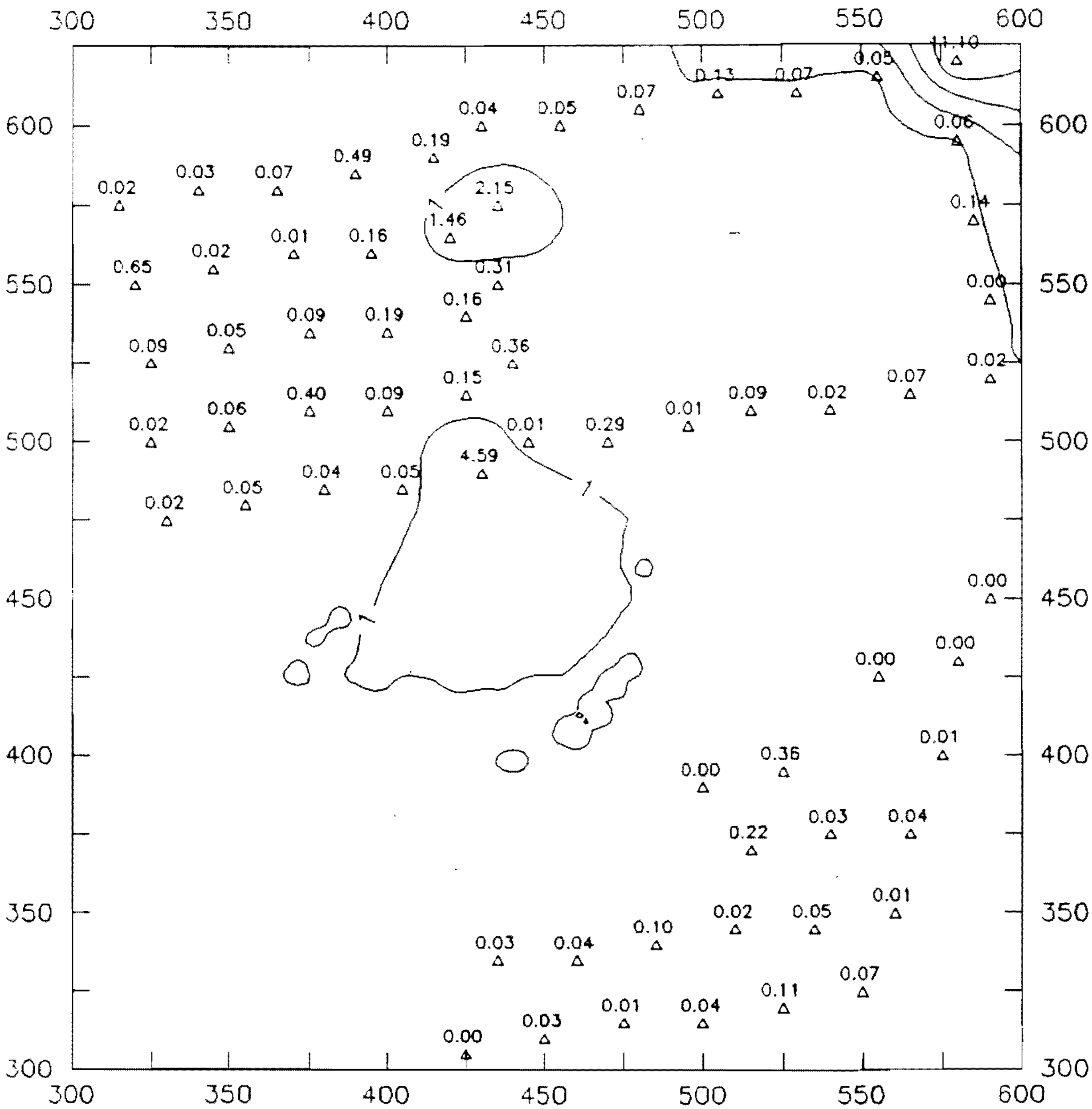


Plutonium-238 (pCi/g) in soil from Area 3. Grid units are in feet relative to New Mexico State plane coordinates E485 000 and N1 755 000.

Figure D-5. Plutonium-238 in Soil from Area 11. (Soholt 1990, 0698)

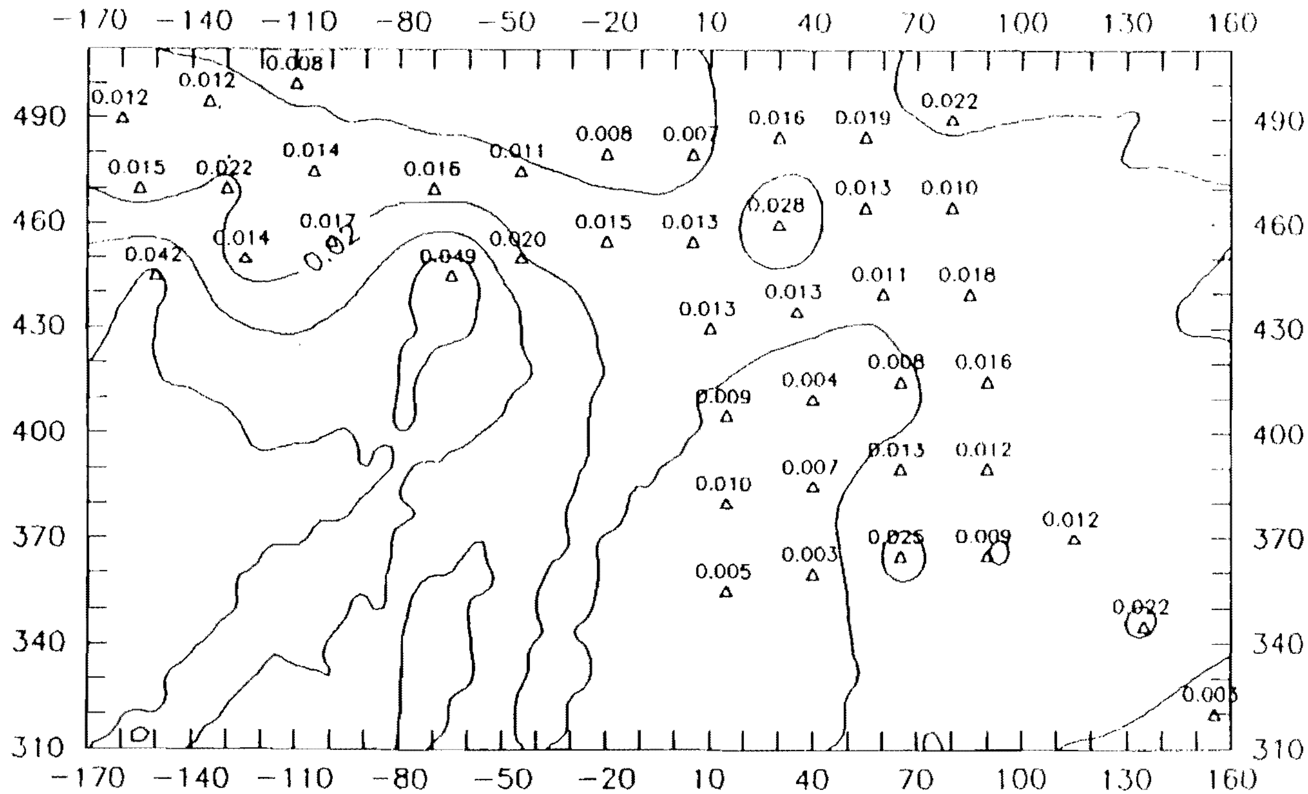


Plutonium-238 (pCi/g) in soil from Area 11. Grid units are in feet relative to New Mexico State plane coordinates E484 000 and N1 755 000.



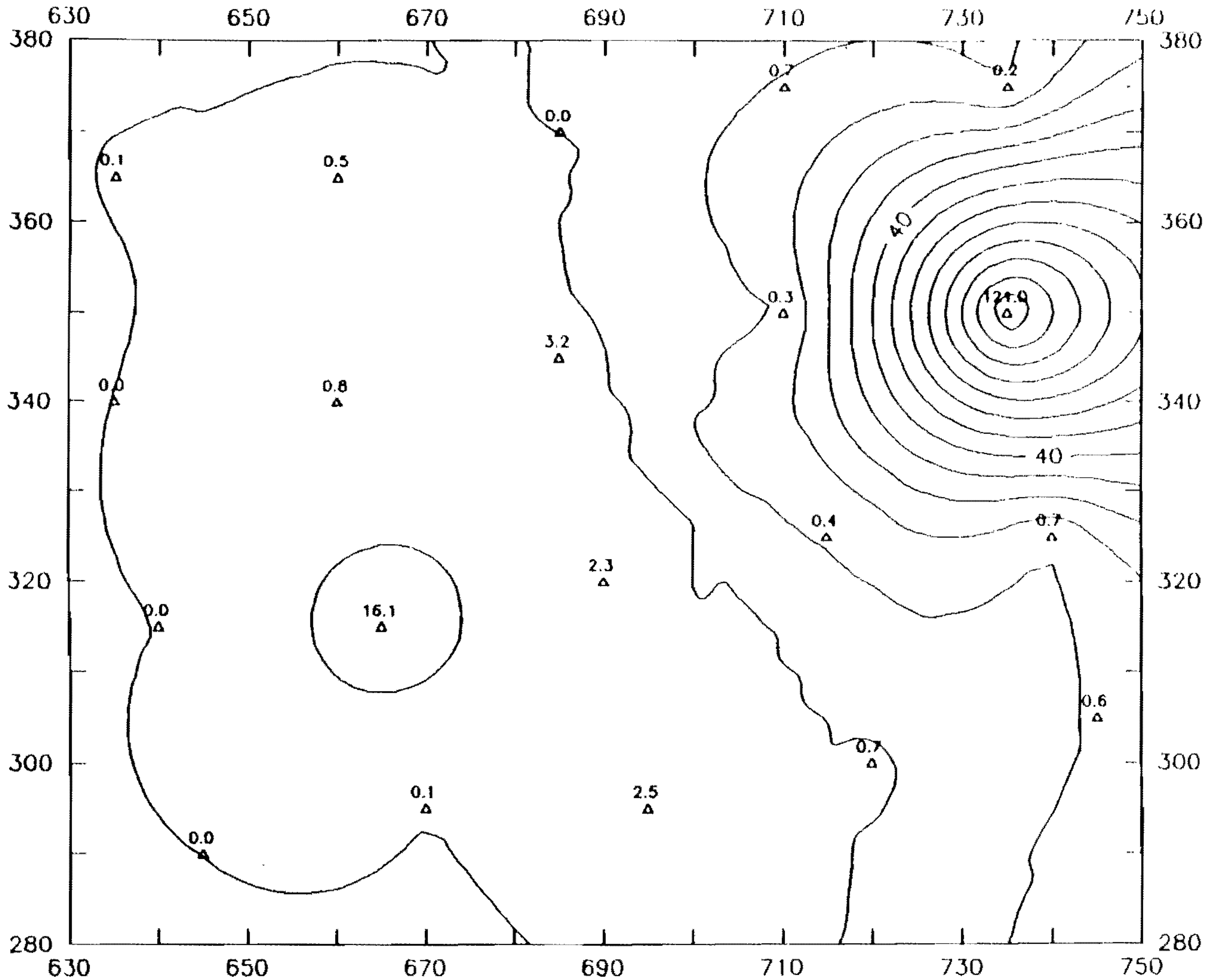
Plutonium-239 (pCi/g) from Areas 2, 2A, and 2B. Grid units are in feet relative to New Mexico State plane coordinates E485 000 and N1 755 000.

Figure D-6. Plutonium-239 from Areas 2, 2A, and 2B. (Soholt 1990, 0698)



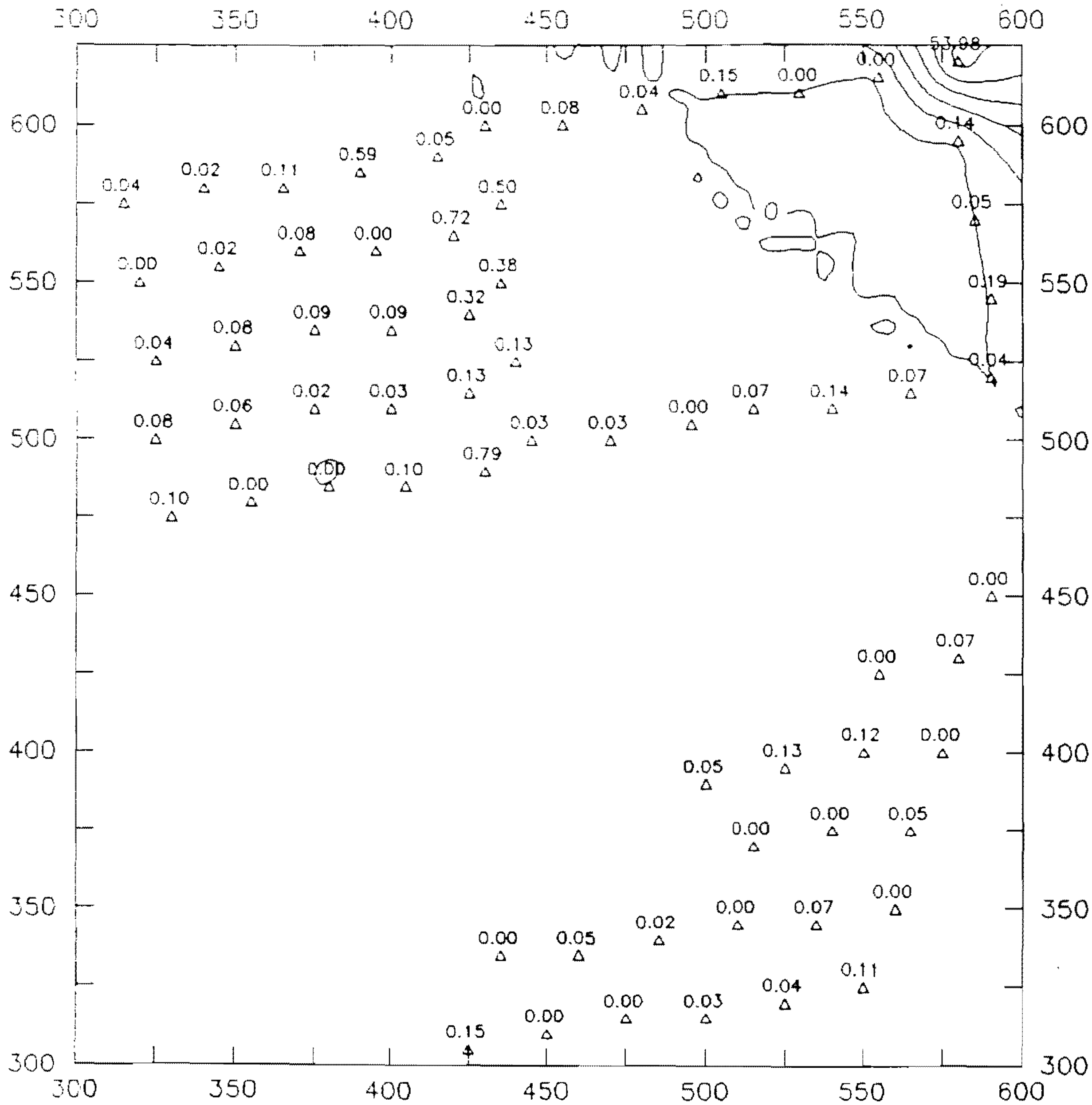
Plutonium-239 (pCi/g) from Area 3. Grid units are in feet relative to New Mexico State plane coordinates E485 000 and N1 755 000.

Figure D-7. Plutonium-239 from Area 3. (Soholt 1990, 0698)



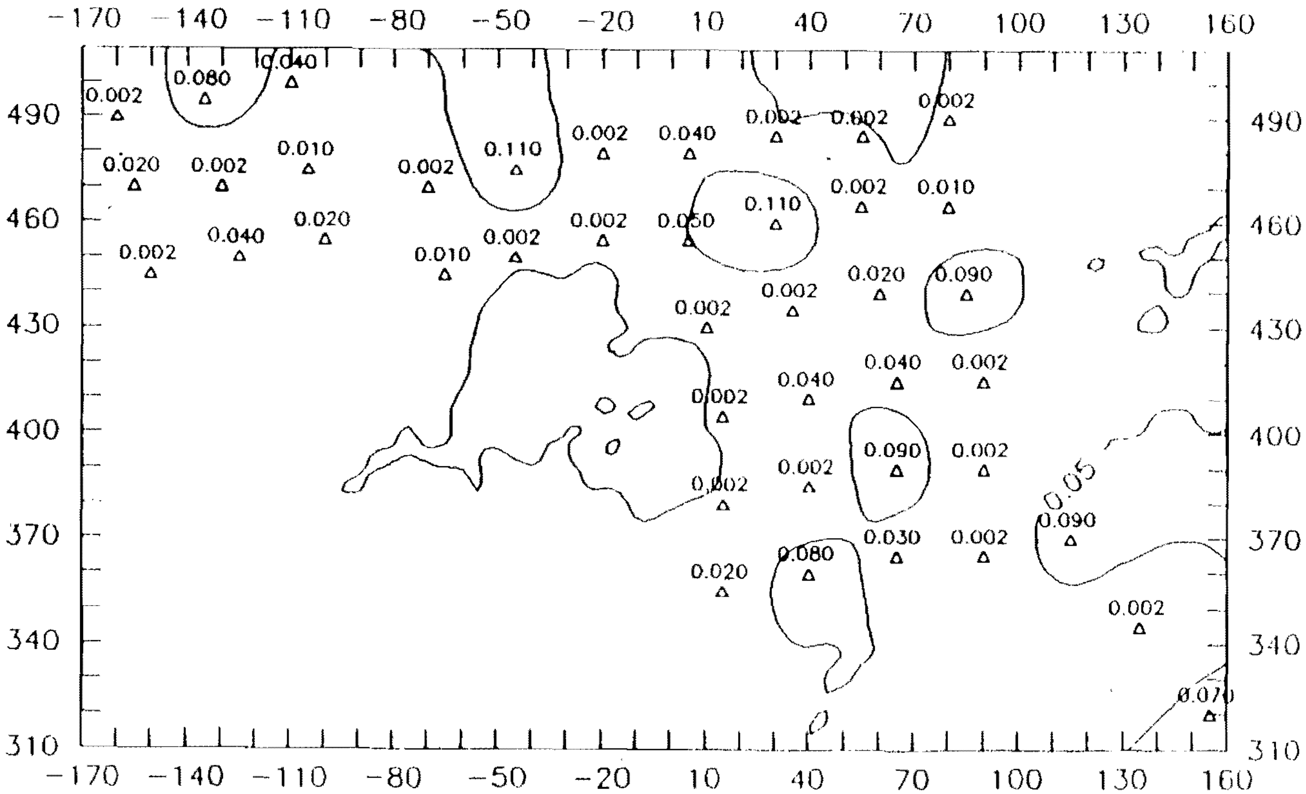
Plutonium-239 (pCi/g) in soil from Area 11. Grid units are in feet relative to New Mexico State plane coordinates E484 000 and N1 755 000.

Figure D-8. Plutonium-239 in Soil from Area 11. (Soholt 1990, 0698)



Americium-241 (pCi/g) in soil from Areas 2, 2A, and 2B. Grid units are in feet relative to New Mexico State plane coordinates E485 000 and N1 755 000.

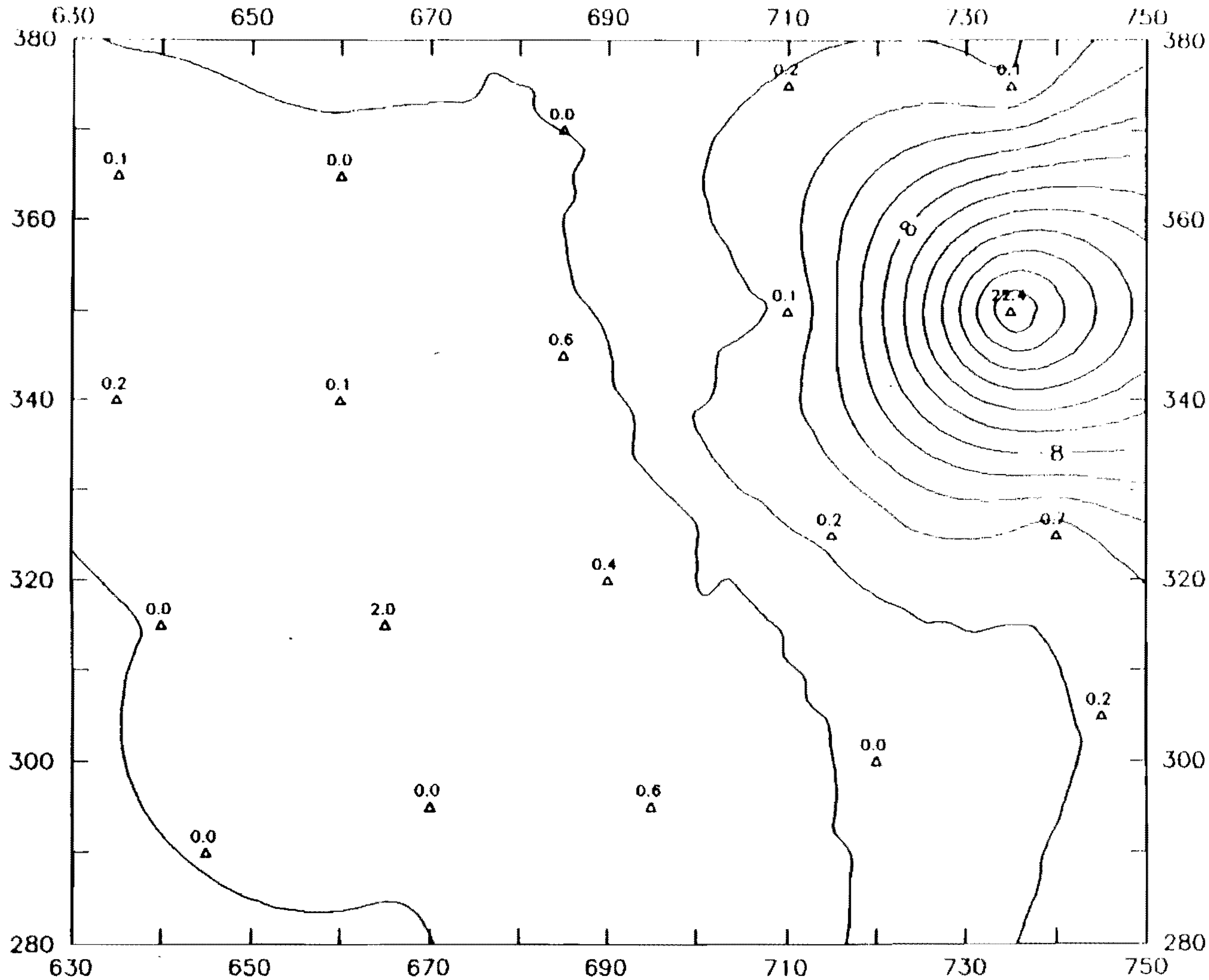
Figure D-9. Americium-241 in Soil from Areas 2, 2A, and 2B. (Soholt 1990, 0698)



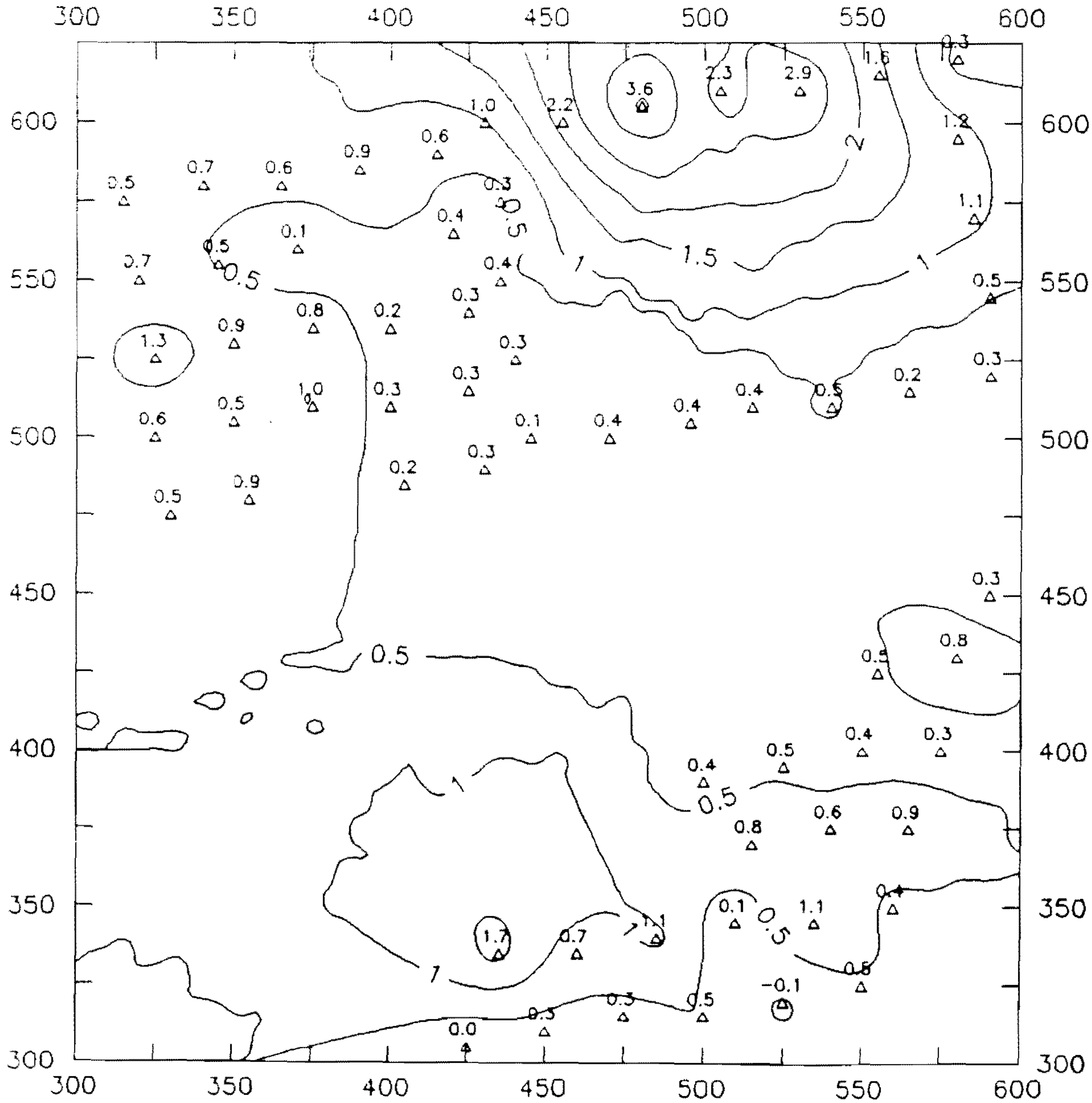
Americium-241 (pCi/g) from Area 3. Grid units are in feet relative to New Mexico State plane coordinates E485 000 and N1 755 000.

Figure D-10. Americium-241 from Area 3. (Soholt 1990, 0698)

Figure D-11. Americium-241 in Soil from Area 11. (Soholt 1990, 0698)



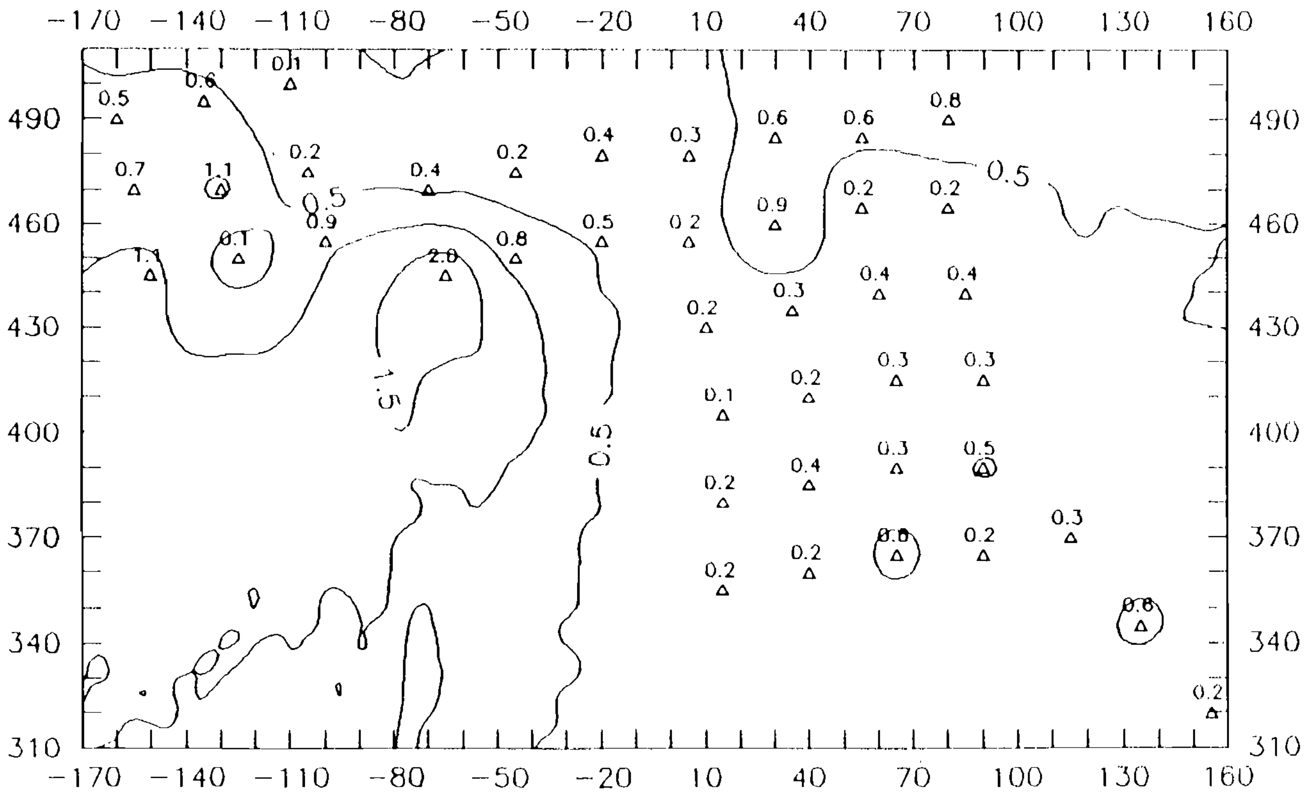
Americium-241 (pCi/g) in soil from Area 11. Grid units are in feet relative to New Mexico State plane coordinates E484 000 and N1 755 000.



Cesium-137 (pCi/g) in soil from Areas 2, 2A, and 2B. Grid units are in feet relative to New Mexico State plane coordinates E485 000 and N1 755 000.

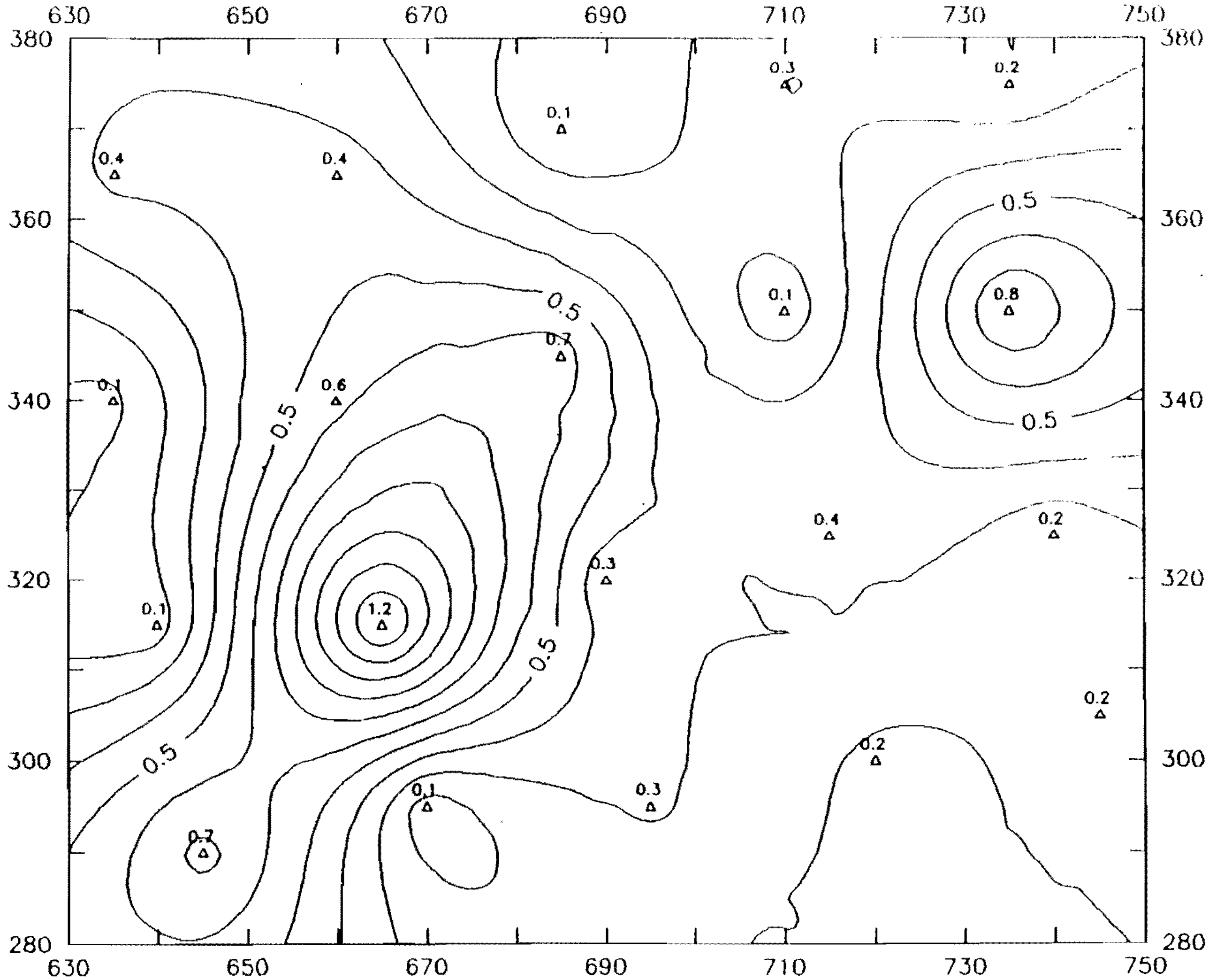
Figure D-12. Cesium-137 in Soil from Areas 2, 2A, and 2B. (Soholt 1990, 0698)

Figure D-13. Cesium-137 in Soil from Area 3. (Soholt 1990, 0698)



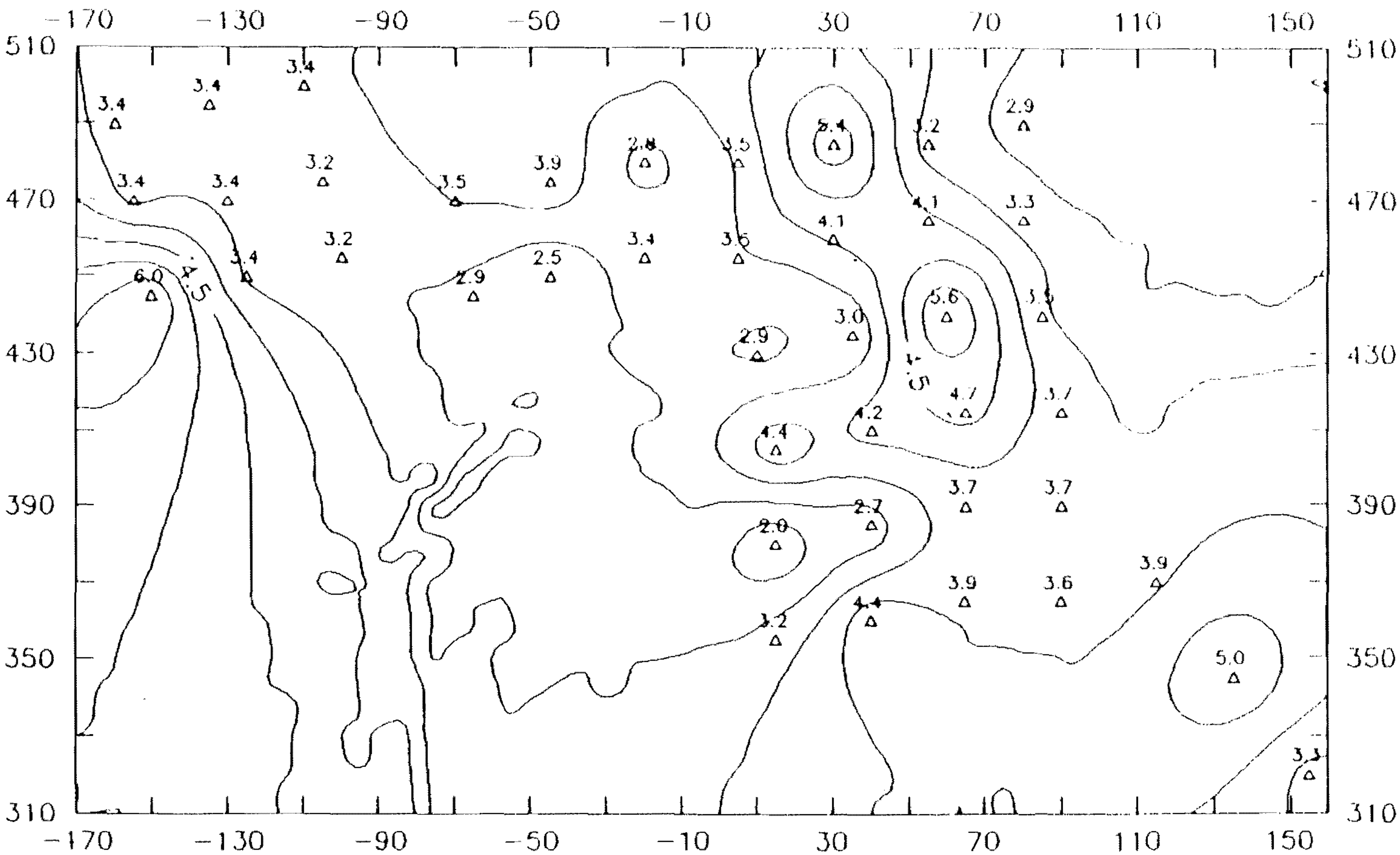
Cesium-137 (pCi/g) in soil from Area 3. Grid units are in feet relative to New Mexico State plane coordinates E485 000 and N1 755 000.

Figure D-14. Cesium-137 in Soil from Area 11. (Soholt 1990, 0698)

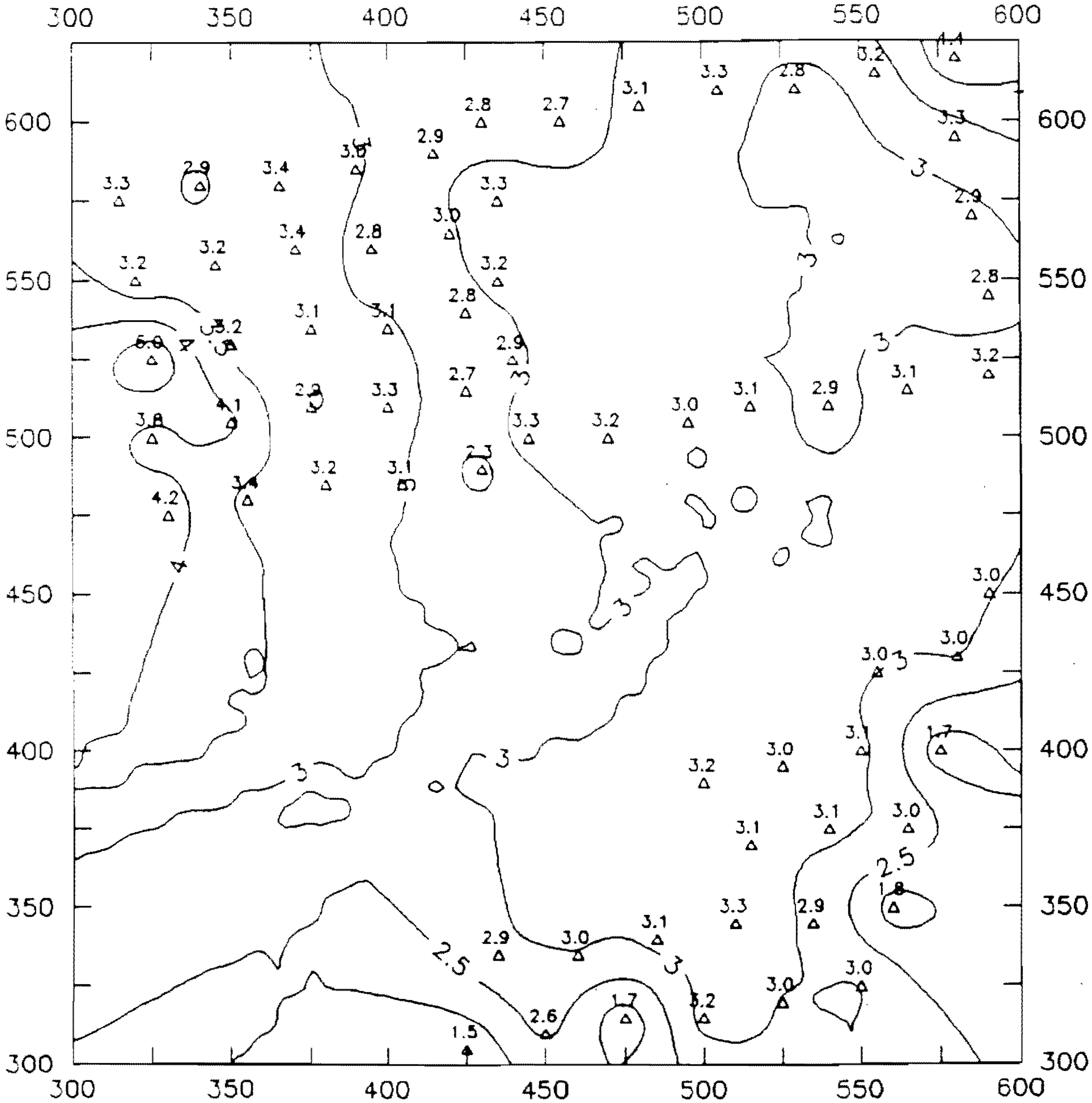


Cesium-137 (pCi/g) in soil from Area 11. Grid units are in feet relative to New Mexico State plane coordinates E484 000 and N1 755 000.

Figure D-15. Uranium in Soil from Area 3. (Soholt 1990, 0698)



Uranium (mg/g) in soil from Area 3. Grid units are in feet relative to New Mexico State plane coordinates E485 000 and N1 755 000.



Uranium (mg/g) in soil from Areas 2, 2A, and 2B. Grid units are in feet relative to New Mexico State plane coordinates E485 000 and N1 755 000.

Figure D-16. Uranium in Soil from Areas 2, 2A, and 2B. (Soholt 1990, 0698)

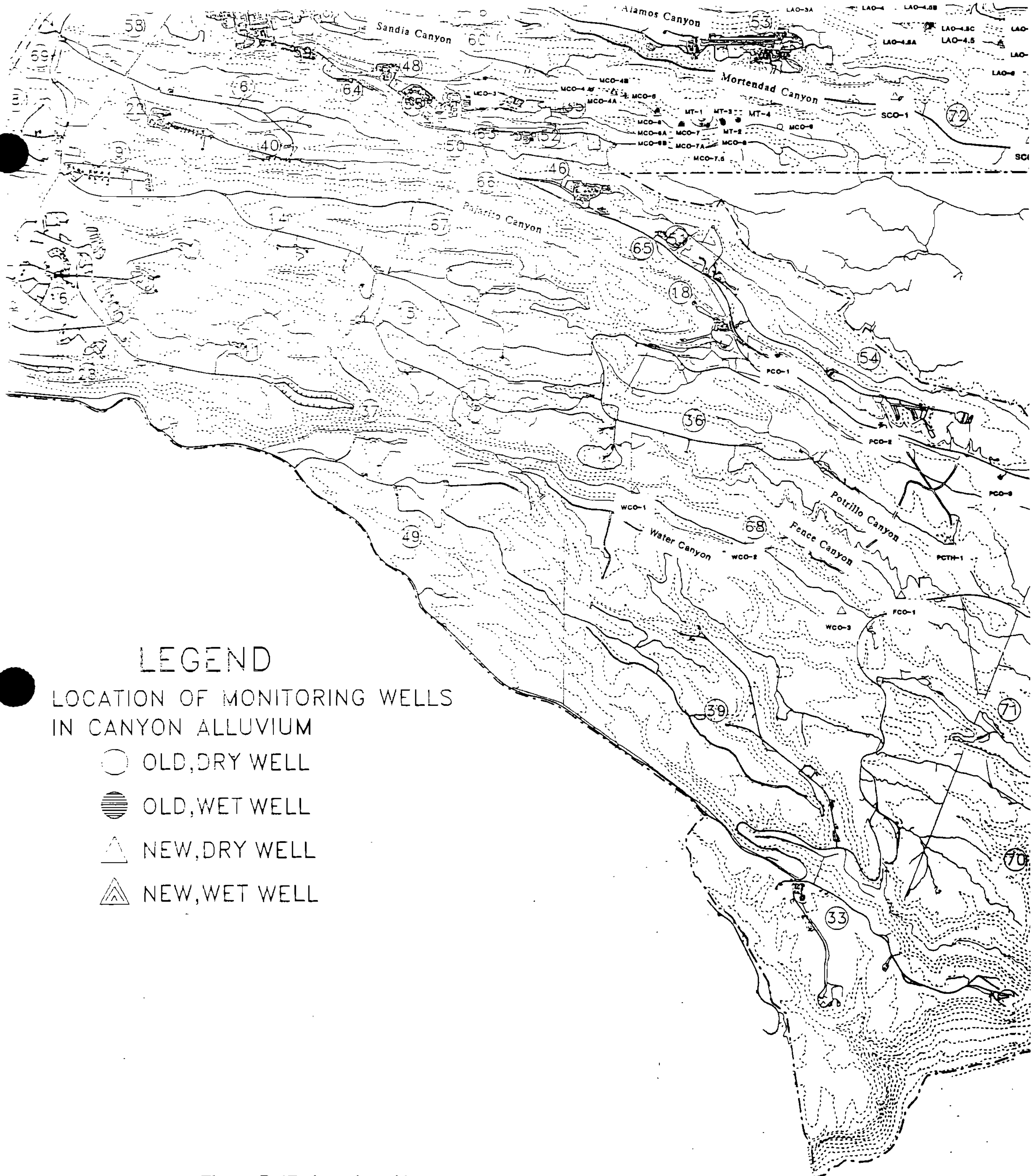
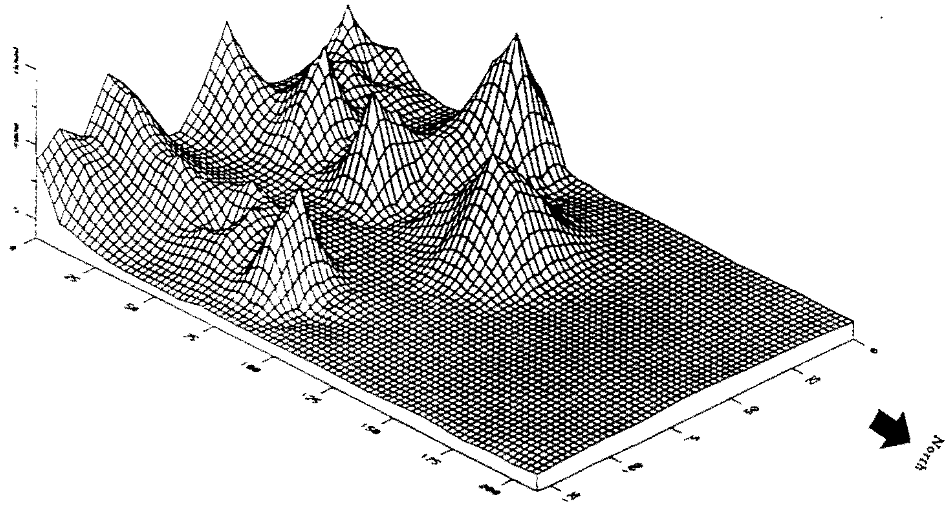


Figure D-17. Location of Monitoring Wells in Canyon Alluvium.

2000 0 2000 4000 FEET

N



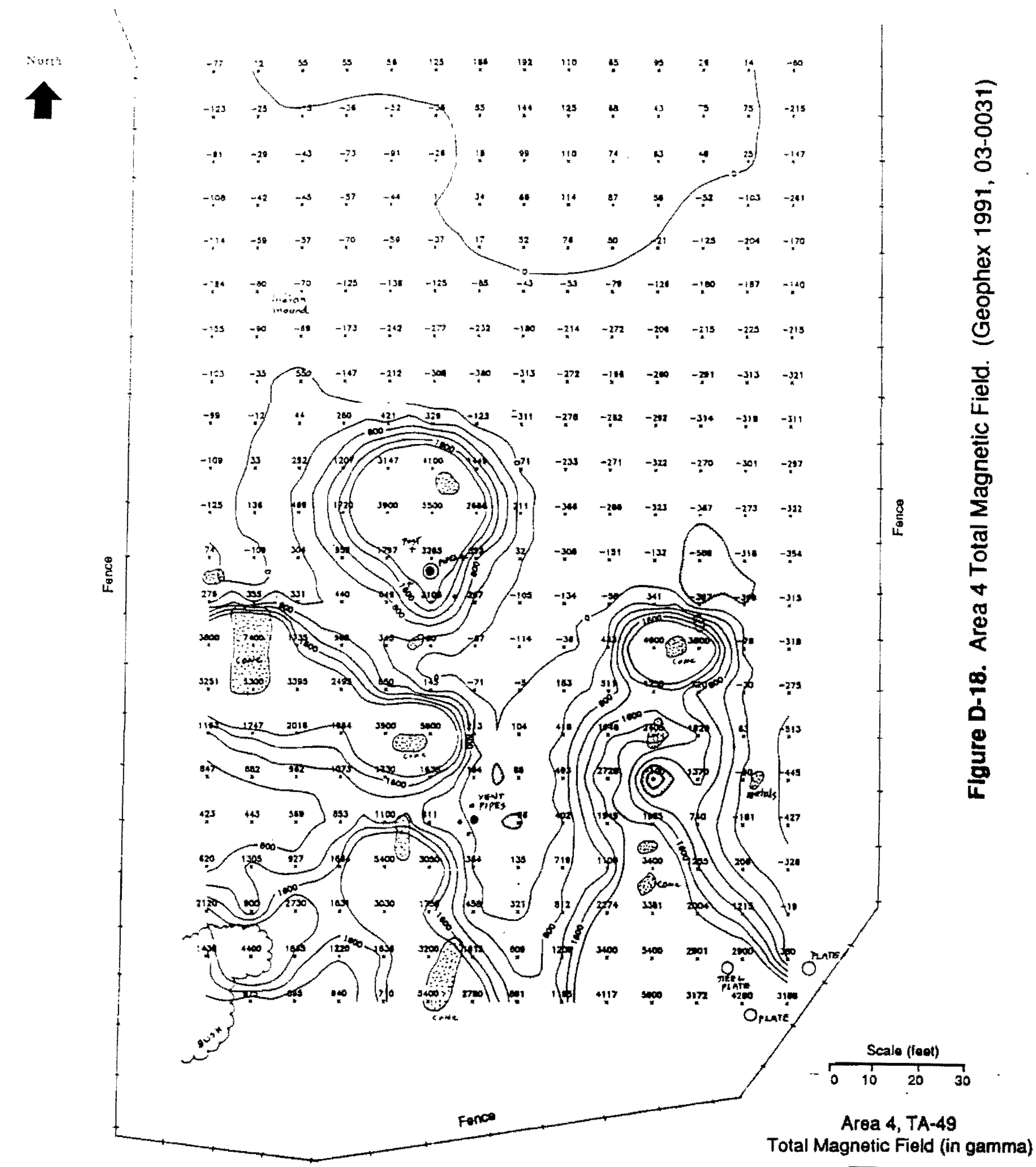
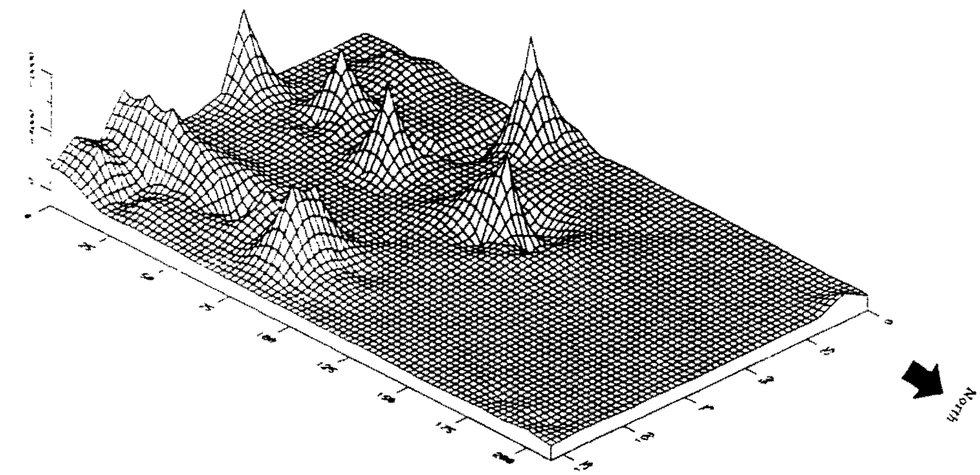


Figure D-18. Area 4 Total Magnetic Field. (Geophex 1991, 03-0031)

Geophex

Area 4 (Test Shafts): total field magnetic map (in gamma); Background = 51,600 gamma; Contour interval = 400 gamma.



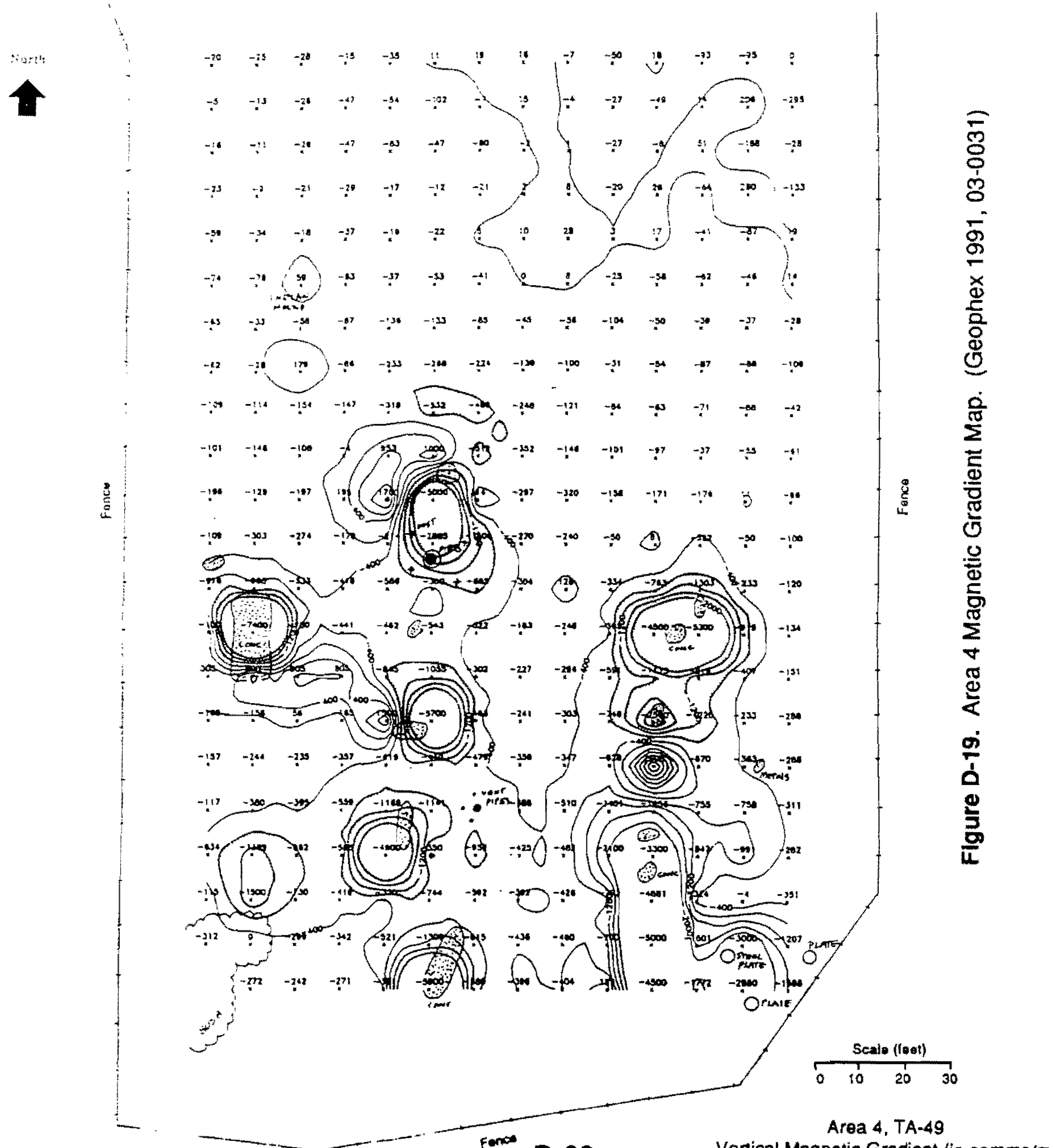


Figure D-19. Area 4 Magnetic Gradient Map. (Geophex 1991, 03-0031)

Geophex

Area 4: Magnetic gradient map (in gamma/m; positive-downward); Contour interval = 400 gamma/m. The fish-net view is shown upside down for a clear view.

Area 11: Magnetic gradient map (in gamma/m; positive-downward); Contour interval = 200 gamma/m. The fish-net view is shown upside down for a clear view.

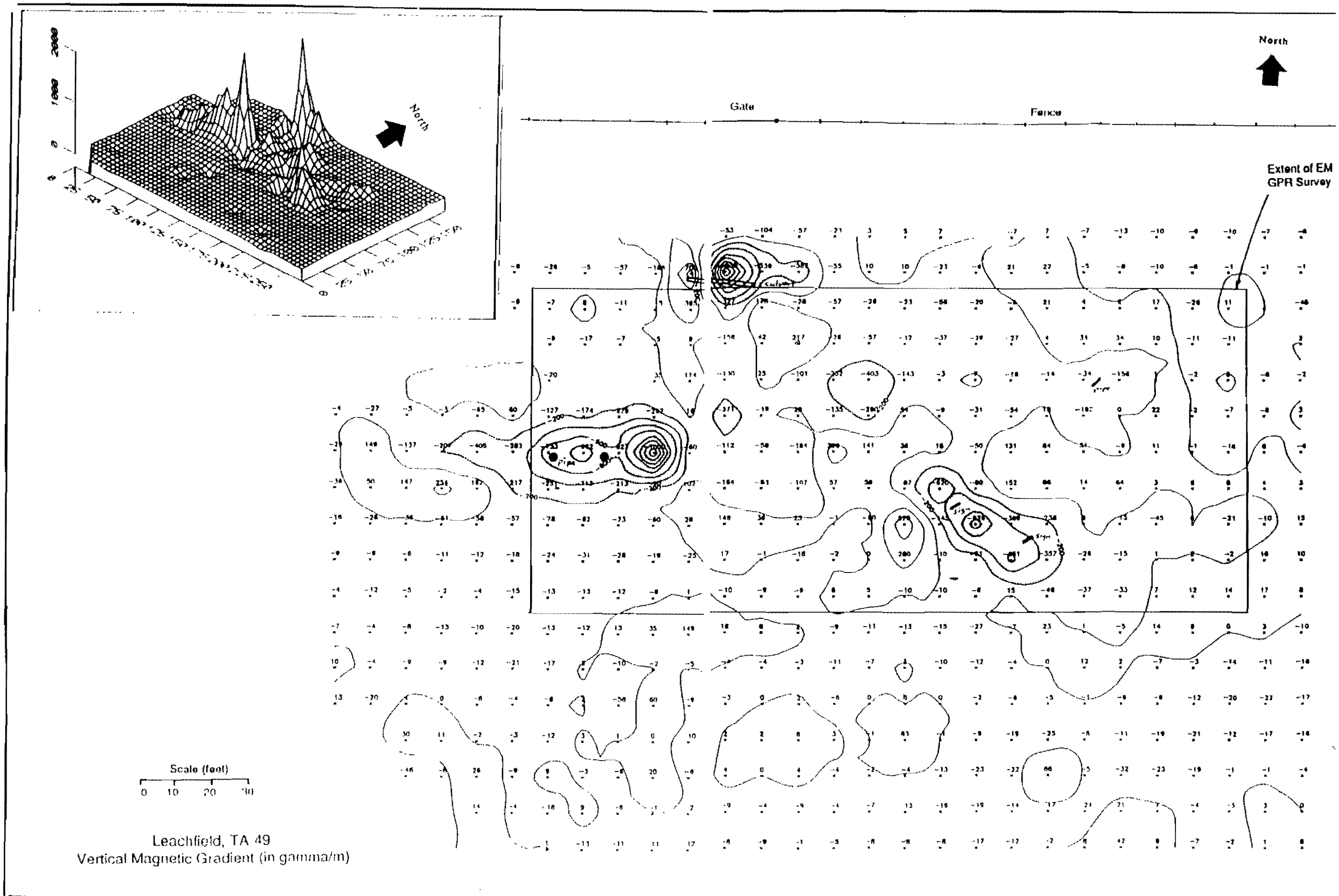
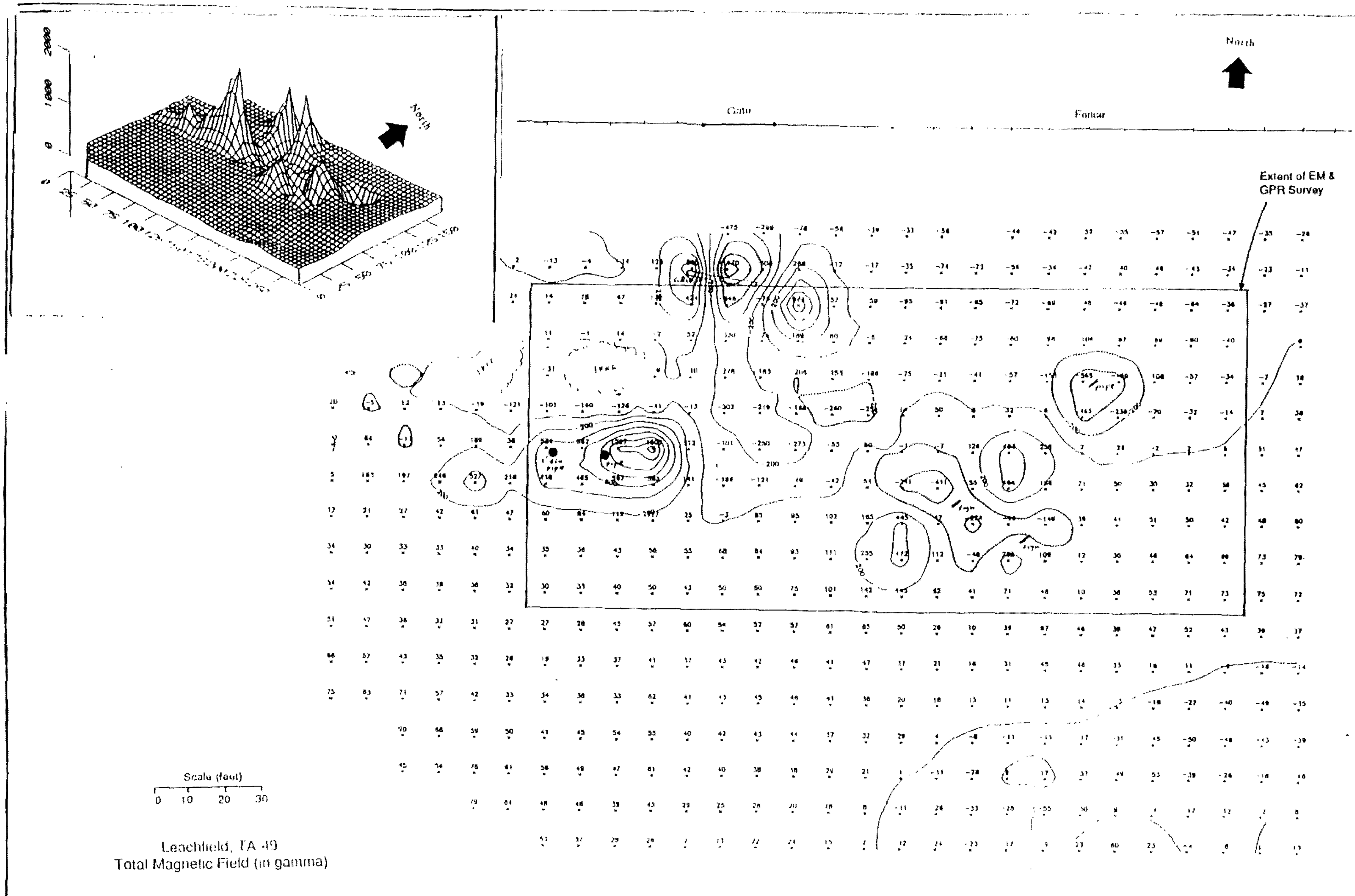


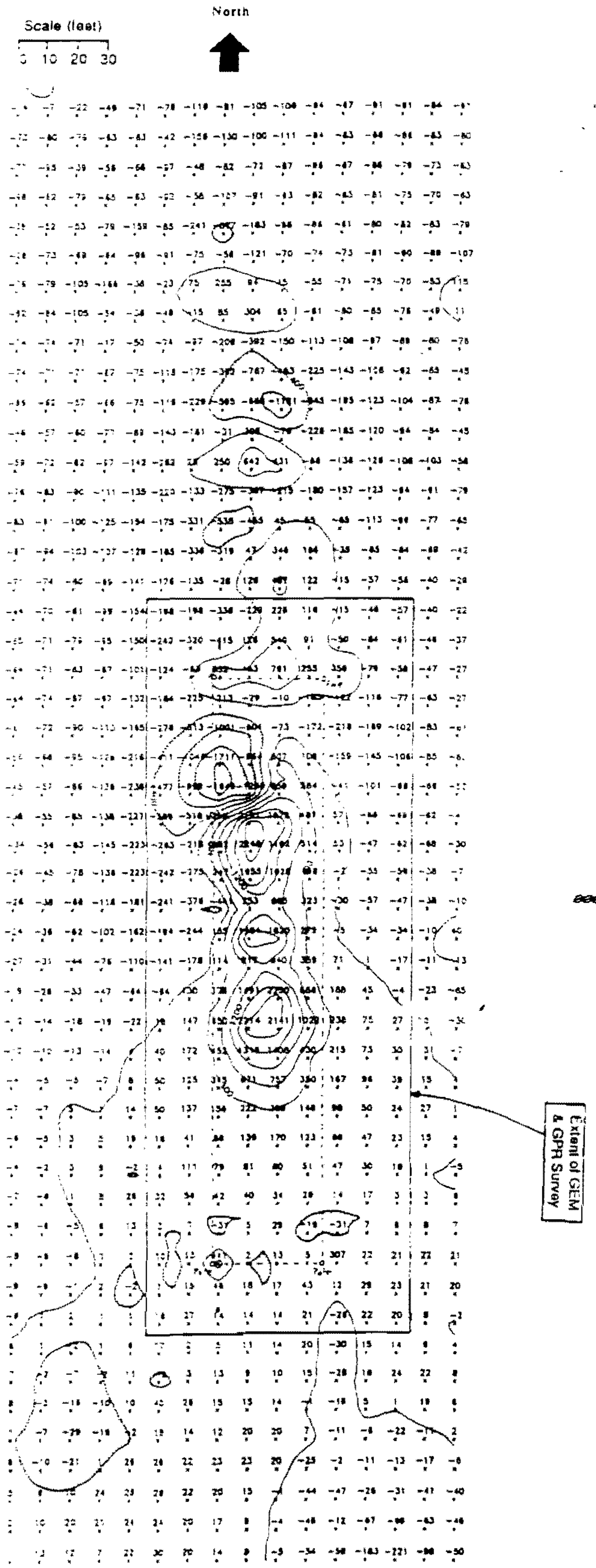
Figure D-21. Area 11 Magnetic Gradient Map. (Geophex 1991, 03-0031)



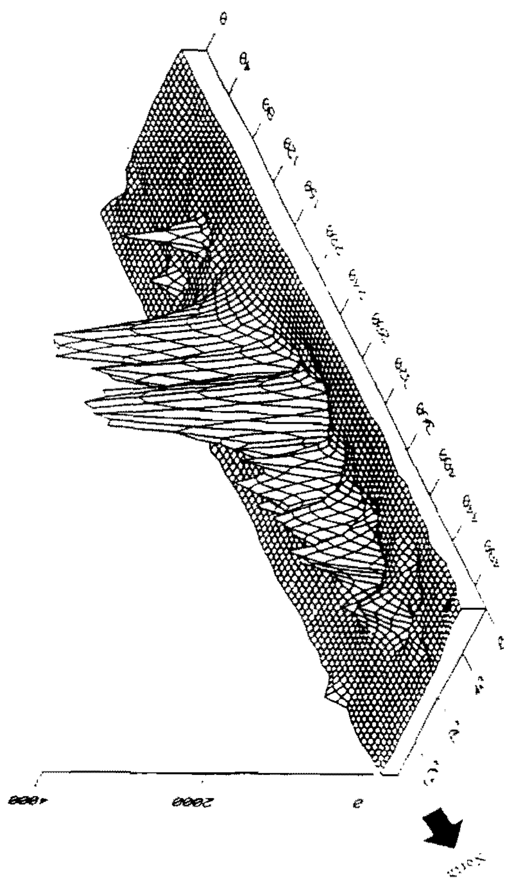
Geophex

Figure 3.2-1. Area 11 (Leach Field): total field magnetic map (in gamma); Background = 52,000 gamma; Contour interval = 200 gamma.

Figure D-20. Area 11 Total Magnetic Field. (Geophex 1991, 03-0031)



Landfill, TA-49:
Total Field Magnetic Data



Landfill: Total field magnetic map (in gamma); Background = 52,200 gamma; Contour interval = 400 gamma.

Figure D-22. Landfill Total Magnetic Field. (Geophex 1991, 03-0031)

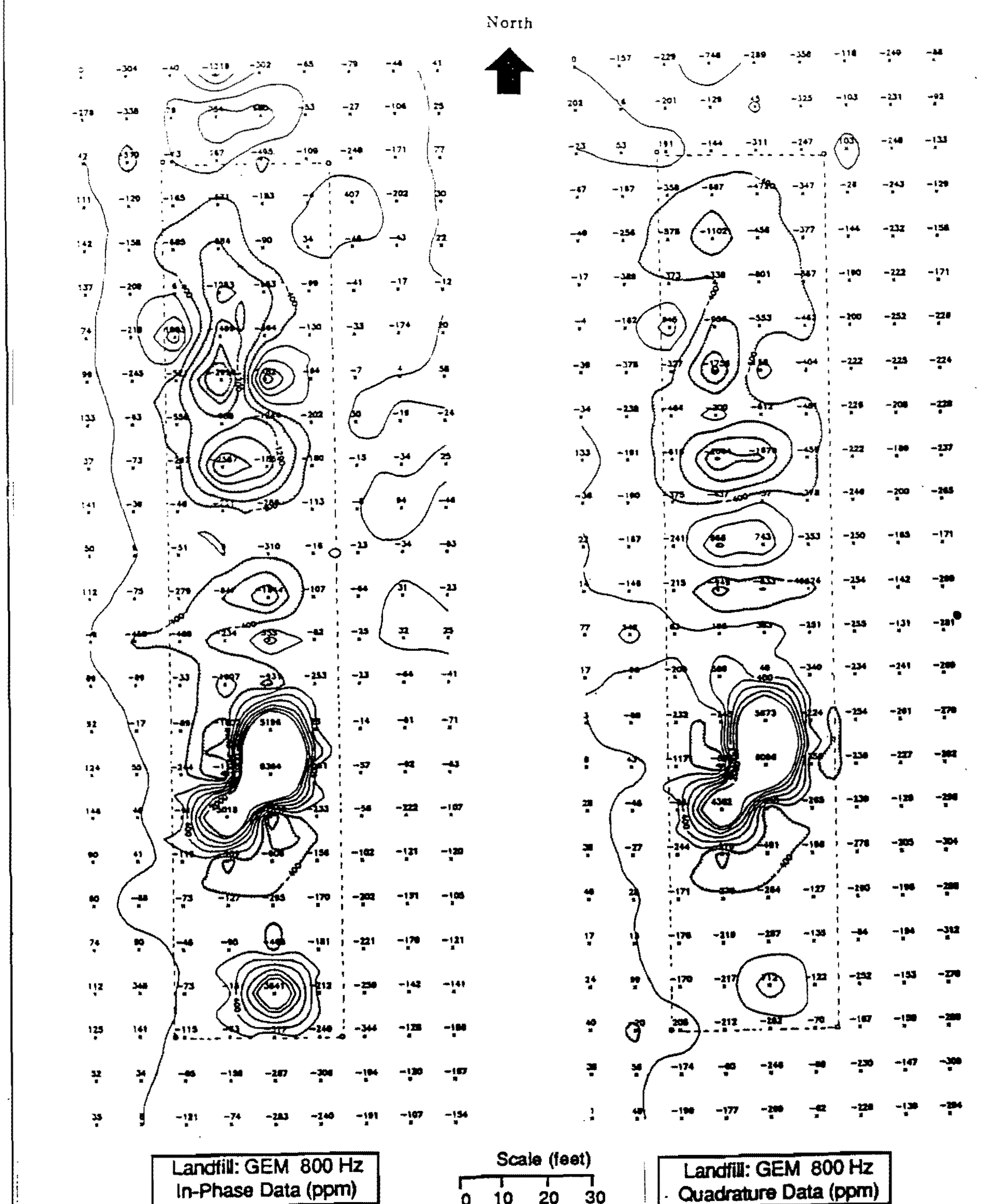
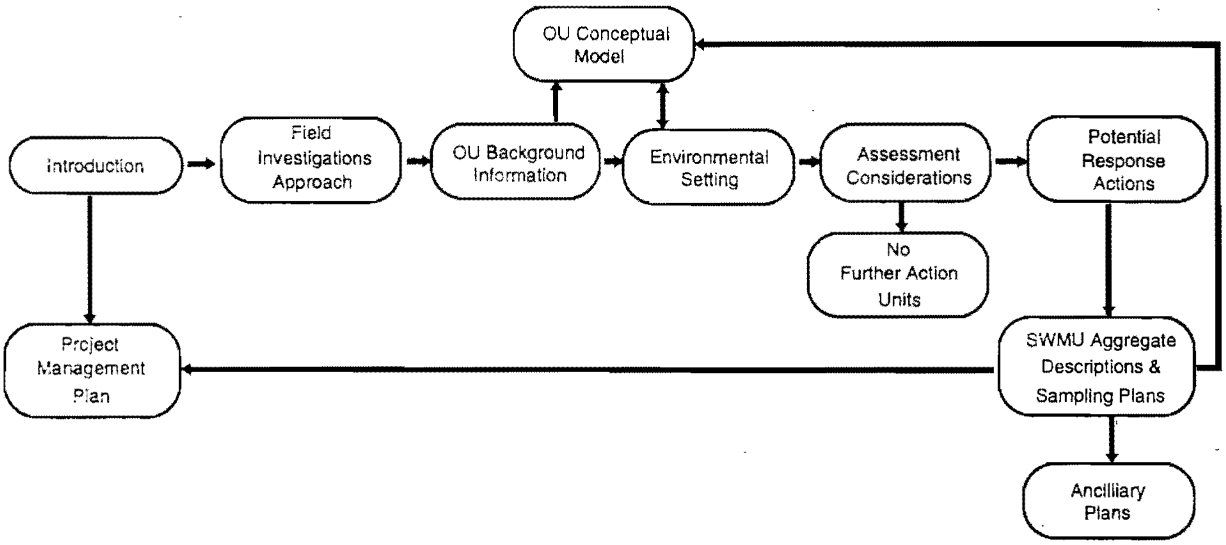


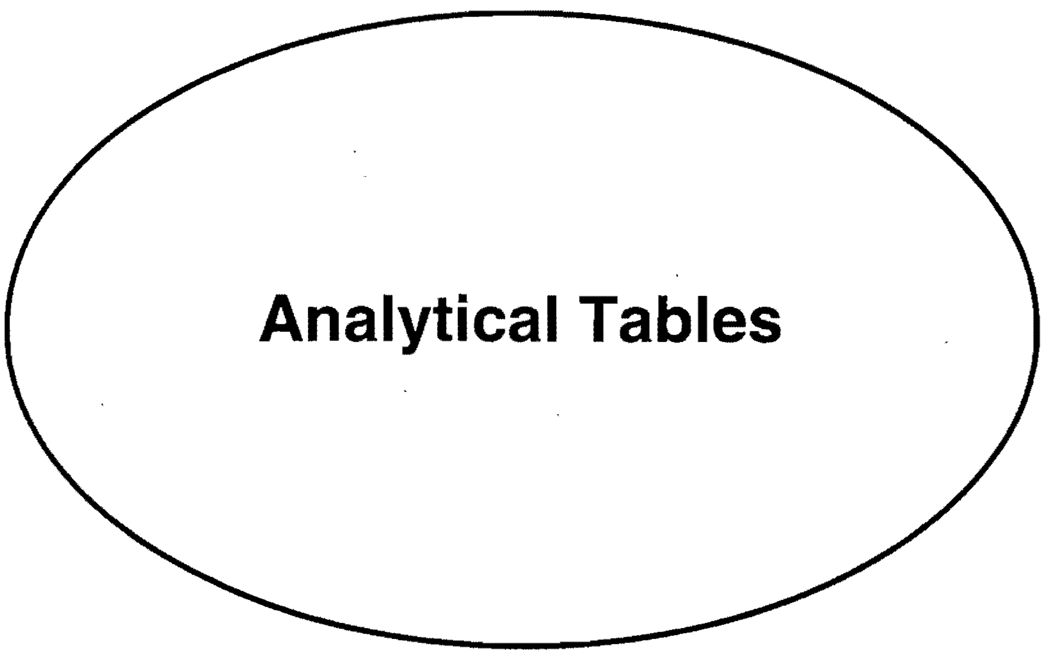
Figure D-23. Landfill Magnetic Gradient Map. (Geophex 1991, 03-0031)

Geophex

Landfill: Electromagnetic data (in ppm);
800 Hz; Contour interval = 400 ppm.

APPENDIX E


OU Conceptual Model
Introduction
Field Investigations Approach
OU Background Information
Environmental Setting
Assessment Considerations
Potential Response Actions
No Further Action Units
Project Management Plan
SWMU Aggregate Descriptions & Sampling Plans
Ancilliary Plans


Analytical Tables

LIST OF TABLES

The Screening and Analysis Tables in this appendix denote analyses to be carried out for media samples collected during the RFI for the TA-49 OU, as specified in the detailed sampling plans described in Chapters 6 and 7. As described in these chapters, roughly 50% of the planned samples (randomly chosen, plus all samples found to exhibit above background radionuclide levels as indicated by gross alpha, gross beta, or gamma spectrometry measurements), will be submitted for analyses in an offsite analytical laboratory. Therefore, as per this strategy, "X's" in the Screening and Analysis Tables do not necessarily require that the indicated analysis be performed. The sampling plans in Chapters 6 and 7 must also be consulted to determine the required analyses.

TABLE E-1

SCREENING AND ANALYSIS FOR PHASE I BASE INVESTIGATIONS

Sample Type	Sampling Location	Interval	Sample Identification	Field Screening: Gross Alpha/Beta	Field Screening: Gross Gamma	Field or Off-Site Laboratory Measurements: Gross Alpha/Beta	Gamma Spectrometry	Total Uranium	Isotopic Plutonium	RCRA Metals (SW 6010)	Tritium	Isotopic Uranium
Surface Soil Sample	1	0.0 - 6.0 In		X	X	X	X	X	X	X	X	X
	2	0.0 - 6.0 In		X	X	X	X	X	X	X	X	X
	3	0.0 - 6.0 In		X	X	X	X	X	X	X	X	X
	4	0.0 - 6.0 In		X	X	X	X	X	X	X	X	X
	5	0.0 - 6.0 In		X	X	X	X	X	X	X	X	X
	6	0.0 - 6.0 In		X	X	X	X	X	X	X	X	X
	7	0.0 - 6.0 In		X	X	X	X	X	X	X	X	X
	8	0.0 - 6.0 In		X	X	X	X	X	X	X	X	X
	9	0.0 - 6.0 In		X	X	X	X	X	X	X	X	X
QA/QC												
Rinsate Blank				X	X	X	X	X	X	X	X	X
Field Duplicate				X	X	X	X	X	X	X	X	X
Field Blank				X	X	X	X	X	X	X	X	X
Total number of screening and analysis				12	12	12	12	12	12	12	12	12

TABLE E-2 (a)

SCREENING AND ANALYSIS FOR PHASE I SURFACE INVESTIGATIONS AT AREA 11.

Sample Type	Sampling Location	Interval	Sample Identification	Field Screening: Gross Alpha/Beta	Field Screening: Gross Gamma	Field or Off-Site Laboratory Measurements: Gross Alpha/Beta	Gamma Spectrometry	Total Uranium	Isotopic Plutonium	RCRA Metals (SW 6010)
Surface Soil Sample	1	0.0 - 6.0 In		X	X	X	X	X	X	X
	2	0.0 - 6.0 In		X	X	X	X	X	X	X
	3	0.0 - 6.0 In		X	X	X	X	X	X	X
	4	0.0 - 6.0 In		X	X	X	X	X	X	X
	5	0.0 - 6.0 In		X	X	X	X	X	X	X
	6	0.0 - 6.0 In		X	X	X	X	X	X	X
	7	0.0 - 6.0 In		X	X	X	X	X	X	X
	8	0.0 - 6.0 In		X	X	X	X	X	X	X
	9	0.0 - 6.0 In		X	X	X	X	X	X	X
	10	0.0 - 6.0 In		X	X	X	X	X	X	X
	11	0.0 - 6.0 In		X	X	X	X	X	X	X
	12	0.0 - 6.0 In		X	X	X	X	X	X	X
	13	0.0 - 6.0 In		X	X	X	X	X	X	X
	14	0.0 - 6.0 In		X	X	X	X	X	X	X
	15	0.0 - 6.0 In		X	X	X	X	X	X	X
	16	0.0 - 6.0 In		X	X	X	X	X	X	X
	17	0.0 - 6.0 In		X	X	X	X	X	X	X
	18	0.0 - 6.0 In		X	X	X	X	X	X	X
	19	0.0 - 6.0 In		X	X	X	X	X	X	X
	20	0.0 - 6.0 In		X	X	X	X	X	X	X
QA/QC										
Rinsate Blank				X	X	X	X	X	X	X
Field Duplicate				X	X	X	X	X	X	X
Field Blank				X	X	X	X	X	X	X

TABLE E-2 (a) Continued

SCREENING AND ANALYSIS FOR PHASE I SURFACE INVESTIGATIONS AT AREA 11.

Sample Type	Sampling Location	Interval	Sample Identification	Field Screening: Gross Alpha/Beta	Field Screening: Gross Gamma	Field or Off-Site Laboratory Measurements: Gross Alpha/Beta	Gamma Spectrometry	Total Uranium	Isotopic Plutonium	RCRA Metals (SW 6010)
Surface Soil Sample	20	0.0 - 6.0 In		X	X	X	X	X	X	X
	21	0.0 - 6.0 In		X	X	X	X	X	X	X
	22	0.0 - 6.0 In		X	X	X	X	X	X	X
	23	0.0 - 6.0 In		X	X	X	X	X	X	X
	24	0.0 - 6.0 In		X	X	X	X	X	X	X
	25	0.0 - 6.0 In		X	X	X	X	X	X	X
	26	0.0 - 6.0 In		X	X	X	X	X	X	X
	27	0.0 - 6.0 In		X	X	X	X	X	X	X
	28	0.0 - 6.0 In		X	X	X	X	X	X	X
	29	0.0 - 6.0 In		X	X	X	X	X	X	X
	30	0.0 - 6.0 In		X	X	X	X	X	X	X
	31	0.0 - 6.0 In		X	X	X	X	X	X	X
	32	0.0 - 6.0 In		X	X	X	X	X	X	X
	33	0.0 - 6.0 In		X	X	X	X	X	X	X
	34	0.0 - 6.0 In		X	X	X	X	X	X	X
	35	0.0 - 6.0 In		X	X	X	X	X	X	X
	36	0.0 - 6.0 In		X	X	X	X	X	X	X
	37	0.0 - 6.0 In		X	X	X	X	X	X	X
	38	0.0 - 6.0 In		X	X	X	X	X	X	X
	39	0.0 - 6.0 In		X	X	X	X	X	X	X
	40	0.0 - 6.0 In		X	X	X	X	X	X	X
QA/QC										
Rinsate Blank				X	X	X	X	X	X	X
Field Duplicate				X	X	X	X	X	X	X
Field Blank				X	X	X	X	X	X	X
Total number of screening and analysis				46	46	46	46	23	23	23

TABLE E-2 (b)

SCREENING AND ANALYSIS FOR PHASE I SUBSURFACE INVESTIGATIONS AT AREA 11 (SWMU 49-003).

Sample Type	Sampling Location	Interval	Sample Identification	Field Screening: Gross Alpha/Beta	Field Screening: Gross Gamma	Field or Off-Site Laboratory Measurements: Gross Alpha/Beta	Gamma Spectrometry	Total Uranium	Isotopic Plutonium	RCRA Metals (SW 6010)	SVOC (SW 8240)	HEs
Borehole Sample	1	0 - 3 ft		X	X	X	X	X	X	X	X	
	1	3 - 6 ft		X	X	X	X	X	X	X	X	
	1	6 - 9 ft		X	X	X	X	X	X	X	X	
	2	0 - 3 ft		X	X	X	X	X	X	X	X	
	2	3 - 6 ft		X	X	X	X	X	X	X	X	
	2	6 - 9 ft		X	X	X	X	X	X	X	X	
	3	0 - 3 ft		X	X	X	X	X	X	X	X	
	3	3 - 6 ft		X	X	X	X	X	X	X	X	
	3	6 - 9 ft		X	X	X	X	X	X	X	X	
	4	0 - 3 ft		X	X	X	X	X	X	X	X	
	4	3 - 6 ft		X	X	X	X	X	X	X	X	
	4	6 - 9 ft		X	X	X	X	X	X	X	X	
	5	0 - 3 ft		X	X	X	X	X	X	X	X	
	5	3 - 6 ft		X	X	X	X	X	X	X	X	
	5	6 - 9 ft		X	X	X	X	X	X	X	X	
	6	0 - 3 ft		X	X	X	X	X	X	X	X	
	6	3 - 6 ft		X	X	X	X	X	X	X	X	
	6	6 - 9 ft		X	X	X	X	X	X	X	X	
QA/QC												
Rinsate Blank				X	X	X	X	X	X	X	X	
Field Duplicate				X	X	X	X	X	X	X	X	
Field Blank				X	X	X	X	X	X	X	X	

TABLE E-2 (b) Continued

SCREENING AND ANALYSIS FOR PHASE I SUBSURFACE INVESTIGATIONS AT AREA 11 (SWMU 49-003).

Sample Type	Sampling Location	Interval	Sample Identification	Field Screening: Gross Alpha/Beta	Field Screening: Gross Gamma	Field Screening: HEs	Field or Off-Site Laboratory Measurements: Gross Alpha/Beta	Gamma Spectrometry	Total Uranium	Isotopic Plutonium	RCRA Metals (SW 6010)	SVOC (SW 8240)	HEs
Borehole Sample	8	0 - 3 ft		X	X		X	X	X	X	X	X	
	8	3 - 6 ft		X	X		X	X	X	X	X	X	
	8	6 - 9 ft		X	X		X	X	X	X	X	X	
	9	0 - 3 ft		X	X		X	X	X	X	X	X	
	9	3 - 6 ft		X	X		X	X	X	X	X	X	
	9	6 - 9 ft		X	X		X	X	X	X	X	X	
	10	0 - 3 ft		X	X		X	X	X	X	X	X	
	10	3 - 6 ft		X	X		X	X	X	X	X	X	
	10	6 - 9 ft		X	X		X	X	X	X	X	X	
	11	0 - 3 ft		X	X		X	X	X	X	X	X	
	11	3 - 6 ft		X	X		X	X	X	X	X	X	
	11	6 - 9 ft		X	X		X	X	X	X	X	X	
	12	0 - 3 ft		X	X		X	X	X	X	X	X	
	12	3 - 6 ft		X	X		X	X	X	X	X	X	
	12	6 - 9 ft		X	X		X	X	X	X	X	X	
	13	0 - 3 ft		X	X		X	X	X	X	X	X	
	13	3 - 6 ft		X	X		X	X	X	X	X	X	
	14	10 - 15 ft		X	X	X	X	X	X	X	X	X	X
	15	10 - 15 ft		X	X	X	X	X	X	X	X	X	X
QA/QC													
Rinsate Blank				X	X		X	X	X	X	X	X	X
Field Duplicate				X	X		X	X	X	X	X	X	X
Field Blank				X	X		X	X	X	X	X	X	X
Total number of screening and analysis				46	46	2	46	46	23	23	39	23	2

TABLE E-3 (a)

SCREENING AND ANALYSIS FOR PHASE I BASE INVESTIGATIONS AT AREA 6 SOIL Contamination Area [SWMU 49-008(a)]

Sample Type	Sampling Location	Interval	Sample Identification	Field Screening: Gross Alpha/Beta	Field Screening: Gross Gamma	Field or Off-Site Laboratory Measurements: Gross Alpha/Beta	Field or Off-Site Laboratory Measurements: Gamma Spectrometry	Field or Off-Site Laboratory Measurements: Total Uranium	Field or Off-Site Laboratory Measurements: Isotopic Plutonium	Field or Off-Site Laboratory Measurements: RCRA Metals (SW 6010)
Surface Soil Sample	1	0.0 - 6.0 In		X	X	X	X	X	X	X
	2	0.0 - 6.0 In		X	X	X	X	X	X	X
	3	0.0 - 6.0 In		X	X	X	X	X	X	X
	4	0.0 - 6.0 In		X	X	X	X	X	X	X
	5	0.0 - 6.0 In		X	X	X	X	X	X	X
	6	0.0 - 6.0 In		X	X	X	X	X	X	X
	7	0.0 - 6.0 In		X	X	X	X	X	X	X
	8	0.0 - 6.0 In		X	X	X	X	X	X	X
	9	0.0 - 6.0 In		X	X	X	X	X	X	X
	10	0.0 - 6.0 In		X	X	X	X	X	X	X
	11	0.0 - 6.0 In		X	X	X	X	X	X	X
	12	0.0 - 6.0 In		X	X	X	X	X	X	X
	13	0.0 - 6.0 In		X	X	X	X	X	X	X
	14	0.0 - 6.0 In		X	X	X	X	X	X	X
	15	0.0 - 6.0 In		X	X	X	X	X	X	X
	16	0.0 - 6.0 In		X	X	X	X	X	X	X
	17	0.0 - 6.0 In		X	X	X	X	X	X	X
	18	0.0 - 6.0 In		X	X	X	X	X	X	X
	19	0.0 - 6.0 In		X	X	X	X	X	X	X
QA/QC										
Rinsate Blank				X	X	X	X	X	X	X
Field Duplicate				X	X	X	X	X	X	X
Field Blank				X	X	X	X	X	X	X
Total number of screening and analysis				22	22	22	22	11	11	11

TABLE E-3 (b)

SCREENING AND ANALYSIS FOR PHASE I BASE INVESTIGATIONS THE OPEN BURNING/LANDFILL AREA (SWMU 49-004)

Sample Type	Sampling Location	Interval	Sample Identification	Field Screening: Gross Alpha/Beta	Field Screening: Gross Gamma	Field or Off-Site Laboratory Measurements: Gross Alpha/Beta	Gamma Spectrometry	Total Uranium	Isotopic Plutonium	RCRA Metals (SW 6010)
Surface Soil Sample	1	0.0 - 6.0 In		X	X	X	X	X	X	X
	2	0.0 - 6.0 In		X	X	X	X	X	X	X
	3	0.0 - 6.0 In		X	X	X	X	X	X	X
	4	0.0 - 6.0 In		X	X	X	X	X	X	X
	5	0.0 - 6.0 In		X	X	X	X	X	X	X
	6	0.0 - 6.0 In		X	X	X	X	X	X	X
	7	0.0 - 6.0 In		X	X	X	X	X	X	X
	8	0.0 - 6.0 In		X	X	X	X	X	X	X
	9	0.0 - 6.0 In		X	X	X	X	X	X	X
	10	0.0 - 6.0 In		X	X	X	X	X	X	X
	11	0.0 - 6.0 In		X	X	X	X	X	X	X
	12	0.0 - 6.0 In		X	X	X	X	X	X	X
	13	0.0 - 6.0 In		X	X	X	X	X	X	X
	14	0.0 - 6.0 In		X	X	X	X	X	X	X
	15	0.0 - 6.0 In		X	X	X	X	X	X	X
	16	0.0 - 6.0 In		X	X	X	X	X	X	X
	17	0.0 - 6.0 In		X	X	X	X	X	X	X
QA/QC										
Rinsate Blank				X	X	X	X	X	X	X
Field Duplicate				X	X	X	X	X	X	X
Field Blank				X	X	X	X	X	X	X

TABLE E-3 (b)

SCREENING AND ANALYSIS FOR PHASE I BASE INVESTIGATIONS THE OPEN BURNING/LANDFILL AREA (SWMU 49-004)

Sample Type	Sampling Location	Interval	Sample Identification	Field Screening: Gross Alpha/Beta	Field Screening: Gross Gamma	Field or Off-Site Laboratory Measurements: Gross Alpha/Beta	Gamma Spectrometry	Total Uranium	Isotopic Plutonium	RCRA Metals (SW 6010)
Surface Soil Sample	18	0.0 - 6.0 In		X	X	X	X	X	X	X
	19	0.0 - 6.0 In		X	X	X	X	X	X	X
	20	0.0 - 6.0 In		X	X	X	X	X	X	X
	21	0.0 - 6.0 In		X	X	X	X	X	X	X
	22	0.0 - 6.0 In		X	X	X	X	X	X	X
	23	0.0 - 6.0 In		X	X	X	X	X	X	X
	24	0.0 - 6.0 In		X	X	X	X	X	X	X
	25	0.0 - 6.0 In		X	X	X	X	X	X	X
	26	0.0 - 6.0 In		X	X	X	X	X	X	X
	27	0.0 - 6.0 In		X	X	X	X	X	X	X
	28	0.0 - 6.0 In		X	X	X	X	X	X	X
	29	0.0 - 6.0 In		X	X	X	X	X	X	X
	30	0.0 - 6.0 In		X	X	X	X	X	X	X
	31	0.0 - 6.0 In		X	X	X	X	X	X	X
	32	0.0 - 6.0 In		X	X	X	X	X	X	X
	33	0.0 - 6.0 In		X	X	X	X	X	X	X
	34	0.0 - 6.0 In		X	X	X	X	X	X	X
QA/QC										
Rinsate Blank				X	X	X	X	X	X	X
Field Duplicate				X	X	X	X	X	X	X
Field Blank				X	X	X	X	X	X	X
Total number of screening and analysis				40	40	40	40	20	20	20

TABLE E-3 (c)

SCREENING AND ANALYSIS FOR PHASE I BASE INVESTIGATIONS THE SMALL LANDFILLS [SWMUs 49-005 (a) and (b)]

Sample Type	Sampling Location	Interval	Sample Identification	Field Screening: Gross Alpha/Beta	Field Screening: Gross Gamma	Field or Off-Site Laboratory Measurements: Gross Alpha/Beta	Gamma Spectrometry	Total Uranium	Isotopic Plutonium	RCRA Metals (SW 6010)
Surface Soil Sample	1	0.0 - 6.0 In		X	X	X	X	X	X	X
	2	0.0 - 6.0 In		X	X	X	X	X	X	X
	3	0.0 - 6.0 In		X	X	X	X	X	X	X
	4	0.0 - 6.0 In		X	X	X	X	X	X	X
Total number of screening and analysis				4	4	4	4	2	2	2

TABLE E-3 (d)

SCREENING AND ANALYSIS FOR PHASE I BASE INVESTIGATIONS THE OPEN BURNING/LANDFILL AREA (SWMU 49-004) THE SMALL LANDFILLS [SWMUs 49-005 (a) and (b)]

Sample Type	Sampling Location	Interval	Sample Identification	Field Screening: Gross Alpha/Beta	Field Screening: Gross Gamma	Field or Off-Site Laboratory Measurements: Gross Alpha/Beta	Gamma Spectrometry	Total Uranium	Isotopic Plutonium	RCRA Metals (SW 6010)	SVOC (SW 8240)
Borehole Sample	1	1 - 5 ft		X	X	X	X	X	X	X	X
	1	5 - 10 ft		X	X	X	X	X	X	X	X
	1	10 - 15 ft		X	X	X	X	X	X	X	X
	2	1 - 5 ft		X	X	X	X	X	X	X	X
	2	5 - 10 ft		X	X	X	X	X	X	X	X
	2	10 - 15 ft		X	X	X	X	X	X	X	X
	3	1 - 5 ft		X	X	X	X	X	X	X	X
	3	5 - 10 ft		X	X	X	X	X	X	X	X
	3	10 - 15 ft		X	X	X	X	X	X	X	X
	4	1 - 5 ft		X	X	X	X	X	X	X	X
	4	5 - 10 ft		X	X	X	X	X	X	X	X
	4	10 - 15 ft		X	X	X	X	X	X	X	X
	5	1 - 5 ft		X	X	X	X	X	X	X	X
	5	5 - 10 ft		X	X	X	X	X	X	X	X
	5	10 - 15 ft		X	X	X	X	X	X	X	X
	6	1 - 5 ft		X	X	X	X	X	X	X	X
	6	5 - 10 ft		X	X	X	X	X	X	X	X
	6	10 - 15 ft		X	X	X	X	X	X	X	X
QA/QC (Core)											
Rinsate Blank				X	X	X	X	X	X	X	X
Field Duplicate				X	X	X	X	X	X	X	X
Field Blank				X	X	X	X	X	X	X	X

TABLE E-3 (d) continued

SCREENING AND ANALYSIS FOR PHASE I BASE INVESTIGATIONS THE OPEN BURNING/LANDFILL AREA (SWMU 49-004) THE SMALL LANDFILLS [SWMUs 49-005 (a) and (b)]

Sample Type	Sampling Location	Interval	Sample Identification	Field Screening: Gross Alpha/Beta	Field Screening: Gross Gamma	Field or Off-Site Laboratory Measurements: Gross Alpha/Beta	Gamma Spectrometry	Total Uranium	Isotopic Plutonium	RCRA Metals (SW 6010)	SVOC (SW 8240)
Borehole Sample	7	1 - 5 ft		X	X	X	X	X	X	X	X
	7	5 - 10 ft		X	X	X	X	X	X	X	X
	7	10 - 15 ft		X	X	X	X	X	X	X	X
	8	5 - 10 ft		X	X	X	X	X	X	X	X
	9	5 - 10 ft		X	X	X	X	X	X	X	X
QA/QC (Core)											
Rinsate Blank				X	X	X	X	X	X	X	X
Field Duplicate				X	X	X	X	X	X	X	X
Field Blank				X	X	X	X	X	X	X	X
Total number of screening and analysis				26	26	26	26	13	13	13	13

TABLE E-4 (a)

SCREENING AND ANALYSIS FOR PHASE I BASE INVESTIGATIONS AREA 5

Sample Type	Sampling Location	Interval	Sample Identification	Field Screening: Gross Alpha/Beta	Field Screening: Gross Gamma	Field or Off-Site Laboratory Measurements: Gross Alpha/Beta	Gamma Spectrometry	Total Uranium	Isotopic Plutonium	RCRA Metals (SW 6010)	PCB (SW 8080)
Surface Soil Sample	1	0.0 - 6.0 In		X	X	X	X	X	X	X	
	2	0.0 - 6.0 In		X	X	X	X	X	X	X	
	3	0.0 - 6.0 In		X	X	X	X	X	X	X	
	4	0.0 - 6.0 In		X	X	X	X	X	X	X	
	5	0.0 - 6.0 In		X	X	X	X	X	X	X	
	6	0.0 - 6.0 In		X	X	X	X	X	X	X	
	7	0.0 - 6.0 In		X	X	X	X	X	X	X	
	8	0.0 - 6.0 In		X	X	X	X	X	X	X	
	9	0.0 - 6.0 In		X	X	X	X	X	X	X	
	10	0.0 - 6.0 In		X	X	X	X	X	X	X	
	11	0.0 - 6.0 In		X	X	X	X	X	X	X	
	12	0.0 - 6.0 In		X	X	X	X	X	X	X	
	13	0.0 - 6.0 In		X	X	X	X	X	X	X	
	14	0.0 - 6.0 In		X	X	X	X	X	X	X	
	15	0.0 - 6.0 In		X	X	X	X	X	X	X	
	16	0.0 - 6.0 In		X	X	X	X	X	X	X	
	17	0.0 - 6.0 In									X
	18	0.0 - 6.0 In									X
	19	0.0 - 6.0 In									X
	20	0.0 - 6.0 In									X
QA/QC											
Rinsate Blank				X	X	X	X	X	X	X	
Field Duplicate				X	X	X	X	X	X	X	
Field Blank				X	X	X	X	X	X	X	

TABLE E-4 (a)
(continued)
SCREENING AND ANALYSIS FOR PHASE I BASE INVESTIGATIONS
AREA 5

Sample Type	Sampling Location	Interval	Sample Identification	Field Screening: Gross Alpha/Beta	Field Screening: Gross Gamma	Field or Off-Site Laboratory Measurements: Gross Alpha/Beta	Gamma Spectrometry	Total Uranium	Isotopic Plutonium	RCRA Metals (SW 6010)	SVOC (SW 8240)	PCB (SW 8080)
Drainline Soil;	11	0.0 - 6.0 In		X	X	X	X	X	X	X	X	
	12	0.0 - 6.0 In		X	X	X	X	X	X	X	X	
	13	0.0 - 6.0 In		X	X	X	X	X	X	X	X	
	14	0.0 - 6.0 In		X	X	X	X	X	X	X	X	
	15	0.0 - 6.0 In		X	X	X	X	X	X	X	X	
	16	0.0 - 6.0 In		X	X	X	X	X	X	X	X	
	17	0.0 - 6.0 In		X	X	X	X	X	X	X	X	
	18	0.0 - 6.0 In		X	X	X	X	X	X	X	X	
	19	0.0 - 6.0 In		X	X	X	X	X	X	X	X	
	20	0.0 - 6.0 In		X	X	X	X	X	X	X	X	
QA/QC												
Rinsate Blank				X	X	X	X	X	X	X		
Field Duplicate				X	X	X	X	X	X	X		
Field Blank				X	X	X	X	X	X	X		
Total number of screening and analysis				32	32	32	32	16	16	16	10	4

TABLE E-4 (b)

SCREENING AND ANALYSIS FOR PHASE I BASE INVESTIGATIONS AREA 5

Sample Type	Sampling Location	Interval	Sample Identification	Field Screening: Gross Alpha/Beta	Field Screening: Gross Gamma	Field or Off-Site Laboratory Measurements: Gross Alpha/Beta	Gamma Spectrometry	Total Uranium	Isotopic Plutonium	RCRA Metals (SW 6010)	SVOC (SW 8240)
Borehole Samples	1	5 - 10 ft		X	X	X	X	X	X	X	X
	2	5 - 10 ft		X	X	X	X	X	X	X	X
Total number of screening and analysis				2	2	2	2	2	2	2	2

TABLE E-5

SCREENING AND ANALYSIS FOR PHASE I BASE INVESTIGATIONS AREA 10

Sample Type	Sampling Location	Interval	Sample Identification	Field Screening: Gross Alpha/Beta	Field Screening: Gross Gamma	Field or Off-Site Laboratory Measurements: Gross Alpha/Beta	Gamma Spectrometry	Total Uranium	Isotopic Plutonium	RCRA Metals (SW 6010)	SVOC (SW 8240)	PCB (SW 8080)
Surface Soil	1	0.0 - 6.0 In		X	X	X	X	X	X	X		
	2	0.0 - 6.0 In		X	X	X	X	X	X	X		
	3	0.0 - 6.0 In		X	X	X	X	X	X	X		
	4	0.0 - 6.0 In		X	X	X	X	X	X	X		
	5	0.0 - 6.0 In		X	X	X	X	X	X	X		
	6	0.0 - 6.0 In		X	X	X	X	X	X	X		
	7	0.0 - 6.0 In		X	X	X	X	X	X	X		
	8	0.0 - 6.0 In		X	X	X	X	X	X	X		
	9	0.0 - 6.0 In		X	X	X	X	X	X	X		
	10	0.0 - 6.0 In		X	X	X	X	X	X	X		
	11	0.0 - 6.0 In		X	X	X	X	X	X	X		
	12	0.0 - 6.0 In		X	X	X	X	X	X	X		
	13	0.0 - 6.0 In		X	X	X	X	X	X	X	X	X
	14	0.0 - 6.0 In		X	X	X	X	X	X	X	X	X
	15	0.0 - 6.0 In		X	X	X	X	X	X	X	X	X
	16	0.0 - 6.0 In		X	X	X	X	X	X	X	X	X
	17	0.0 - 6.0 In		X	X	X	X	X	X	X	X	X
	18	0.0 - 6.0 In		X	X	X	X	X	X	X	X	X
QA/QC												
Rinsate Blank				X	X	X	X	X	X	X		
Field Duplicate				X	X	X	X	X	X	X		
Field Blank				X	X	X	X	X	X	X		
Total number of screening and analysis				21	21	21	21	11	11	11	6	6

TABLE E-6

SCREENING AND ANALYSIS FOR PHASE I BASE INVESTIGATIONS AREA 12

Sample Type	Sampling Location	Interval	Sample Identification	Field Screening: Gross Alpha/Beta	Field Screening: Gross Gamma	Field or Off-Site Laboratory Measurements: Gross Alpha/Beta	Gamma Spectrometry	Total Uranium	Isotopic Plutonium	RCRA Metals (SW 6010)	SVOC (SW 8240)	PCB (SW 8080)
Surface Soil Sample	1	0.0 - 6.0 In		X	X	X	X	X	X	X		
	2	0.0 - 6.0 In		X	X	X	X	X	X	X		
	3	0.0 - 6.0 In		X	X	X	X	X	X	X		
	4	0.0 - 6.0 In		X	X	X	X	X	X	X		
	5	0.0 - 6.0 In		X	X	X	X	X	X	X		
	6	0.0 - 6.0 In		X	X	X	X	X	X	X		
	7	0.0 - 6.0 In		X	X	X	X	X	X	X		
	8	0.0 - 6.0 In		X	X	X	X	X	X	X		
	9	0.0 - 6.0 In		X	X	X	X	X	X	X		
	10	0.0 - 6.0 In		X	X	X	X	X	X	X		
	11	0.0 - 6.0 In		X	X	X	X	X	X	X		
	12	0.0 - 6.0 In		X	X	X	X	X	X	X	X	X
	13	0.0 - 6.0 In		X	X	X	X	X	X	X	X	X
	14	0.0 - 6.0 In		X	X	X	X	X	X	X	X	X
	15	0.0 - 6.0 In		X	X	X	X	X	X	X	X	X
	16	0.0 - 6.0 In		X	X	X	X	X	X	X	X	X
	17	0.0 - 6.0 In		X	X	X	X	X	X	X	X	X
	18	0.0 - 6.0 In		X	X	X	X	X	X	X	X	X
	19	0.0 - 6.0 In		X	X	X	X	X	X	X	X	X
	20	0.0 - 6.0 In		X	X	X	X	X	X	X	X	X
QA/QC												
Rinsate Blank				X	X	X	X	X	X	X		
Field Duplicate				X	X	X	X	X	X	X		
Field Blank				X	X	X	X	X	X	X		
Total number of screening and analysis				23	23	23	23	12	12	12	9	9

TABLE E-1(APPENDIX E)

SCREENING AND ANALYSIS FOR PHASE I BASE INVESTIGATIONS

Sample Type	Sampling Location	Interval	Sample Identification	Field Screening: Gross Alpha/Beta	Field Screening: Gross Gamma	Field or Off-Site Laboratory Measurements: Gross Alpha/Beta	Gamma Spectrometry	Total Uranium	Isotopic Plutonium	RCRA Metals (SW 6010)
Surface Soil Sample	1	0.0 - 6.0 In		X	X	X	X	X	X	X
	2	0.0 - 6.0 In		X	X	X	X	X	X	X
	3	0.0 - 6.0 In		X	X	X	X	X	X	X
	4	0.0 - 6.0 In		X	X	X	X	X	X	X
	5	0.0 - 6.0 In		X	X	X	X	X	X	X
	6	0.0 - 6.0 In		X	X	X	X	X	X	X
	7	0.0 - 6.0 In		X	X	X	X	X	X	X
	8	0.0 - 6.0 In		X	X	X	X	X	X	X
	9	0.0 - 6.0 In		X	X	X	X	X	X	X
	10	0.0 - 6.0 In		X	X	X	X	X	X	X
	11	0.0 - 6.0 In		X	X	X	X	X	X	X
	12	0.0 - 6.0 In		X	X	X	X	X	X	X
	13	0.0 - 6.0 In		X	X	X	X	X	X	X
	14	0.0 - 6.0 In		X	X	X	X	X	X	X
	15	0.0 - 6.0 In		X	X	X	X	X	X	X
	16	0.0 - 6.0 In		X	X	X	X	X	X	X
	17	0.0 - 6.0 In		X	X	X	X	X	X	X
	18	0.0 - 6.0 In		X	X	X	X	X	X	X
	19	0.0 - 6.0 In		X	X	X	X	X	X	X
	20	0.0 - 6.0 In		X	X	X	X	X	X	X
QA/QC										
Rinsate Blank				X	X	X	X	X	X	X
Field Duplicate				X	X	X	X	X	X	X
Field Blank				X	X	X	X	X	X	X
Total number of screening and analysis				23	23	23	23	12	12	12

TABLE E-7 (b)

SCREENING AND ANALYSIS FOR PHASE I SURFACE INVESTIGATIONS AREA 2

Sample Type	Sampling Location	Interval	Sample Identification	Field Screening: Gross Alpha/Beta	Field Screening: Gross Gamma	Field or Off-Site Laboratory Measurements: Gross Alpha/Beta	Gamma Spectrometry	Total Uranium	Isotopic Plutonium	RCRA Metals (SW 6010)
Surface Soil Sample	1	0.0 - 6.0 In		X	X	X	X	X	X	X
	2	0.0 - 6.0 In		X	X	X	X	X	X	X
	3	0.0 - 6.0 In		X	X	X	X	X	X	X
	4	0.0 - 6.0 In		X	X	X	X	X	X	X
	5	0.0 - 6.0 In		X	X	X	X	X	X	X
	6	0.0 - 6.0 In		X	X	X	X	X	X	X
	7	0.0 - 6.0 In		X	X	X	X	X	X	X
	8	0.0 - 6.0 In		X	X	X	X	X	X	X
	9	0.0 - 6.0 In		X	X	X	X	X	X	X
	10	0.0 - 6.0 In		X	X	X	X	X	X	X
	11	0.0 - 6.0 In		X	X	X	X	X	X	X
	12	0.0 - 6.0 In		X	X	X	X	X	X	X
	13	0.0 - 6.0 In		X	X	X	X	X	X	X
	14	0.0 - 6.0 In		X	X	X	X	X	X	X
	15	0.0 - 6.0 In		X	X	X	X	X	X	X
	16	0.0 - 6.0 In		X	X	X	X	X	X	X
	17	0.0 - 6.0 In		X	X	X	X	X	X	X
	18	0.0 - 6.0 In		X	X	X	X	X	X	X
	19	0.0 - 6.0 In		X	X	X	X	X	X	X
	20	0.0 - 6.0 In		X	X	X	X	X	X	X
QA/QC										
Rinsate Blank				X	X	X	X	X	X	X
Field Duplicate				X	X	X	X	X	X	X
Field Blank				X	X	X	X	X	X	X

TABLE E-7 (b)
(continued)
SCREENING AND ANALYSIS FOR PHASE I SURFACE INVESTIGATIONS AREA 2

Sample Type	Sampling Location	Interval	Sample Identification	Field Screening: Gross Alpha/Beta	Field Screening: Gross Gamma	Field or Off-Site Laboratory Measurements: Gross Alpha/Beta	Gamma Spectrometry	Total Uranium	Isotopic Plutonium	RCRA Metals (SW 6010)
Surface Soil Sample	21	0.0 - 6.0 In		X	X	X	X	X	X	X
	22	0.0 - 6.0 In		X	X	X	X	X	X	X
	23	0.0 - 6.0 In		X	X	X	X	X	X	X
	24	0.0 - 6.0 In		X	X	X	X	X	X	X
	25	0.0 - 6.0 In		X	X	X	X	X	X	X
	26	0.0 - 6.0 In		X	X	X	X	X	X	X
	27	0.0 - 6.0 In		X	X	X	X	X	X	X
	28	0.0 - 6.0 In		X	X	X	X	X	X	X
	29	0.0 - 6.0 In		X	X	X	X	X	X	X
	30	0.0 - 6.0 In		X	X	X	X	X	X	X
	31	0.0 - 6.0 In		X	X	X	X	X	X	X
	32	0.0 - 6.0 In		X	X	X	X	X	X	X
	33	0.0 - 6.0 In		X	X	X	X	X	X	X
	34	0.0 - 6.0 In		X	X	X	X	X	X	X
	35	0.0 - 6.0 In		X	X	X	X	X	X	X
	36	0.0 - 6.0 In		X	X	X	X	X	X	X
	37	0.0 - 6.0 In		X	X	X	X	X	X	X
	38	0.0 - 6.0 In		X	X	X	X	X	X	X
	39	0.0 - 6.0 In		X	X	X	X	X	X	X
	40	0.0 - 6.0 In		X	X	X	X	X	X	X
QA/QC										
Rinsate Blank				X	X	X	X	X	X	X
Field Duplicate				X	X	X	X	X	X	X
Field Blank				X	X	X	X	X	X	X

TABLE E-7 (b)
(continued)
SCREENING AND ANALYSIS FOR PHASE I SURFACE INVESTIGATIONS AREA 2

				Field Screening		Field or Off-Site Laboratory Measurements				
Sample Type	Sampling Location	Interval	Sample Identification	Gross Alpha/Beta	Gross Gamma	Gross Alpha/Beta	Gamma Spectrometry	Total Uranium	Isotopic Plutonium	RCRA Metals (SW 6010)
Surface Soil Sample	41	0.0 - 6.0 In		X	X	X	X	X	X	X
	42	0.0 - 6.0 In		X	X	X	X	X	X	X
	43	0.0 - 6.0 In		X	X	X	X	X	X	X
	44	0.0 - 6.0 In		X	X	X	X	X	X	X
	45	0.0 - 6.0 In		X	X	X	X	X	X	X
	46	0.0 - 6.0 In		X	X	X	X	X	X	X
	47	0.0 - 6.0 In		X	X	X	X	X	X	X
	48	0.0 - 6.0 In		X	X	X	X	X	X	X
Total number of screening and analysis				54	54	54	54	27	27	27

TABLE E-7 (c)

SCREENING AND ANALYSIS FOR PHASE I SURFACE INVESTIGATIONS AREA 3

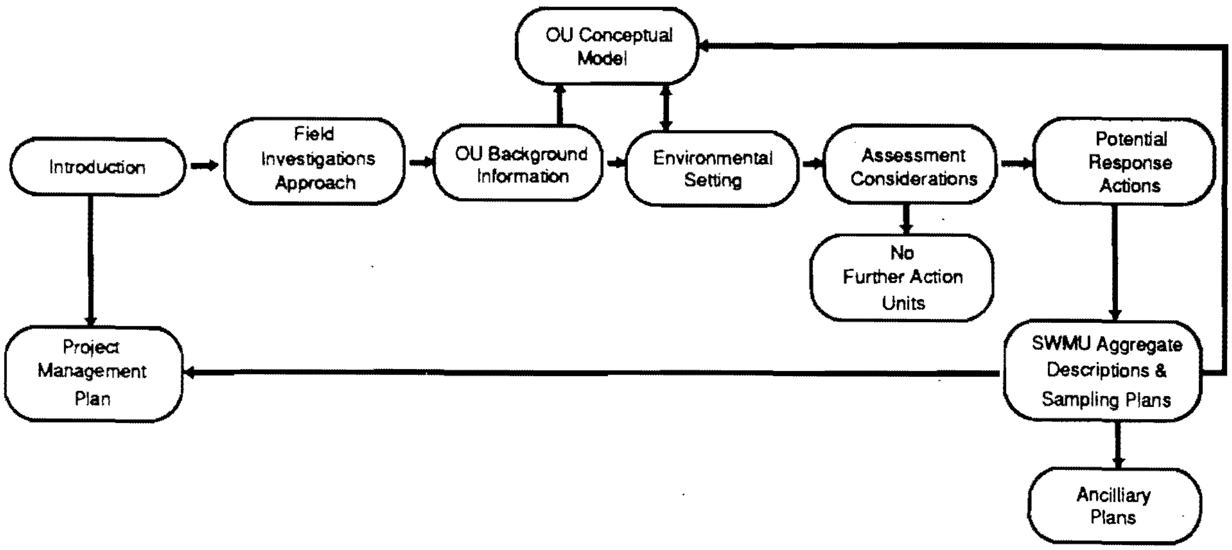
Sample Type	Sampling Location	Interval	Sample Identification	Field Screening: Gross Alpha/Beta	Field Screening: Gross Gamma	Field or Off-Site Laboratory Measurements: Gross Alpha/Beta	Gamma Spectrometry	Total Uranium	Isotopic Plutonium	RCRA Metals (SW 6010)
Surface Soil Sample	1	0.0 - 6.0 In		X	X	X	X	X	X	X
	2	0.0 - 6.0 In		X	X	X	X	X	X	X
	3	0.0 - 6.0 In		X	X	X	X	X	X	X
	4	0.0 - 6.0 In		X	X	X	X	X	X	X
	5	0.0 - 6.0 In		X	X	X	X	X	X	X
	6	0.0 - 6.0 In		X	X	X	X	X	X	X
	7	0.0 - 6.0 In		X	X	X	X	X	X	X
	8	0.0 - 6.0 In		X	X	X	X	X	X	X
	9	0.0 - 6.0 In		X	X	X	X	X	X	X
	10	0.0 - 6.0 In		X	X	X	X	X	X	X
	11	0.0 - 6.0 In		X	X	X	X	X	X	X
	12	0.0 - 6.0 In		X	X	X	X	X	X	X
	13	0.0 - 6.0 In		X	X	X	X	X	X	X
	14	0.0 - 6.0 In		X	X	X	X	X	X	X
	15	0.0 - 6.0 In		X	X	X	X	X	X	X
	16	0.0 - 6.0 In		X	X	X	X	X	X	X
	17	0.0 - 6.0 In		X	X	X	X	X	X	X
	18	0.0 - 6.0 In		X	X	X	X	X	X	X
	19	0.0 - 6.0 In		X	X	X	X	X	X	X
	20	0.0 - 6.0 In		X	X	X	X	X	X	X
QA/QC										
Rinsate Blank				X	X	X	X	X	X	X
Field Duplicate				X	X	X	X	X	X	X
Field Blank				X	X	X	X	X	X	X
Total number of screening and analysis				23	23	23	23	12	12	12

TABLE E-7 (d)

SCREENING AND ANALYSIS FOR PHASE I SURFACE INVESTIGATIONS AREA 4

Sample Type	Sampling Location	Interval	Sample Identification	Field Screening: Gross Alpha/Beta	Field Screening: Gross Gamma	Field or Off-Site Laboratory Measurements: Gross Alpha/Beta	Gamma Spectrometry	Total Uranium	Isotopic Plutonium	RCRA Metals (SW 6010)
Surface Soil Sample	1	0.0 - 6.0 In		X	X	X	X	X	X	X
	2	0.0 - 6.0 In		X	X	X	X	X	X	X
	3	0.0 - 6.0 In		X	X	X	X	X	X	X
	4	0.0 - 6.0 In		X	X	X	X	X	X	X
	5	0.0 - 6.0 In		X	X	X	X	X	X	X
	6	0.0 - 6.0 In		X	X	X	X	X	X	X
	7	0.0 - 6.0 In		X	X	X	X	X	X	X
	8	0.0 - 6.0 In		X	X	X	X	X	X	X
	9	0.0 - 6.0 In		X	X	X	X	X	X	X
	10	0.0 - 6.0 In		X	X	X	X	X	X	X
	11	0.0 - 6.0 In		X	X	X	X	X	X	X
	12	0.0 - 6.0 In		X	X	X	X	X	X	X
	13	0.0 - 6.0 In		X	X	X	X	X	X	X
	14	0.0 - 6.0 In		X	X	X	X	X	X	X
	15	0.0 - 6.0 In		X	X	X	X	X	X	X
	16	0.0 - 6.0 In		X	X	X	X	X	X	X
	17	0.0 - 6.0 In		X	X	X	X	X	X	X
	18	0.0 - 6.0 In		X	X	X	X	X	X	X
	19	0.0 - 6.0 In		X	X	X	X	X	X	X
	20	0.0 - 6.0 In		X	X	X	X	X	X	X
QA/QC										
Rinsate Blank				X	X	X	X	X	X	X
Field Duplicate				X	X	X	X	X	X	X
Field Blank				X	X	X	X	X	X	X
Total number of screening and analysis				23	23	23	23	12	12	12

APPENDIX F



Radiological Survey Methods

APPENDIX F - RADIOLOGICAL SURVEY METHODS

F.1 Introduction

Radiological field surveys are primarily scans of the land surface using direct reading or recording instruments. For the TA-49 OU work plan, radiological surveys are used to identify and refine locations where contamination above screening levels may exist. While negative field survey results are not necessarily conclusive evidence for the absence of elevated levels of radioactive contaminants, the probability that such contamination exists can be minimized with the proper design and execution of radiological surveys. When elevated contamination levels are detected, survey equipment allows the precise location of hot spots to be determined for subsequent discrete soil sampling.

Radiological surveys to detect surface contamination are exceptionally convenient and rapid to carry out. Survey methods have the disadvantage that the x-ray and gamma-ray signatures are strongly attenuated by solid matter, and therefore contamination below the surface (in most cases, depths greater than 1-2 in.) are not detected reliably. A second disadvantage is that minimum detection limits are highly isotope specific, depending upon the nuclear characteristics of the decaying isotope.

F.2 Gross Gamma Surveys

Several instruments available that are suitable for gamma surveys include: micro-R meters, NaI detectors of various sizes (with ratemeters and scalers), and Geiger-Mueller detectors. The preferred instruments are micro-R meters with the ability to measure 5µR/hr, and 2-in. by 2-in. NaI detectors with a ratemeter capable of displaying 100 cpm. Some discrete-measurement or continuous-measurement instruments also are available using the same detectors. Surveys typically are conducted by carrying these instruments at waist height at a slow walking pace and observing and recording the ratemeter response. Measurement also may be made at the ground surface to aid in identifying the presence of localized contamination. The applicable LANL ER SOP is

- Measurement of Gamma Radiation Using a Sodium Iodide (NaI) Detector

F.3 Low-Energy Gamma Surveys

FIDLER and PHOSWICH instruments are most commonly used to detect radionuclides which emit low-energy gamma and x-ray radiation. Both instruments are optimized to detect low-energy photons, such as the 60 keV gamma emission from americium-241 or the x-rays that accompany the decay of most heavy radionuclides including uranium, plutonium, and other transuranics. Discrete- or continuous-measurement recording options are available. Surveys typically are conducted by carrying the instruments close to the ground surface, or attaching the instruments to tripods, and observing the ratemeter or scalar. Also, measurements may be made at the ground surface to indentify and precisely locate highly localized contamination. The applicable SOPs are:

- Near Surface and Soil Sample Screening for Low-Energy Gamma Radiation using the FIDLER

- Near Surface and Soil Sample Screening for Low-Energy Gamma Radiation using the PHOSWICH

F.4 Gamma Spectrometry Systems

The Energy Measurements Division of EG&G-Las Vegas operates the Department of Energy's Remote Sensing Laboratory. This laboratory maintains state of the art ground- and airborne-vehicle based gamma spectrometry systems which have been valuable duriong a number of environmental studies involving radioactive contamination at DOE, DoD, and other sites (see Table F.4-1). Figure F.4-1 contains photographs of typical tripod-mounted and ground-vehicle based *in situ* systems used in a recent radiological survey of surface soils at the DOE's Rocky Flats Plant.

Ground-based (*in situ*) gamma spectrometry systems (shown in Figure F.4-1) use liquid nitrogen-cooled high purity germanium (HPGe) detectors mounted on an easily-moved tripod, or on a retractable arm attached to a four-wheel drive vehicle. The retractable arm on the vehicle-based system allows the detector's height above ground to be varied from essentially ground level to about ten meters. A height of about 7.5 meters typically is used, and lead collimators can be used to vary the cone angle available to the detector's sensor.

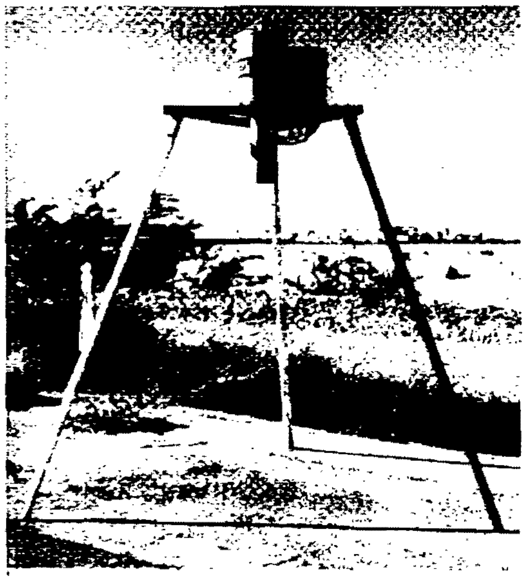
The vehicle also contains a computer processing facility so raw data processing and preliminary contamination mapping can be performed in real time in the field. Subsequent refinement of the data occurs offsite resulting in a map of individual radionuclides (or groups of radionuclides emitting gamma rays of similar energy). Airborne gamma spectrometry systems differ from ground-based systems because they use arrays of sensitive detectors.

Minimum detectable activities for several radionuclides of interest for the TA-49 OU are listed in Table F.4-2. MDAs are listed for both ground-based (*in situ*) and aerial-based systems. Because gamma-rays are strongly attenuated by solid matter, gamma survey methods are useful only for the uppermost portion of the soil horizon. For example, for the 60 keV emission characterizing americium-241, for a uniform distribution with depth, approximately 95% of the unscattered gamma rays reaching the detector would originate within the top 6 cm of the soil and approximately 99% would originate within the top 9 cm.

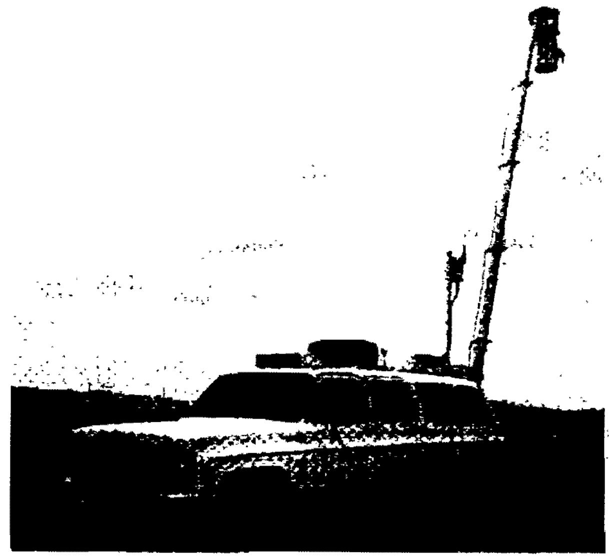
Table F.4-1. Past environmental applications of the Remote Sensing Laboratory's gamma spectrometry systems.

SITE	SURVEY LOCATION	DATE	ISOTOPES OF INTEREST	APPLICATION
Enewetak Atoll	Western Pacific	7/77-12/79	Am^{241}	Cleanup
Gnome	Carlsbad, New Mexico	8/77-9/77	Cs^{137}	Assessment
Johnston Atoll	Western Pacific	4/80-8/80	Am^{241}	Mapping
Middlesex Plant	Middlesex, New Jersey	7/80-11/80	Ra^{226}	Cleanup
Kellex	Jersey City, New Jersey	9/80-11/80	$U^{235,238}$ Th^{232}	Assessment
Area 11	Nevada Test Site	6/81-9/81	Am^{241}	Cleanup
Areas 2, 15, and 21	Los Alamos Natl. Lab.	9/82	Am^{241} Cs^{137}, U^{238}	Mapping
Areas 1-13, 15-20, 25, 26 and 30	Nevada Test Site	6/81-3/86	All measurable	Mapping/ Inventory
Maralinga	South Australia	5/87-7/87	Am^{241}, Cs^{137}, U^{238}	Survey support
Rocky Flats Plant	Golden, Colorado	12/90	Am^{241}, $U^{235,238}$	Assessment

Figure F.4-1. Photographs of *in situ* gamma spectrometry systems operated by the Remote Sensing Laboratory. Photographs are from EG&G (1990).



Tripod Based Sampling System



Surburban Sampling System

Table F.4-2. Typical minimum detectable activities (MDAs) for surface soils using the Remote Sensing Laboratory's *in situ* and helicopter-based gamma spectrometry systems.[1]

ISOTOPE	HELICOPTER[2] $\mu Ci/m^2$	*IN SITU*[3] $\mu Ci/m^2$
Am^{241}	0.1	0.006
Pu^{239}	400	30
U^{235}	0.03	0.003
U^{238}	1.0	0.04
Cs^{137}	0.02	0.002
I^{131}	0.02	0.002
Co^{60}	0.01	0.001

1) An infinite (uniform) surface distribution of radionuclides is assumed. MDAs are from the EG&G reports cited in the reference list. Actual values can vary by a factor of two or more at specific sites, depending upon background.

2) Altitude 30 m, speed 60 knots, 20 NaI(Tl) detectors (12.7 cm x 5.1 cm), 1 second acquisition time.

3) Height 1 m, 20% n-Type High Purity Germanium Detector, 10 min. acquisition time.

Minimum detectable activities also are strongly isotope dependent, as indicated in Table F.4-2. Isotope dependency is due both to the energy of the emission (lower energies are more strongly attenuated and give lower detector response) and the branching factor (fraction of radioactive decays which give rise to gamma ray emission). Of particular relevance to the investigation for the TA-49 OU is the relatively low sensitivity to plutonium emissions, primarily due to the low branching factor. However, sensitivity is excellent to cesium-137, uranium-235 and -238, and americium-241 (the daughter product of the relatively short lived isotope plutonium-241). All of these are important contaminants of concern at the TA-49 OU. The spectrometer system can be optimized for specific isotopes of interest in the survey.

The usual approach for deducing plutonium distributions from gamma-ray techniques is to measure the easily-detected signature from americium-241 and to apply a factor accounting for the americium/plutonium ratio at the site. This approach assumes that the ratio does not vary over the site due to either partitioning of americium and plutonium by environmental processes or the existence of plutonium at various ages and initial isotopic mixtures.

Fractionation of americium and plutonium in the environment has rarely been observed, and past studies generally have shown the process to be negligible at arid or semiarid sites such as TA-49. In addition, the plutonium and americium source history at TA-49 is unusually well defined. Therefore, the TA-49 OU is especially well suited to use americium surface survey results to deduce plutonium levels. In any case, the plutonium/americium levels will be measured at all TA-49 SWMUs from discrete sampling to confirm that the americium/plutonium is adequately well known and the ratio is invariant across the OU.

Results from radiological surveys usually are expressed in units of $\mu Ci/m^2$. Conversion to units of pCi/g requires some knowledge or assumptions about the vertical and lateral distribution of the radionuclide in the soil.

Source term size also has a strong impact on lower detection limits. Table F.4-3 and Figure F.4-2 give some conversion factors and illustrate the lower sensitivity for point versus uniformly distributed sources. For example, consider a typical *in situ* system configuration with a detector height of 7.4 m and a corresponding field of view of about 300 m^2 (20 m diameter). For a uniform surface distribution of americium-241, the minimum detectable activity (MDA) is about 11 pCi/g, or 0.36 mCi for a point source. This sensitivity is comparable to, or better than, that of FIDLER or PHOSWICH systems (not radionuclide-specific) operating at a height of about one meter above land surface, with a corresponding survey area of several square meters.

Figure F.4-2. Typical MDAs and distributed source MDA curve for Rocky Flats buffer zone surface soils. Data are from the report on the *in situ* survey of Rocky Flats (ESG 1991).

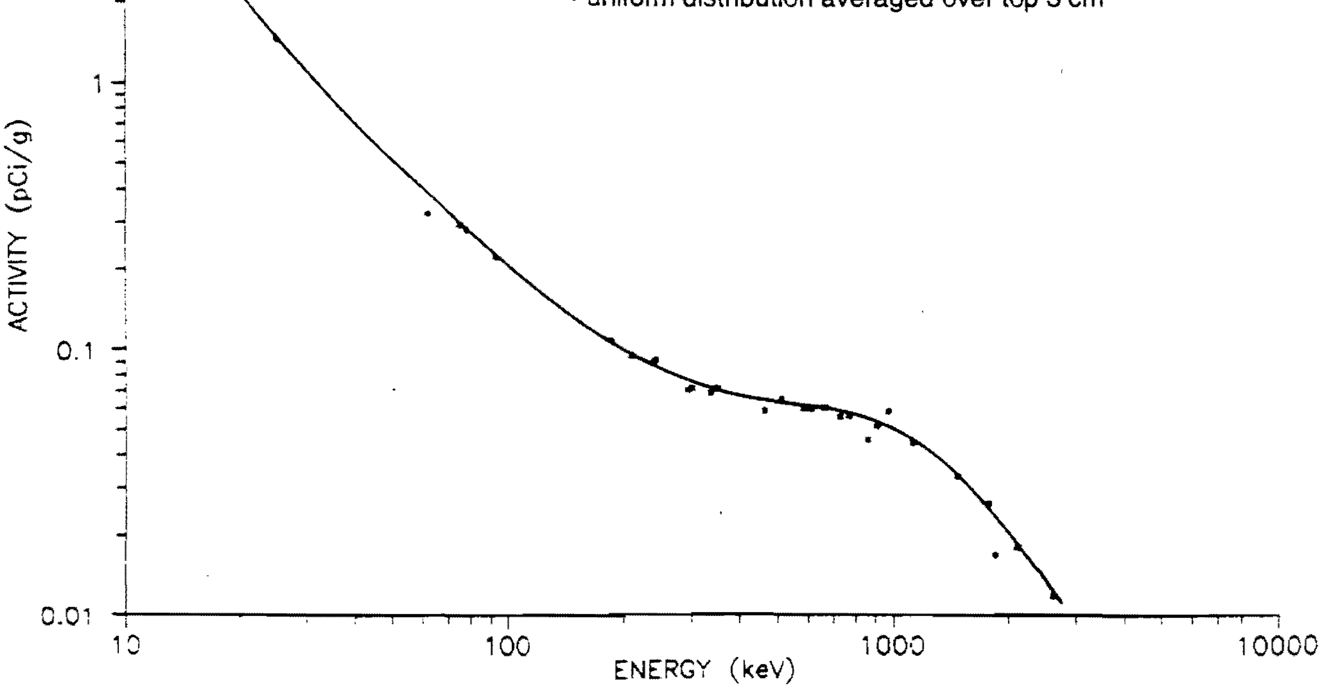
ISOTOPE	MDA (pCi/g)
Am^{241}	0.9
Cs^{137}	0.1
U^{238}	4.1
Ra^{226}	0.2
Th^{232}	0.2
K^{40}	0.2

MDA = Minimum Detectable Activity = A/B where

A = Activity read on graph (pCi/g) for B=1

B = Branching rates (gamma/disintegration)

For:
- three standard deviation statistical uncertainty of typical background spectrum
- 15 minute acquisition time
- 20 % Bare N-type HPGe detector
- 7.5 meter detector elevation
- 46 meter grid
- uniform distribution averaged over top 3 cm



DISTRIBUTED SOURCE MDA CURVE

Table F.4-3. Geometric factors influencing minimum detectable activities. Data are from the report on the aerial radiological survey of the Rocky Flats Plant (ESG 1990).

Minimum Detectable Activity for Several Selected Radioisotopes as a Function of Source Geometries*			
	Surface Sources		Volume Source
Isotope	Point Source (mCi)	Distributed Source ($\mu Ci/m^2$) $\alpha = \infty$	$\left(\frac{pCi}{g}\right)^{**}$ $\alpha = 10$ cm
Am-241	2.9	0.35	11.2
Cs-137	0.27	0.028	0.35

* Assuming a survey altitude of 46 meters.

** Conversion factor to pCi/g relate to the average value of a 5-cm deep soil sample.

Finite Am-241 Source Correction Factors Versus Area of Contamination	
Source Diameter (meters)	Correction Factor
10	37
20	9
40	3.5
60	2.2
80	1.6
100	1.3
140	1.1
>140	1.0

Correction Factors Versus Area of Contamination	
Diameter of Contaminated Circular Area (meters)	Correction Factor
5	300
10	100
25	10
50	6.5
100	2.5
200	1.2
300	1.0
∞	1.0

REFERENCES

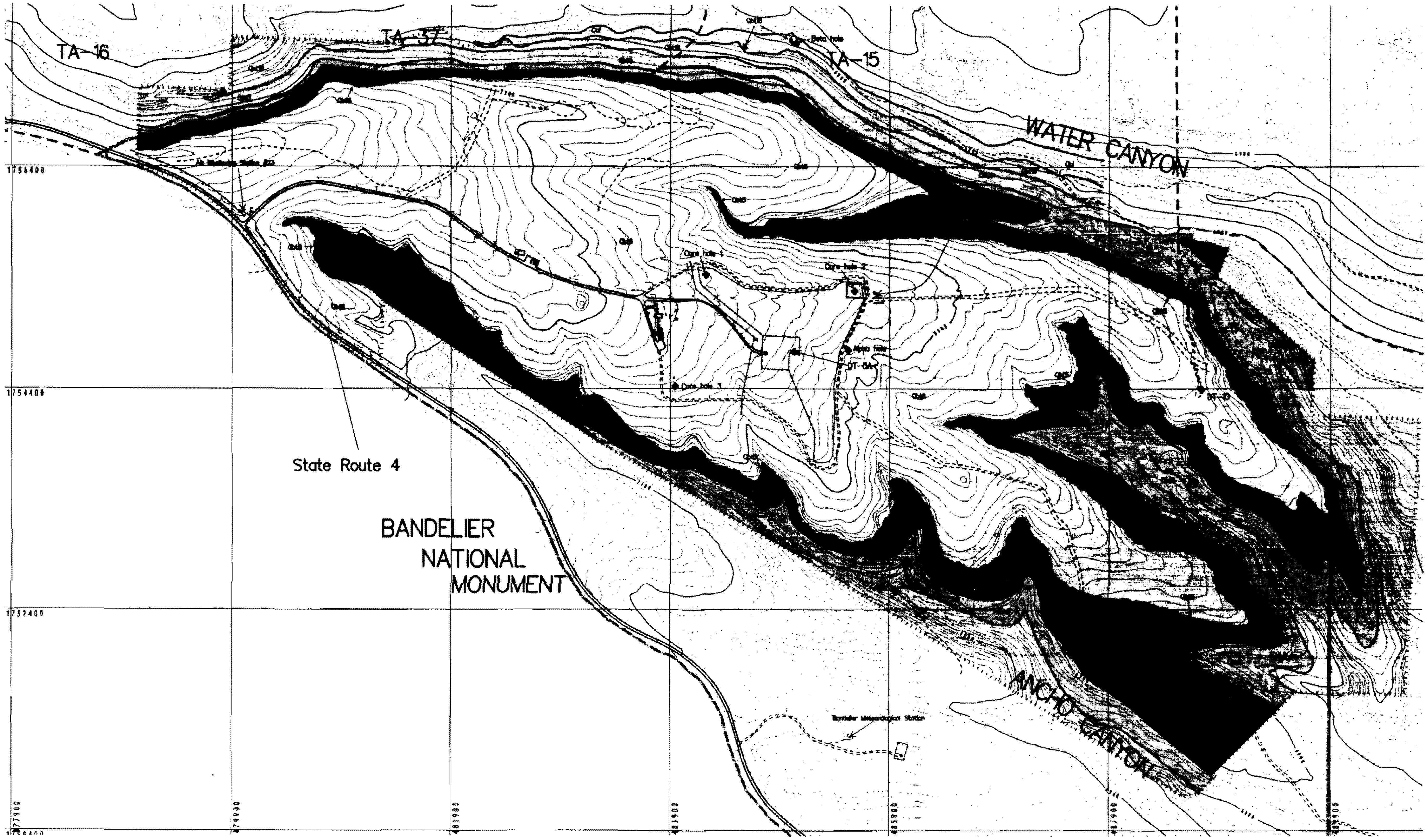
EG&G , "An Aerial Radiological Survey of the United States Department of Energy's Rocky Flats Plant and Surrounding Area", EG&G-10617-1044, UC-702, May 1990.(EG&G 1990).

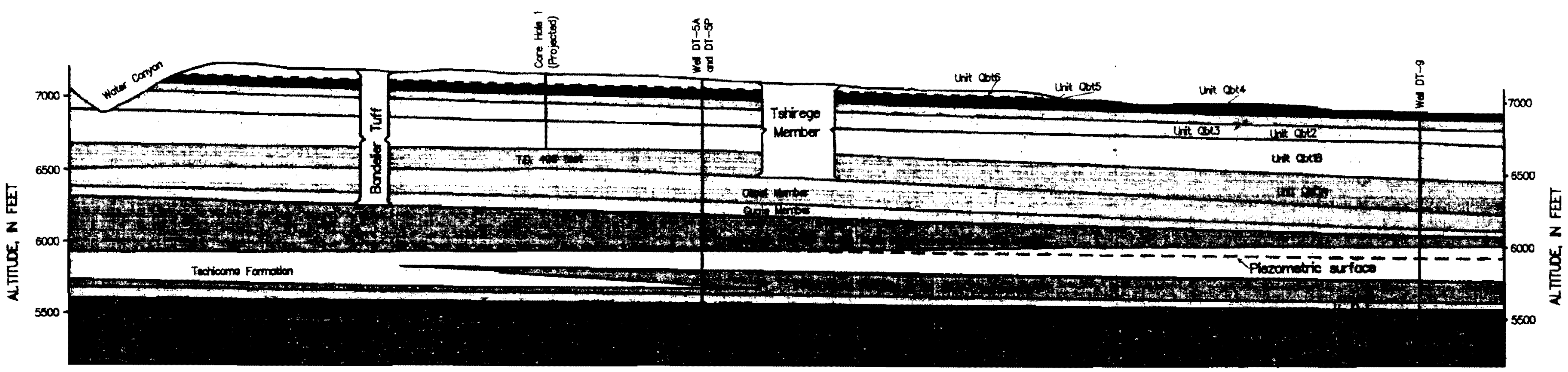
EG&G, "*In Situ* Surveys of United States Department of Energy's Rocky Flats Plants", EGG-10617-1129, UC-702, May 1991 (EG&G 1991).

EG&G , "An *In Situ* Determination of ^{241}Am on Enewetak Atoll", EGG-1183-1778, UC-41, November 1981 (EG&G 1981).

APPENDIX G
HYDROGEOLOGIC MAP OF TA-49
MAY 1992

OU-1144 GEOLOGY OF WEIR AND PURTYMUN (1962)





Compiled by W.D. Purtymun, 1981

CROSS SECTION B – B'

LEGEND

Boundary, OU
Boundary, TA
Contours, 10 foot
Contours, 100 foot
Fence, Industrial
Roads, Dirt
Roads, Paved
Road/Trail

GEOLOGIC UNITS

Qal - Alluvium; mapped only in Water Canyon

Qbt6 - Unit 6; light-pinkish-gray to brownish-pink, moderately welded, rhyolite tuff; cliff-forming unit. Locally includes 2-6 feet of water-laid pumice at top. Covered by thin clayey soil on flat upland areas

UNCONFORMITY?

Qbt5 - Unit 5; light-gray, cross-bedded, medium- to coarse-grained tuffaceous sand 0-4 feet thick; forms notch in cliff (referred to as a surge deposit in TA-49 RFI workplan)

UNCONFORMITY

Qbt4 - Unit 4; gray, friable to moderately welded, pumiceous, rhyolite tuff; cliff-forming unit

Qbt3 - Unit 3; light-gray, friable, pumiceous, rhyolite tuff; slope-forming unit

Qbt2 - Unit 2; light-purplish-gray, welded, rhyolite tuff; cliff-forming unit

Qbt1B - Unit 1B; light-gray to light-pink, pumiceous, rhyolite tuff containing numerous rock fragments; slope-forming unit

Limit of mapping

Geologic contact, mostly concealed; drawn mainly on the basis of topographic expression

Note: All geology taken directly from Weir and Purtymun, and has not been checked for accuracy. Geologic units are not consistent with those of later workers in other portions of the Laboratory.

NORTH, NM State Plane

Grid provides NMSP coordinates, in feet

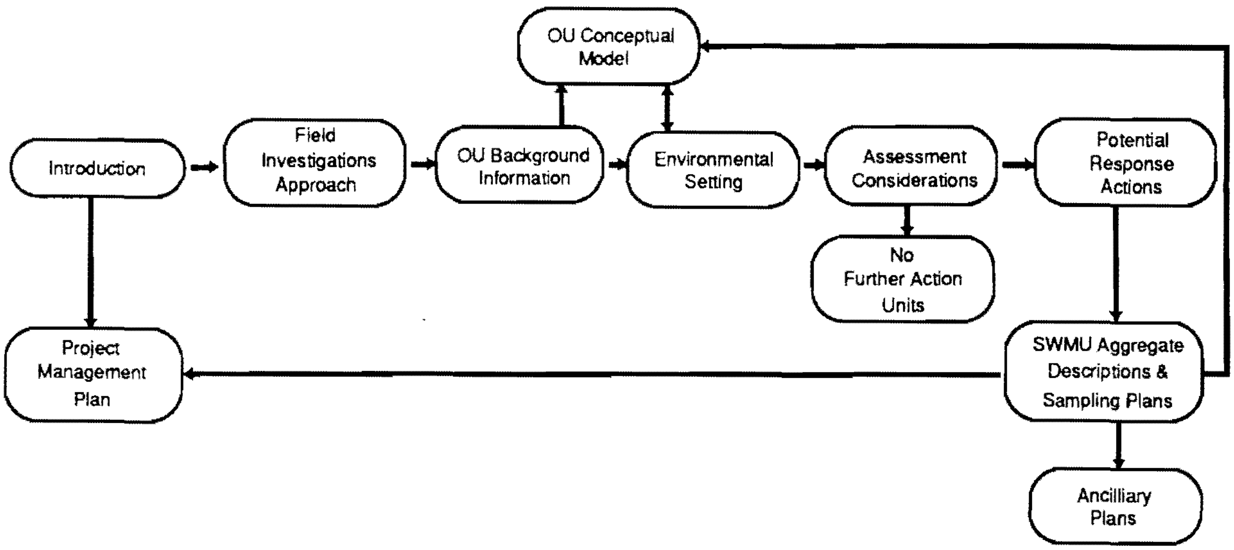
Grid interval, in feet: 2000

0 600 1200 1800 FEET ON GROUND

NOTICE: Information on this map is provisional and has not been checked for accuracy

University of California
Los Alamos National Laboratory
Earth & Environmental Sciences Division
FIMAD Facility for Information Management, Analysis and Display
Produced by: Doug Walther
Date: 92-05-05

APPENDIX H



TA-49 Operable Unit Work Plan Contributors: Education and Relevant Experience

APPENDIX H

TA-49 OPERABLE UNIT WORK PLAN CONTRIBUTORS:

EDUCATION AND RELEVANT EXPERIENCE

I. Administrative Management

NAME AND AFFILIATION	EDUCATION/EXPERTISE	ER PROGRAM ASSIGNMENT
P. Gary Eller	Ph.D. Inorganic Chemistry * 18 years experience in actinide and environmental chemistry research, process development and line/ project management. Over 100 publications in peer-reviewed journals. Member of national/international committees in actinide chemistry.	Project Leader for TA-49 Operable Unit
Robert Vocke, HSE-13	Ph.D. Water Resources * 15 years experience in hazardous waste site assessment, including waste management, regulatory compliance, and program management.	ER Program Manager; EM-13 Group Leader
Lars Soholt, HSE-13	Ph.D. Biology * 20 years experience in assessment of energy and waste management systems, including project management experience.	ER Programmatic Project Leader

II. Technical Contributors

NAME AND AFFILIATION	EDUCATION/EXPERTISE	TA-49 OU ASSIGNMENT
Kathryn D. Bennett, EM-8	M.S. Environmental Science * 2 years experience in NEPA biological activities including Laboratory wetlands evaluation, endangered/threatened species studies, and environmental database development.	NEPA biological evaluation
Clarence J. Duffy, INC-7	Ph.D. Geology * 15 years experience in mineral thermodynamics and phase equilibria. 10 years experience in geochemistry of high level nuclear waste storage (Yucca Mountain Project). 15 years experience in computer code development for data reduction and for modeling mineral thermodynamics and phase equilibria. LANL-ER technical team leader for background studies.	Hydrogeochemistry

T. S. Foxx, EM-8	M.S. Biology * 17 years field ecology and waste site characterization experience. Adjunct Professor, University New Mexico. Author of books and publications on plant and fire ecology.	NEPA biological evaluation
W. C. Francis, Consultant	• Graduate of Kansas City Jr. College. Civil/mechanical engineering courses at University of Kansas and University of New Mexico. Forty years experience in field engineering and surveying, and 35 years LANL supervisory experience. Extensive knowledge of maintenance/construction at virtually all Laboratory technical areas.	Technical review arrival research
Jamie N. Gardner, EES-1	Ph.D. Geology • 15 years experience as a petrologist and structural geologist on petrologic and geothermal problems in a variety of young volcanic systems all over the western United States and Central America. Framework Studies technical team leader for the ER program.	Geology
Doris Garvey, EM-8	M.S. Economics • 6 years experience in Laboratory NEPA programs and management experience in compliance and CEARP activities.	NEPA
Elizabeth J. Kelly, A-1	Ph.D. Biostatistics * 3 years experience in devising sampling plans and data analysis techniques for environmental studies including surface covers, site integrity and decision analysis for ER programs.	Statistics, risk assessment
Beverly Larson, EM-8	M.A. Anthropology, Ph.D. Candidate in Anthropology • 16 years field experience, including 6 years as Laboratory archaeologist. Adjunct processor, University of New Mexico.	NEPA cultural evaluation
P. A. Longmire, INC-4	Ph.D. in Hydrogeochemistry • 16 years combined experience in field hydrology and geochemistry, regulatory oversight (NMEID), UMTRA project, and RCRA/CERCLA remediation (R.F. Weston and LATA). Principal Instructor for Ground Water Geochemistry and	Hydrogeochemistry

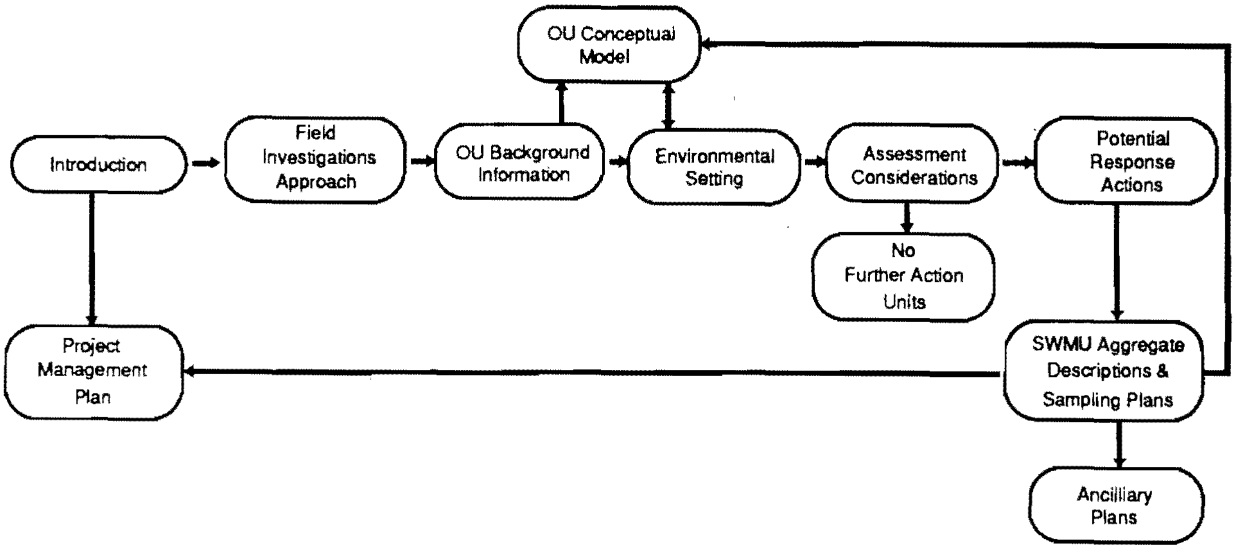
	Geochemical Modeling courses for American Assoc. of Groundwater Scientists and Engineers. Numerous publications in the field.	
Arend Meijer, INC-7	Ph.D. Geochemistry • 20 years experience in geochemistry field and laboratory studies. Adsorption studies Project leader for for the Yucca Mountain Project.	Hydrogeochemistry
Leslie M. Moore, A-1	Ph.D. Mathematics (Statistics) • 6 years experience in statistical support and consulting assistance in nuclear waste siting programs.	Statistics, risk assessment
T. L. Morgan, INC-7	M.S. Engineering Geology • 15 years experience in hydrology field studies, regulatory oversight (NMED), NURE project and plutonium process chemistry. Currently QA leader for INC division activities in the Yucca Mountain Project.	QA, HS&E, hydrology
R. A. Penneman, Consultant	Ph.D. Inorganic Chemistry, Sc.D.(h.c.) * 49 years experience in actinide chemistry and radiation chemistry. Extensive group and management experience at LANL. Over 150 publications in peer-reviewed journals. Member of national/international committees on actinide chemistry.	Technical review, archival research

III. Administrative Support

NAME AND AFFILIATION	EDUCATION/EXPERIENCE	TA-49 OU ASSIGNMENT
Beverly Campbell	• 20 years office management and 10 years word processing.	Coordination, work plan preparation
Mark Ritchey, INC-DO	• Senior in Environmental Biology, Fort Lewis College Working on internship at LANL.	Work plan preparation, technical review
Andrew Calkins, INC-DO	• Senior in Technical Communication, New Mexico Tech. Working on internship at LANL	Work plan preparation, technical editing

Jody Heiken, INC-DO	B.A. English • 11 years experience in technical writing/editing; 5 years as science librarian. Publications in technical writing and library journals.	Technical Editor
Garth Tietjen	B.S. in Illustration, Associate in Design * 11 years experience in technical illustration and design.	Technical Illustrations
Yvonne Herring	• 9 years office experience and word processing.	Work plan preparation
Cindy Maestas	• 8 years office experience and word processing.	Work plan preparation
Aimee Partain, INC-DO	• Sophomore in Environmental Engineering, New Mexico Tech.	Work plan preparation, technical review
Chris Martinez	• Senior, Espanola Valley High School	Work Plan Preparation, Illustration

APPENDIX I



National Environmental Policy Act and Related Documents

APPENDIX I

NATIONAL ENVIRONMENTAL POLICY ACT AND RELATED DOCUMENTS

The NEPA evaluation and document preparation for TA-49 is an ongoing process. Updates to this section will be made as documents become available.

The status of TA-49 NEPA work as of May 20, 1992 is as follows:

Descriptive Title	Status of Document
• NEPA	
DOE Environmental Checklist (DEC)	LANL Internal Review
• Cultural Resources	
Initial Survey summary	In progress
Final Report	In progress
• Biological Resources	
Initial Survey Report	Completed
Final Report	Completed and under review

BIOLOGICAL SUMMARY
TA-49
OPERABLE UNIT # 1144

1.0 INTRODUCTION AND FURTHER INFORMATION

During 1991, field surveys were conducted by the Biological Resource Evaluations Team of the Environmental Protection Group (EM-8) for Operable Unit 1144, Technical Area 49 (Site Characterization). Site Characterization requires surface and subsurface sampling within the TA. Further information concerning the biological field surveys for Operable Unit 1144 is contained in the full report "Biological Assessment for Environmental Restoration Program, Operable Unit 1144". The Biological Assessment will contain specific information on survey methodology, results and mitigation measures. This assessment will also contain information that may aid in defining ecological pathways and vegetation restoration.

DRAFT

2.0 LAWS

Field surveys were conducted for compliance with the Federal Endangered Species Act of 1973, New Mexico's Wildlife Conservation Act, New Mexico Endangered Plant Species Act, Executive Order 11990 "Protection of Wetlands" and Executive Order 11988 "Floodplain Management", 10 CFR 1022 and DOE Order 5400.1.

3.0 METHODOLOGY

The purpose of the surveys was three-fold. The first was to determine the presence or lack of presence of any critical habitat for any State or Federal sensitive, threatened, or endangered plant or animal species within the Operable Unit boundaries. Secondly, surveys were conducted to identify the presence or lack thereof of any sensitive areas such as floodplains and wetlands that may be present within the areas to be sampled and the extent of the areas and general characteristics. The third purpose was to provide additional plant and wildlife data concerning the habitat types within the Operable Unit.

DRAFT

This data provides further baseline information about the biological components of the site for site characterization and determination of pre-sampling conditions. This information is also necessary to support the NEPA documentation and determination of a Categorical Exclusion for the sampling plan for site characterization. Personnel of the Operable Unit propose to collect sediment samples and surface and subsurface samples. The sediment samples are to be taken from existing sediment basins within canyons located in the Operable Unit. Soil samples will be collected from surface and subsurface. In some locations, trenching maybe necessary.

After searching the database maintained in EM-8 containing the habitat requirements for all State and Federally listed threatened, or endangered plant and animal species known to occur within the boundaries of Los Alamos National Laboratory and surrounding areas, a habitat evaluation survey (Level 2) was conducted. A Level 2 survey is performed when there are areas that are not highly disturbed and could potentially support threatened and/or endangered species. Techniques used in a Level 2 survey are designed to gather data on the percent cover, density, and frequency of both the understory and overstory components of the plant community.

The habitat information gathered through the field surveys was then compared to the habitat requirements for species of concern as identified in the database search. If habitat requirements were not met, then no further surveys were conducted and the site was considered cleared for impact on State and Federally listed species. If habitat requirements were met, then specific surveys for the species of concern were conducted. The specific species surveys were done in accordance with pre-established survey protocols. These protocols often require certain meteorological and/or seasonal conditions.

In each location, all wetlands and floodplains within the survey area were noted using National Wetland Inventory Maps and field checks. Characteristics of wetlands, floodplains, and riparian areas are noted using criteria outlined in the Federal Manual for and Identifying and Delineating Jurisdictional Wetlands (1989).

4.0 SPECIES IDENTIFIED

Database searches indicated that the species of concern for this Operable Unit were:

- peregrine falcon (*Falco peregrinus*-Federally Endangered);
- spotted bat (*Euderma maculatum*- State Endangered);
- Wright's fishhook cactus (*Mammillaria wrightii*- State Endangered);
- Santa Fe cholla (*Opuntia viridiflora*-State Endangered); and
- grama grass cactus (*Pediocactus papyracanthus*-State Endangered and Federal Candidate).

5.0 RESULTS AND MITIGATION

5.1 Threatened and Endangered Species

As a result of a habitat evaluation and previous data of the Operable Unit, none of the above (4.0) species appear to have potential for occurrence in the area.

5.2 Wetlands/Floodplains

There are no wetlands located within the Operable Unit. Potential floodplains are found within the canyon systems. Although present, these floodplains will not be adversely impacted by the proposed action and therefor no mitigation measures are necessary.

6.0 BEST MANAGEMENT PRACTICES

Impacts to non-sensitive plant species should be avoided when possible. Off-road driving is especially harmful to plants and soil crust. Vehicular travel should be restricted to existing roads whenever possible. If off-road travel is required, EM-08 should be contacted to monitor the activity. Revegetation may be required at some sites. A list of native plants suitable for revegetation for

Operable Unit 1144 is contained in the final report "Biological Assessment for Environmental Restoration Program, Operable Unit 1144".