Environmental
Restoration
University of California
Environmental Restoration Project, MS M992
Los Alamos, New Mexico 87545
505-667-0808/FAX 505-665-4747

U.S. Department of Energy
Los Alamos Area Office, MS A316
Environmental Restoration Program
Los Alamos, New Mexico 87544
505-667-7203/FAX 505-665-4504

APR 1999
RECEIVED

Date: April 9, 1999
Refer to: EM/ER:99-079

Mr. Benito Garcia
NMED-HRMB
P.O. Box 26110
Santa Fe, NM 87502

HSWA CAR 1/106/21

SUBJECT: SUBMITTAL OF VOLUNTARY CORRECTIVE MEASURE PLAN FOR CONSOLIDATED PRS 21-027(d)-99

Dear Mr. Garcia:

Enclosed is a copy of the Voluntary Corrective Measure (VCM) Plan for Consolidated PRS 21-027(d)-99, (Enclosure 1) for your review. We would appreciate an expedited turn around for comments because of the scheduled April 15, 1999 start up date. We believe this is possible based on the successful interactions of our personnel on this project to date.

Please note that the preparation of Appendix A, Ecological Scoping Checklist, and Appendix B, Surface Water Evaluation (formerly known as 4.5 Assessment) are in progress. These appendices will be forwarded to the NMED upon their completion. Enclosure 2, an update for the Technical Area 21 reference set, includes references that correspond to this plan. Instructions for the updates are included.

If you have any questions, please call Dave McInroy at (505) 667-0819 or Deba Daymon at (505) 667-9021.

Sincerely,

Julie A. Canepa, Program Manager
LANL/ER Project

Sincerely,

Theodore J. Taylor, Program Manager
DOE/LAAO

JC/TT/SE/gt

10375

Enclosures: (1) VCM Plan for Consolidated PRS 21-027(d)-99
(2) Update to Reference Set for Material Disposal Areas Technical Area 21

Cy (w/encs.):
M. Buksa, EM/ER, MS M992, enclosure 1 only
D. Daymon, EES-13, MS M992, enclosure 1 only
J. Mose, LAAO, MS A316, enclosure 1 only
T. Taylor, LAAO, MS A316, enclosure 1 and 2
J. Kieling, NMED-DOE OB, enclosure 1 only
RPF, MS M707, enclosure 1 and table of contents of enclosure 2

Cy (w/o encs.):
T. George, EM/ER, MS M992
T. Grieggs, ESH-19, MS M992
M. Kirsch, EM/ER, MS M992
D. McInroy, EM/ER, MS M992
G. McMath, EM/ER, MS M992
J. Plum, LAAO, MS A316
M. Springer, EM/TD, MS J591
EM/ER File, MS M992
Tracker RM 604, MS M992

LIBRARY COPY

LA-UR-99-1613
April 1999

Voluntary Corrective Measure Plan for Consolidated Potential Release Site

21-027(d)-99

Environmental Restoration Project
A Department of Energy Environmental Cleanup Program

Los Alamos
NATIONAL LABORATORY
Los Alamos, NM 87545

Los Alamos National Laboratory, an affirmative action/equal opportunity employer, is operated by the University of California for the United States Department of Energy under contract W-7405-ENG-36.

Produced by the Material Disposal Area Focus Area

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the Regents of the University of California, the United States Government nor any agency thereof, nor any of their employees make any warranty, express or implied, or assume any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represent that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the Regents of the University of California, the United States Government, or any agency thereof.

Los Alamos National Laboratory strongly supports academic freedom and a researcher's right to publish; as an institution, however, the Laboratory does not endorse the viewpoint of a publication or guarantee its technical correctness. By acceptance of this article, the publisher recognizes that the U.S. government retains a nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or to allow others to do so, for U.S. Government purposes. Los Alamos National Laboratory requests that the publisher identify this article as work performed under the auspices of the U.S. Department of Energy.

CONTENTS

1.0 INTRODUCTION **1**

2.0 CONSOLIDATED PRS 21-027(d)-99 ..... **5**

2.1 DESCRIPTION AND OPERATIONAL HISTORY 5
2.1.1 Description *5*
2.1.2 Operational History *5*
2.2 PREVIOUS INVESTIGATORY ACTIVITIES 5
2.3 SITE CONCEPTUAL MODEL 6

3.0 CLEANUP LEVELS **7**

4.0 VOLUNTARY CORRECTIVE MEASURE **8**

4.1 RATIONAL AND OBJECTIVES 8
4.2 NON-NTISV ACTIVITIES 8
4.2.1 VCP Investigation *8*
4.2.2 Borehole Samples *11*
4.3 NTISV ACTIVITIES 11
4.3.1 Baseline Sampling *14*
4.3.2 NTISV *14*
4.3.2.1 Equipment 14
4.3.2.1.1 Electrical Power Supply System 14
4.3.2.1.2 Off-Gas Treatment System 15
4.3.2.2 Site Setup 17
4.3.2.2.1 Construction and Configuration 17
4.3.2.2.2 Predemonstration Sampling 22
4.3.2.2.3 Melt-Profile Monitoring Wells 24
4.3.2.2.4 Site Preconditioning 24
4.3.2.2.5 Electrode Placement in Cold Test Pit 25
4.3.2.2.6 Starter Plane Injection in Cold Test Pit 26
4.3.2.2.7 NTISV Equipment Setup Completion 27
4.3.2.3 Melt Process 27
4.3.2.3.1 Melt-Monitoring Methodologies 27
4.3.2.3.1.1 Temperature Profiling 27
4.3.2.3.1.2 Tomography 29
4.3.2.3.2 Duration and Shutdown Criteria 30
4.3.2.3.3 Off-Gas Sampling 30
4.3.3 Postmelt Sampling *30*
4.3.3.1 Vitrified Mass 30
4.3.3.2 Soil/Fill 32
4.3.4 Site Restoration *32*

5.0 WASTE MANAGEMENT **32**

6.0 SCHEDULE **33**

7.0 REFERENCES **33**

APPENDIX A ECOLOGICAL SCOPING CHECKLIST A-1

APPENDIX B SURFACE WATER ASSESSMENT (FORMERLY KNOWN AS 4.5 ASSESSMENTS) B-1

APPENDIX C NTISV PROJECT SCHEDULE C-1

FIGURES

Figure 2-1	Location map of TA-21 within Los Alamos National Laboratory, Los Alamos County, New Mexico	2
Figure 2-2	Locations of PRS 21-027(d), AOC C-21-028, and the NTISV cold demonstration area	3
Figure 2-3	Site map with estimated locations for AOC C-21-028 and the NTISV cold demonstration area	4
Figure 4-1	Schematic of cold test pit and sample locations	9
Figure 4-2	Estimated baseline sample locations and proposed borehole locations	12
Figure 4-3	Illustration of planar melting	1
Figure 4-4	NTISV off-gas treatment system	16
Figure 4-5	Long-dimensional cross-section of the construction of simulated absorption bed and instrument trenches	1
Figure 4-6	Plan view of simulated absorption bed construction	19
Figure 4-7	Long-dimension cross-section of thermocouple layout plan	20
Figure 4-8	Short-dimension cross-section of cold demonstration thermocouple layout	21
Figure 4-9	Plan view of cold demonstration thermocouple	22
Figure 4-10	Plan view of the typical preconditioning pattern around an absorption bed	25

TABLES

Table 4-1	Baseline samples, cold test pit samples, VCP trench samples, and borehole samples	10
Table 4-2	Predemonstration sampling	23
Table 4-3	Cold demonstration power schedule	28
Table 4-4	Postdemonstration sampling	3
Table 5-1	Anticipated waste type and volume for VCM	33

ACRONYMS AND ABBREVIATIONS

AC	alternating current
AOC	area of Cochran
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
CEARP	Comprehensive Environmental Assessment and Response Program
CeO_2	cerium oxide
Co	carbon monoxide
CO_2	carbon dioxide
Cs_2CO_3	cesium carbonate
COPC	chemical of potential concern
DOE	US Department of Energy
DP	Delta Prime
EM-SWO	Environmental Management Solid Waste Operations
EPA	Environmental Protection Agency
ER	environmental restoration
ERT	electrical resistance tomography
ESH	Environment, Safety, and Health (Division)
GPR	ground-penetrating radar
HEPA	high-effeciency particulate air
HRMB	Hazardous and Radioactive Materials Bureau
IM	interim measure
ISV	in situ vitrification
Laboratory	Los Alamos National Laboratory
LANL	Los Alamos National Laboratory
LASL	Los Alamos Scientific Laboratory
MDA	material disposal area
MSE-TA	MSE Technology Applications
NFA	no further action
NMED	New Mexico Environment Department

NTISV	nontraditional in situ vitrification
PCB	polychlorinated biphenyl
PRS	potential release site
RCRA	Resource Conservation and Recovery Act
RFI	RCRA facility investigation
SOP	standard operating procedure
SWMU	solid waste management unit
SVOC	semivolatile organic compound
TA	technical area
TC	thermocouple
TPH	total petroleum hydrocarbons
UST	underground storage tank
VCM	voluntary corrective measure
VCP	vitrified clay pipe
VOC	volatile organic compound

1.0 INTRODUCTION

This voluntary corrective measures (VCM) plan presents an approach for the characterization and remediation of an area of concern (AOC) and a solid waste management unit (SWMU) located in Technical Area (TA) 21 at Los Alamos National Laboratory (the Laboratory) (Figure 1-1). The Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) for the SWMU [21-027(d)] was completed in 1992; it was subsequently recommended for no further action (NFA) (LANL 1994, 31591). Environmental Protection Agency (EPA) concurred with the NFA recommendation in 1995, and New Mexico Environment Department (NMED) subsequently stated that the SWMU was suitable for NFA in December 1996 (Dinwiddie 1996, 55815). The SWMU is listed in Table A of the Hazardous and Solid Waste Amendments Module. The AOC (C-21-028) was submitted for NFA in the TA-21 work plan (LANL 1991, 07529) because it was a site for which records showed that no documented releases had occurred. The AOC was subsequently proposed for NFA to US Department of Energy (D OE), as noted in the March 1995 Request for Permit Modification (LANL 1995, 45365), and was approved for NFA by DOE (Taylor 1995, 50023.1). Locations of the AOC and SWMU are shown in Figure 1-2.

In 1998, DOE EM-50 selected Material Disposal Area (MDA) V at TA-21 as a suitable area to demonstrate nontraditional in situ vitrification (NTISV) technology (MSE-TA et al. 1998, 62930). This VCM will include a cold (no radiological contamination) demonstration of that technology outside the boundaries of MDA V. If the cold demonstration is successful, a hot (with radiological contamination) deployment will take place at MDA V. MSE Technology Applications (MSE-TA) will lead the demonstration team; Geosafe will conduct the test under subcontract to MSE-TA. The goal of this demonstration is to demonstrate the capabilities of the NTISV technology. As part of the NTISV demonstration, a cold test pit was constructed just north of MDA V in an area that was thought to be unaffected by releases from potential release sites (PRSs) (Figure 1-3). However, hydrocarbons in the form of weathered diesel were found in the subsurface.

After the detection of hydrocarbon odors and staining during the construction of the NTISV cold test pit, it was decided by NMED at a meeting on March 4, 1999, that these sites should be further evaluated as a VCM (Canepa and Taylor 1999, 62883). The VCM would include the cold demonstration and characterization of the hydrocarbon release. During the March 4 meeting, AOC C-21-028 was proposed for consolidation with SWMU 21-027(d) for this VCM. The similar operational history, geographic proximity, transport mechanism of concern (i.e., the discharge are of the outfall has been investigated previously), and the type of investigation required to assess residual hydrocarbon contamination in the upper reaches of these sites support consolidation of the AOC and SWMU. The consolidation proposal has been approved by NMED, and the AOC and SWMU will be referred to as consolidated PRS 21-027(d)-99.

Two VCM activities will be conducted in parallel; Geosafe and the Environmental Restoration (ER) Project will perform the NTISV cold demonstration, and the ER Project will perform characterization and confirmation sampling. The NTISV project will be implemented in two phases. The first phase, or cold demonstration, will be done as a VCM on a portion of the consolidated PRS and will be described in this plan. The second phase, or hot deployment, will be done as an interim measure (IM) on absorption bed 1 of MDA V. The IM plan will be developed and submitted to NMED for review after the successful completion of the cold test; therefore, no IM activities are described in this plan.

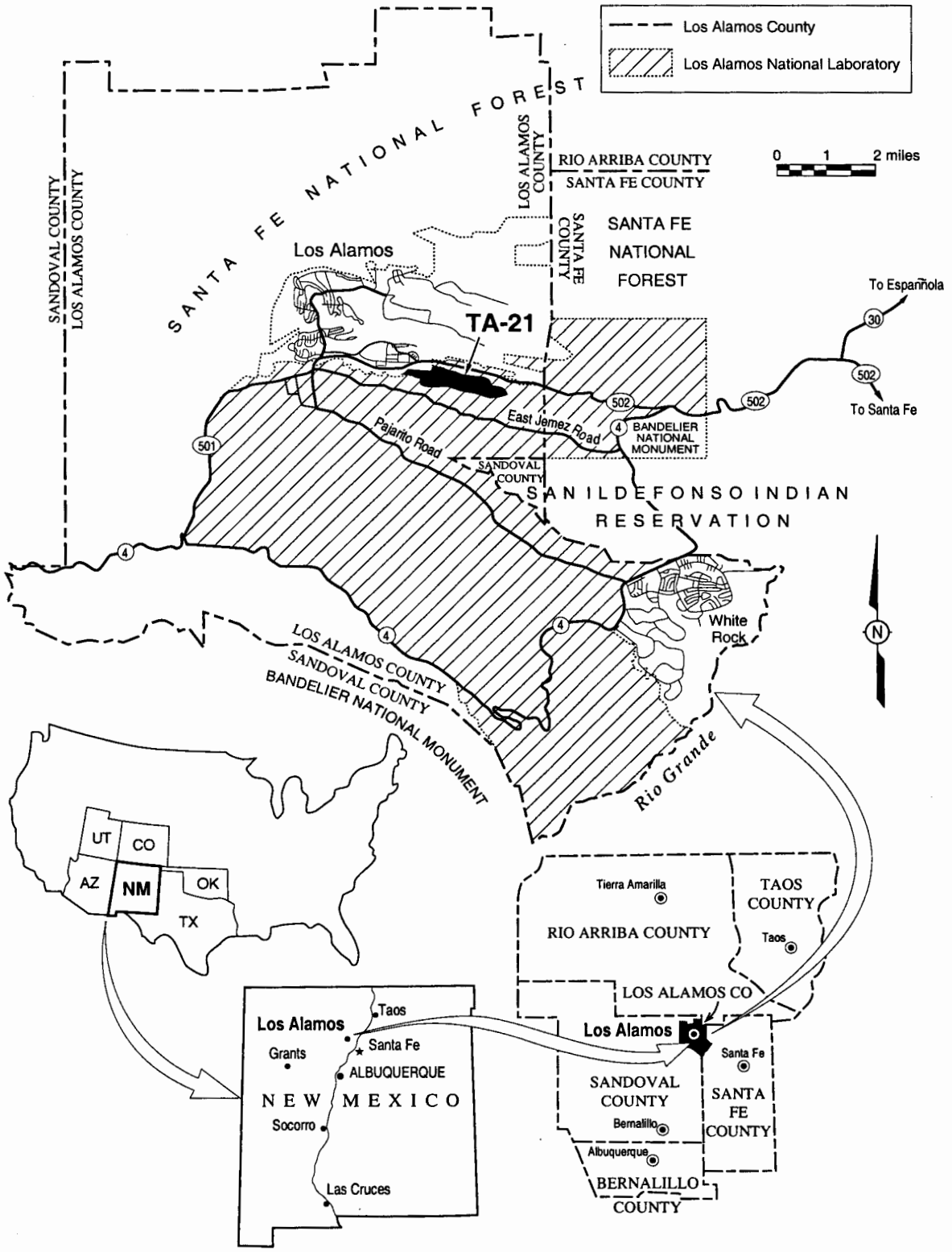


Figure 1-1. Location map of TA-21 within Los Alamos National Laboratory, Los Alamos County, New Mexico

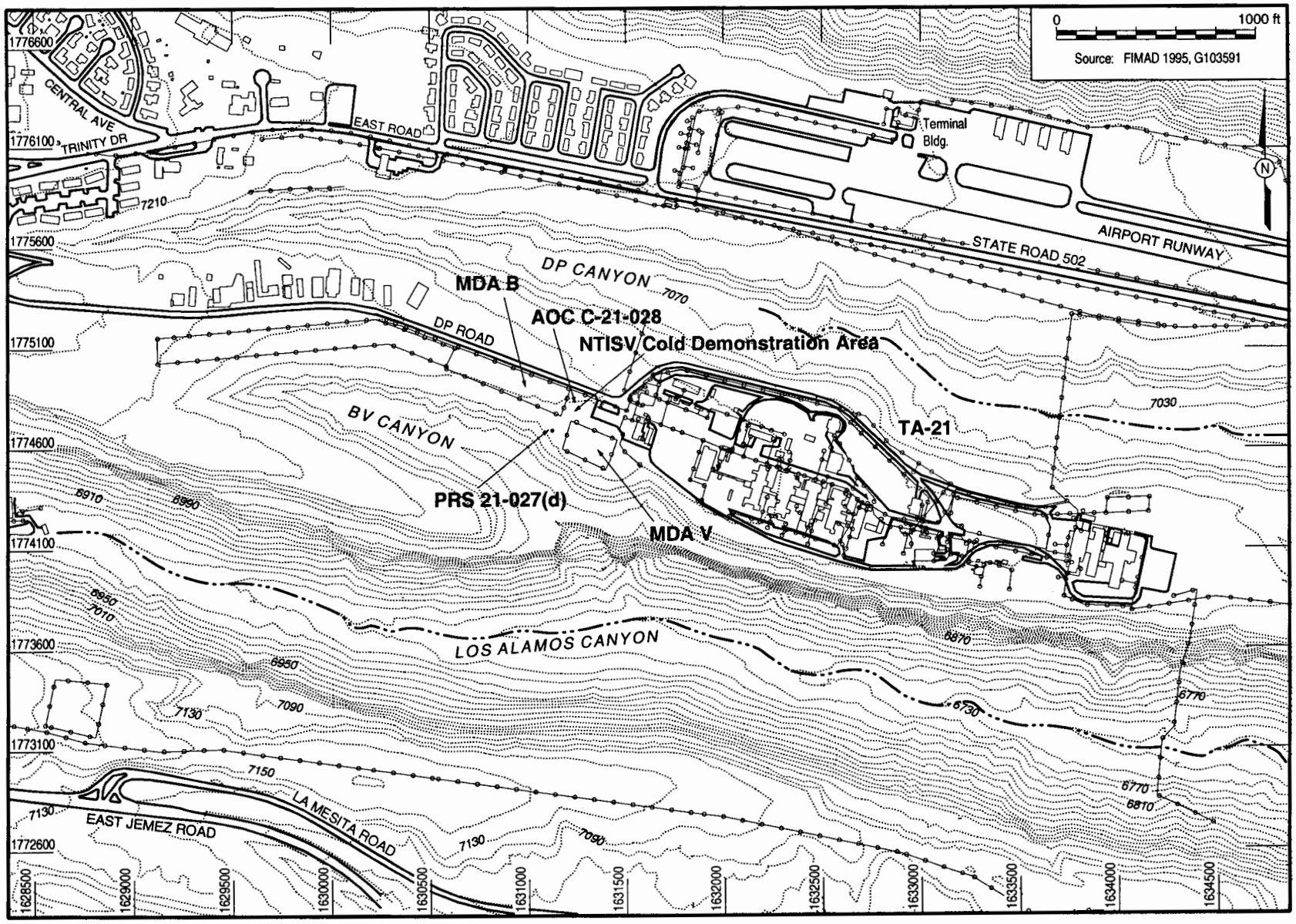


Figure 1-2. Locations of PRS 21-027(d), AOC C-21-028, and the NTISV cold demonstration area

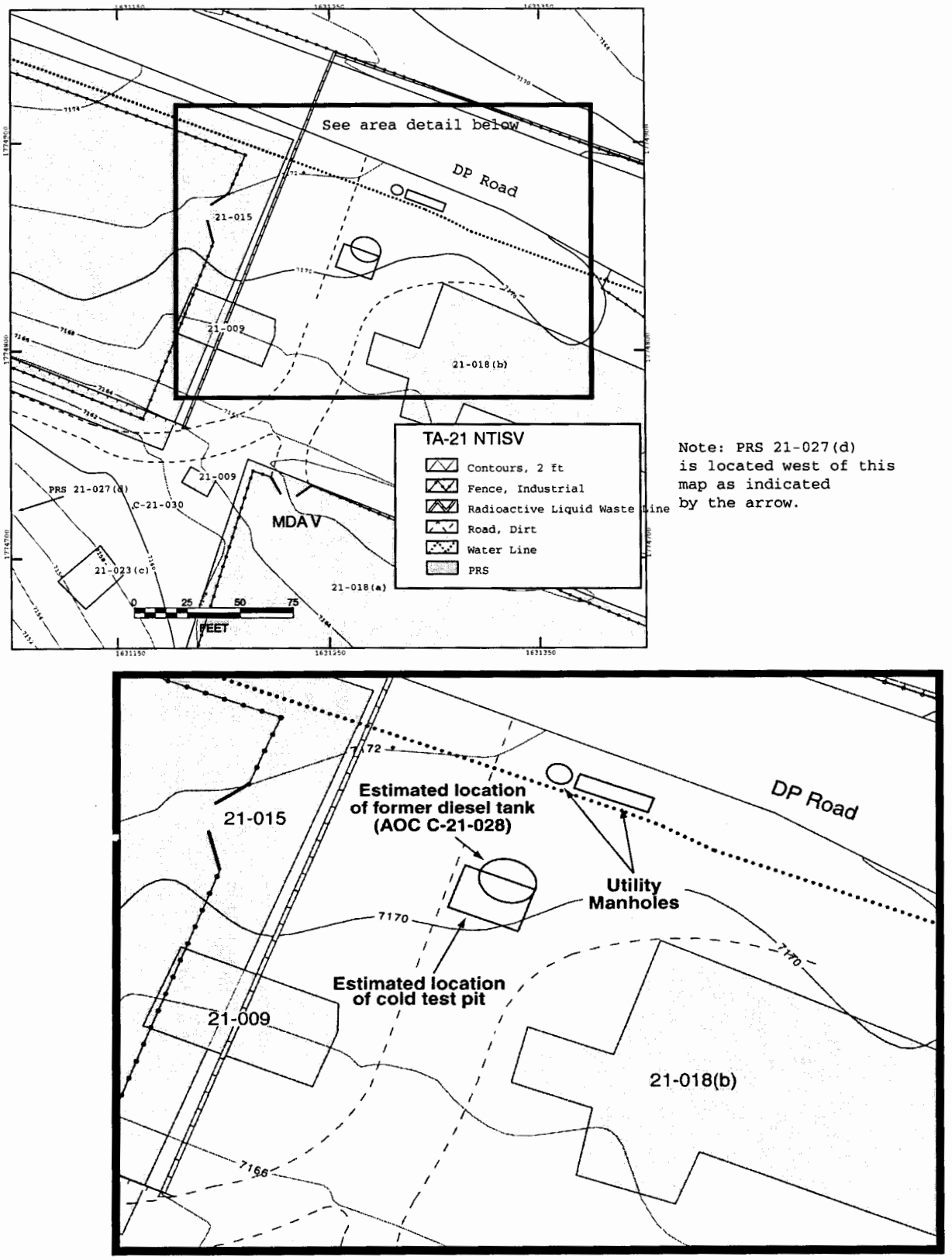


Figure 1-3. Site map with estimated locations for AOC C-21-028 and the NTISV cold demonstration area

2.0 CONSOLIDATED PRS 21-027(d)-99

2.1 Description and Operational History

2.1.1 Description

TA-21 (Figure 1-1) is located on Delta Prime (DP) Mesa, on the Laboratory's northern boundary immediately east-southeast of the Los Alamos townsite. TA-21 encompasses the area south of the stream channels in DP Canyon and north of Los Alamos Canyon (Figure 1-2).

Based on recent findings, the description provided for AOC C-21-028 in this section is more accurate than that provided in the March 8, 1999, letter (Canepa and Taylor 1999, 62883). AOC C-21-028 was a 12,788-gal. above-ground fuel tank and was installed in July 1945 (LANL 1989, 11941). SWMU 21-027(d) was the drainline outfall for this tank. When the tank was installed, a drainage ditch extended to the southwest from a bermed area around the tank (LASL 1948, 24368). When Building TA-21-33 was built over the drainage ditch area, the ditch was rerouted around the west end of the building and then south toward the rim of DP mesa (LASL 1948, 24368). In 1948, a reinforced concrete secondary containment was built around the tank to contain any potential releases from the tank (Francis 1999, 62745). During construction of the secondary containment, a drainline was installed in the original drainage ditch from the tank and connected to a sump in the center of the south side of the containment. The first segment of the drainline from the sump to a gate valve just outside the containment wall was a 4-in. steel pipe. At the gate valve, the drainline changed to a vitrified clay pipe (VCP) and was routed around Building TA-21-33 and eventually angled more to the southwest and the edge of DP mesa south of the MDA B fence (LASL 1948, 24368). The above-ground storage tank was removed in 1960 (LANL 1989, 11941), and the drainline was removed in March 1965 (LANL 1991, 07529).

2.1.2 Operational History

The CEARP report (DOE 1987, 8657) indicates the presence of a diesel tank with a drain that extended towards the canyon. The SWMU report (LANL 1990, 7511) states that it is unknown whether this tank leaked or if there were hazardous releases from the drainline. The Release Site Database (LANL 1989, 11941) mentions that the tank was installed in July 1945 and removed in 1960. Francis (1999, 62745) states that the tank was installed in 1945 to store diesel fuel for the backup operation of the boiler in the laundry. Because the laundry was connected to the steam plant, there was no need to operate the boiler. It is possible that the boiler and, therefore, the fuel from the diesel tank were never used. However, the exact date of connection of the laundry to the steam system has not been established with certainty. It is possible the boiler and fuel system were used for several years.

2.2 Previous Investigatory Activities

Characterization of SWMU 21-027(d) at the location of the drainline outfall was performed in 1992 in accordance with the RFI work plan (LANL 1991, 07529) (Figure 1-3). The 1992 sampling activities consisted of a radiological field survey and the collection of surface soil samples from six locations. All soil samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), inorganics, gamma-emitting radionuclides, tritium, total uranium and plutonium, and strontium-90. Analytical results were reported to EPA Region VI in the RFI phase report in February 1994 (LANL 1994, 31591). Based on the results of the investigation, no

contaminants of concern were identified, and a recommendation of no further action was proposed. The site was determined as being suitable for NFA and was approved for NFA by EPA in 1995. Although the site was considered suitable for NFA in the December 1996 notice of determination from NMED (Dinwiddie 1996, 55815), it has not yet been removed from Table A of Module VIII of the Laboratory's Hazardous Waste Facility Permit.

2.3 Site Conceptual Model

The site conceptual model was developed to describe a likely contaminant source area, exposure pathways, and potential receptors. For this VCM, the contaminant source area is that underlying the former above-ground tank location where petroleum hydrocarbons may have leaked and/or been spilled. There is a high confidence that the nature of contamination has been defined as petroleum hydrocarbons, although samples will be analyzed for organics, inorganics, and radionuclides. Based on current site knowledge, it appears that residual petroleum hydrocarbon contamination is confined to the subsurface beneath the former above-ground tank.

The exposure pathways are the mechanisms through which an organism may come into contact with a chemical of potential concern (COPC) in the environment, e.g., inhalation, ingestion, or dermal contact. As a result, the following potential human exposure pathways were identified in the conceptual exposure model:

- direct soil ingestion;
- dermal contact with contaminated soil; and
- inhalation of contaminated soil-derived particulates.

Ecological receptors are unlikely to be impacted by contamination at this site because residual petroleum hydrocarbon contamination is only in the subsurface. Ingestion and dermal contact are the most likely pathways for terrestrial animals to be exposed to the contaminants at this site. The ecological checklist is included in Appendix A.

An understanding of the fate and transport processes associated with the contaminants is an integral part of the conceptual site model. Both surface and subsurface migration of petroleum product may have contributed to the movement of the petroleum hydrocarbons at this mesa-top location. Spilled product would be expected to move on the surface downgradient, ultimately moving into the subsurface where fracture flow is a possible transport mechanism. The staining observed during the construction of the cold demonstration bed is evidence of migration in subsurface to tuff. Some water-driven product migration on the mesa top might also have occurred in response to rainfall events, but this would have only been possible before installation of the secondary containment. This release mechanism would probably be associated with one or more discrete release events; none are known to have occurred during the period of tank operation.

Surface Water Assessment. At the Laboratory, surface water runoff and sediment transport are among the potential migration pathways by which contaminants might be transported to off-site receptors. Surface water may also access subsurface contaminants exposed by soil erosion. Soil erosion is dependent on several factors, including soil properties, the amount of vegetative cover, the slope of the contaminated area, exposure, the intensity and frequency of precipitation, and seismic activity.

The Laboratory's ER Project has assessed sediment transport and erosion concerns at specific PRSs. Surface water assessments (formerly known as 4.5 assessments) provide a basis for

prioritizing and scheduling actions to control erosion of potentially contaminated soils at specific PRSs. The procedure is a two-part evaluation. Part A is a compilation of existing PRS analytical data, site maps, and knowledge-of-process information. Part B is an assessment of the erosion/sediment transport potential at the PRS. Erosion potential is numerically rated from 1 to 100 using a matrix system. PRSs that score below 40 have a low erosion potential; those that score from 40 to 60 have a medium erosion potential; and those that score above 60 have a high erosion potential.

Preparation of the surface water assessment for consolidated PRS 21-027(d)-99 is in progress. Details will be provided in Appendix B.

3.0 CLEANUP LEVELS

The primary objective in establishing cleanup levels for this VCM is to set thresholds for site soils that are protective of human health and the environment. As stated in our letter dated March 8, 1999 (Canepa and Taylor 1999, 62883), hydrocarbon contamination associated with former AOC-21-028 was discovered during excavation of the NTISV cold test pit. To simplify the derivation of cleanup levels for this VCM, the ER Project is proposing to conduct the cleanup of this site in accordance with cleanup level requirements specified in the New Mexico Underground Storage Tank (UST) regulations (NMED 1996, 58202). The decision to adopt the cleanup levels was driven by a similarity in the product contained within a UST and this above-ground tank. Residual hydrocarbon contamination remaining southeast of the demonstration pit excavation (within the sphere of influence of the melt) will be processed by the NTISV, and post-test confirmation samples will be collected and analyzed (Section 4.3.3).

The ER Project expects that there will be no threat to human health or the environment from any residual hydrocarbon contamination after the NTISV cold demonstration for the following reasons.

- No highly contaminated soil has been encountered at this site.
- The depth to groundwater beneath TA-21 is approximately 1150 ft.
- There are no private water supply wells within a 100-ft radius or municipal water wells within a 1-mi. radius of the site.
- There are no surface watercourses within 500 ft.
- The nearest utility corridor is approximately 25 ft to the north; but horizontal extent in this direction has already been defined to less than cleanup levels and near detection limits on the north side wall of the cold pit excavation. The hydrocarbon contamination was not observed within 25 ft of the corridor.

Therefore, the Laboratory plans to remediate the site to a soil cleanup level of 1000 ppm total petroleum hydrocarbons (TPH); 500 ppb of benzene, toluene, ethylbenzene, and xylenes (BTEX); and 10 ppm of benzene.

During the course of this VCM, if COPCs are found to be present that are different from hydrocarbons, this plan will be modified to address cleanup levels for any new COPCS and submitted to NMED for review.

4.0 VOLUNTARY CORRECTIVE MEASURE

The site characterization of consolidated PRS 21-027(d)-99 and the NTISV cold demonstration are being performed in parallel under this VCM. All activities will be performed under the site-specific health and safety plan (LANL 1999, 63038), which was developed in accordance with the ER Project health and safety plan (LANL 1998, 58714).

4.1 Rational and Objectives

The NTISV cold demonstration project was proposed for implementation at a location that was thought to be unaffected by releases from PRSs. The ER Project collected baseline samples from the proposed area for the cold demonstration to determine if the location was indeed free of contamination. Analytical results for the baseline samples showed low levels of toluene. Hazardous and Radioactive Materials Bureau (HRMB) verbally agreed on February 24, 1999, that the cold demonstration could continue at this location. During excavation of the cold test pit, hydrocarbon contamination was detected. All activities were stopped, and HRMB was notified of the presence of contamination. To determine the course of action for the cold demonstration, the Laboratory, DOE, and HRMB met on site on March 3, 1999, and held a conference call on March 4. All agreed that the cold demonstration could continue, but it was to be considered a VCM for a feasibility demonstration of the NTISV technology because of the presence of hydrocarbons at the location (Canepa and Taylor 1999, 62883).

The objectives of this VCM are to

- identify COPCs for consolidated PRS 21-027(d)-99;
- collect additional data to define extent of contamination to ensure cleanup criteria are met;
- demonstrate the feasibility of using NTISV in a geologic setting similar to that of the absorption beds at MDA V;
- demonstrate the ability of NTISV to process COPCs to values below the stipulated cleanup levels;
- confirm that any COPCs remaining are below cleanup levels; and
- ensure sample quantity, location, and quality are sufficient to support a recommendation of NFA, depending on the analytical results or support planning for additional corrective action if cleanup levels are not met..

4.2 Non-NTISV Activities

4.2.1 VCP Investigation

In addition to the discovery of the hydrocarbon contamination, a VCP was also uncovered during excavation of the cold test pit (Figure 4-1). This VCP is probably not the drainline from AOC C-21-028 because approximately 12 ft of VCP was removed from the north side of the excavation. This would place the above-ground tank too far north of the known tank location observed in an old photograph (LASL 1945, 62919) and an engineering drawing (LASL 1948, 62912). The

engineering drawing indicates that the VCP drainline from the above-ground storage tank exited the secondary containment from near the middle of the south containment wall (LASL 1948, 62912). Also, the old photographs and the engineering drawing illustrate the approximate north side of the tank lines up with the north side of Building 21-14, which is still in place. The origin and use of the VCP are not known but is likely an abandoned potable water system drainline originating in the utility corridor to the north.

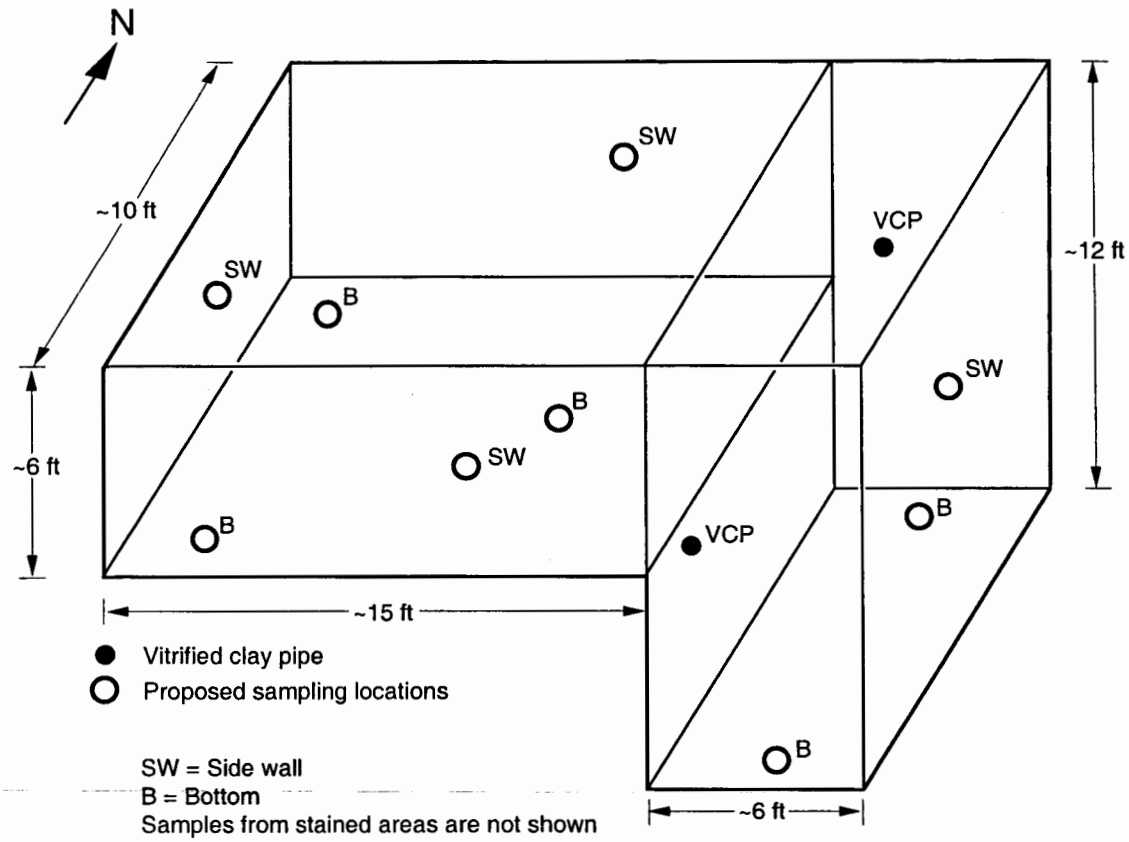


Figure 4-1. Schematic of cold test pit and sample locations

The VCP was excavated and removed from the north and south sides of the cold test pit until the pipe was outside the area of influence of the NTISV melt. Approximately 12 ft of the VCP was removed from the north side, and approximately 13 ft was removed from the south side of the excavation. The VCP and soils were field screened during removal. No organics were detected, and there was no radioactivity detected above background. There were no signs of staining adjacent to and beneath the pipe. The VCP did not contain any sludge, and the field screening results were 0.0 ppm for the photoionization detector. Radioactivity was not detectable above area background. One sample was collected from beneath the VCP removed north of the excavation, and one sample was collected from the VCP removed south of the excavation. Samples were collected from the backhoe bucket because of health and safety issues associated with the depth of the trench. These samples were analyzed for VOCs, SVOCs, metals, TPH (diesel range), and gross alpha/beta/gamma (Table 4-1). All samples were collected according to applicable ER standard operating procedures (SOPs).

TABLE 4-1
BASELINE SAMPLES, COLD TEST PIT SAMPLES, VCP TRENCH SAMPLES, AND BOREHOLE SAMPLES

Sample Location	Number of Samples	Analytical Methods
Baseline Samples[a]		
Proposed cold test pit location	4	VOC, SVOC, pesticides/PCBs, gross alpha/beta/gamma, tritium
Cold Test Pit Samples[a]		
Bottom of excavation	5	VOC, SVOC, gross alpha/beta/gamma, metals
Sidewalls (nonstained areas)	4	VOC, SVOC, gross alpha/beta/gamma, metals
Bottom and sidewalls (stained areas)	3[b]	VOC, SVOC, gross alpha/beta/gamma, metals
VCP Trench Samples[a]		
Beneath north extension	1	TPH (diesel), VOC, SVOC, gross alpha/beta/gamma, metals
Beneath south extension	1	TPH (diesel), VOC, SVOC, gross alpha/beta/gamma, metals
Borehole Samples[a]		
Borehole southeast of thermocouple (TC) excavation[c]	2	TPH (diesel), VOC, SVOC, gross alpha/beta/gamma, metals
Borehole east of first borehole	2	TPH (diesel), VOC, SVOC, gross alpha/beta/gamma, metals
Borehole southeast of first borehole	2	TPH (diesel), VOC, SVOC, gross alpha/beta/gamma, metals
Borehole south of first borehole	2	TPH (diesel), VOC, SVOC, gross alpha/beta/gamma, metals
Borehole west of cold test pit	2	TPH (diesel), VOC, SVOC, gross alpha/beta/gamma, metals
Post-NTISV Samples		
Soils adjacent to the melt	3	TPH (diesel), VOC, SVOC, gross alpha/beta/gamma, metals

a. These samples have been collected; results will be included in the VCM report.
b. Includes one duplicate sample
c. Point of reference for remaining boreholes

If analytical results from beneath the VCP indicate that residual contamination is below the proposed cleanup levels in Section 3.0, the remaining VCP to the south will not be removed. If

analytical results are above the proposed cleanup levels, the VCP south of the cold test pit will be excavated and removed, and samples will be collected from beneath the pipe. Samples will be analyzed as described above.

4.2.2 Borehole Samples

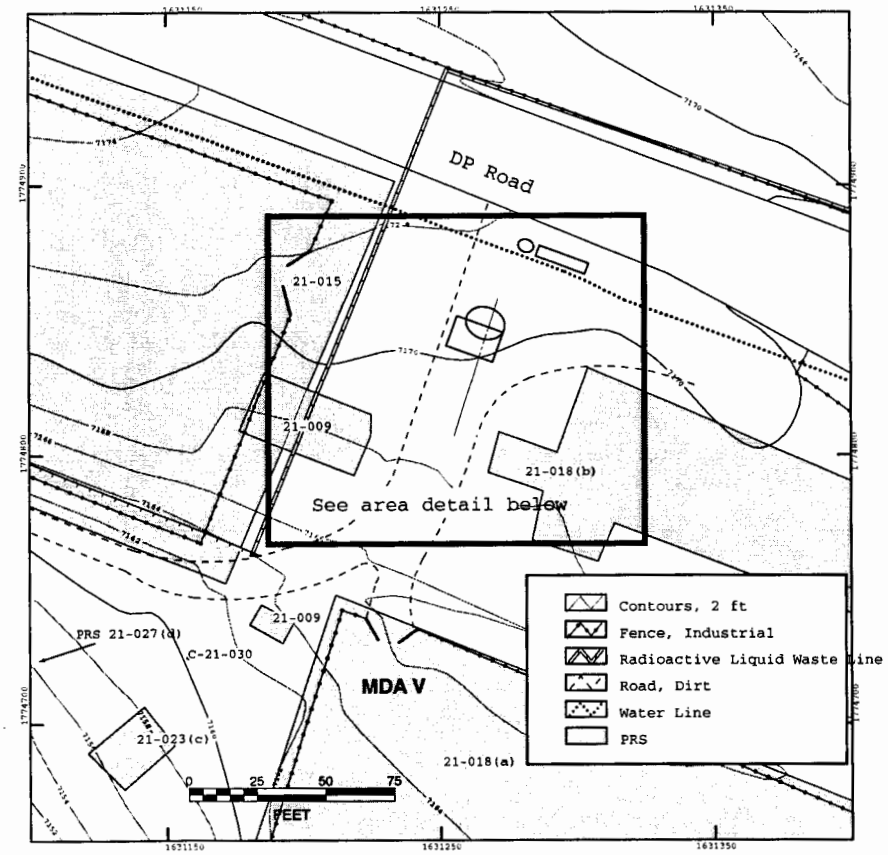
Before initiating the cold demonstration, approximately four boreholes (Figure 4-2) were drilled south, east, and southeast of the previously observed hydrocarbon staining in the cold test pit to document vertical and lateral extent of contamination. In addition, one borehole was drilled west of the excavation to determine the lateral extent of hydrocarbon contamination. Continuous core was collected to an estimated maximum depth of 35 ft below ground surface (bgs). An immunoassay field test kit was used to test for TPH. A minimum of two samples was collected from each borehole. The first sample was collected from the zone of highest hydrocarbon concentration. The second sample was collected from the bottom of the borehole or where the immunoassay kit results are below 500 ppm for two consecutive 5-ft intervals. Samples were analyzed for SVOCs, VOCs, metals, TPH (diesel range), and gross alpha, beta, and gamma (Table 4-1). All samples were collected according to applicable ER SOPs.

All waste (sample preparation liquids, drill cuttings, PPE) generated during these activities will be stored and handled according to applicable regulations.

4.3 NTISV Activities

For this demonstration, Geosafe will be using an adaptation to conventional ISV; this adaptation is termed planar ISV. Information on the NTISV technology was obtained from the Geosafe Corporation report (1999, 63039). In conventional ISV, electrical energy melts the soil/constituent matrix from the top down. A set of graphite electrodes emplaced in the upper regions of the target vitrification zone deliver the electrical energy to the soil. Soil, by its very nature, is very insulative both electrically and thermally. Therefore, a conductive pathway must be placed between the electrodes to promote initial current flow in the system. A horizontal array of starter tubes placed on top of the target vitrification zone form the circuit between the electrodes. These tubes contain a mixture of ground graphite and glass-forming materials. The mixture provides a conductive path to allow current to flow between the electrodes. The flow of current through the pathway generates heat that melts the soil surrounding the path. As the starter path is consumed, the current flow is transferred into the molten soil, which is now adequately conductive. This melting process is initiated in the upper region of the target zone and is propagated downward through the soil/constituent matrix by the action of gravity and continued melting. Conventional ISV generates a very durable, high-quality glassy product. This product has superior leach-rate characteristics and is, therefore, very effective at immobilizing radioactive and other nonvolatile constituents. Organic constituents are destroyed by pyrolysis during processing. Volatile heavy metals (such as mercury) are removed from the soil/constituent matrix and routed to the off-gas treatment system for removal by way of wet scrubbing and filtration.

In planar ISV, the same process principles are utilized; however, the horizontal array of starter tubes is replaced with vertically oriented planes of starter material. This process can be used to treat soils that are either containerized or are surrounded by a relatively impermeable barrier (e.g., sealed drums, USTs, or confining geologic stratigraphy). The planes of starter material can be



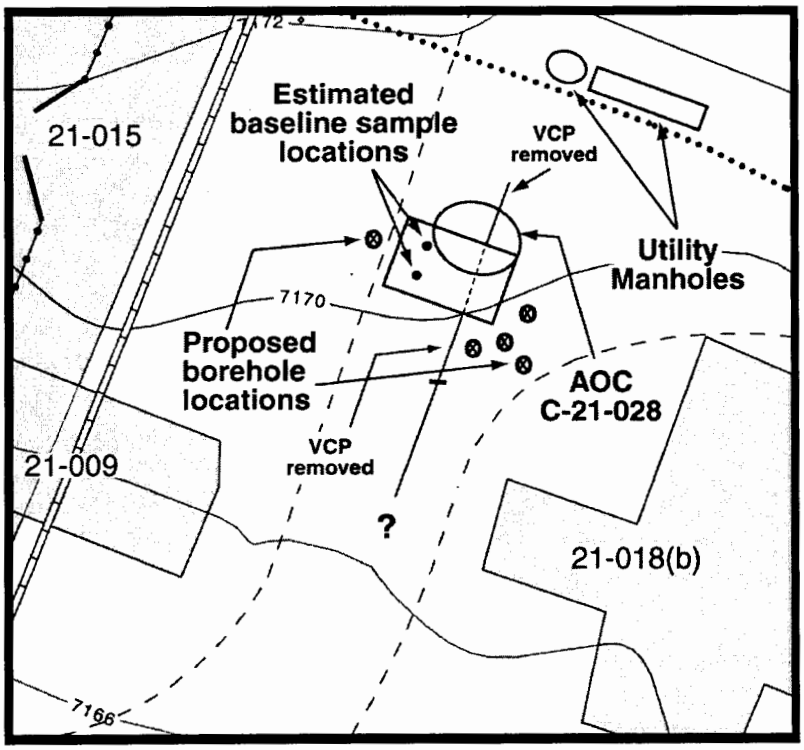


Figure 4-2. Estimated baseline sample locations and proposed borehole locations

positioned at virtually any desired depth and separation between planes, which allows significant control of the initial melt process so that it can be focused for optimal processing of the target zone. This approach can be used to perform subsurface melt start-ups and can also be used at greater depths. The two vertical planes can be sized (both in length and height) to provide complete processing of the target zone. Hazardous contaminants found in the target zone are processed in the same manner as with conventional ISV (i.e., immobilization of radionuclides and heavy metals, destruction of organics, and removal of volatile heavy metals). Figure 4-3 illustrates the basic planar melting technique as applied to a typical absorption bed.

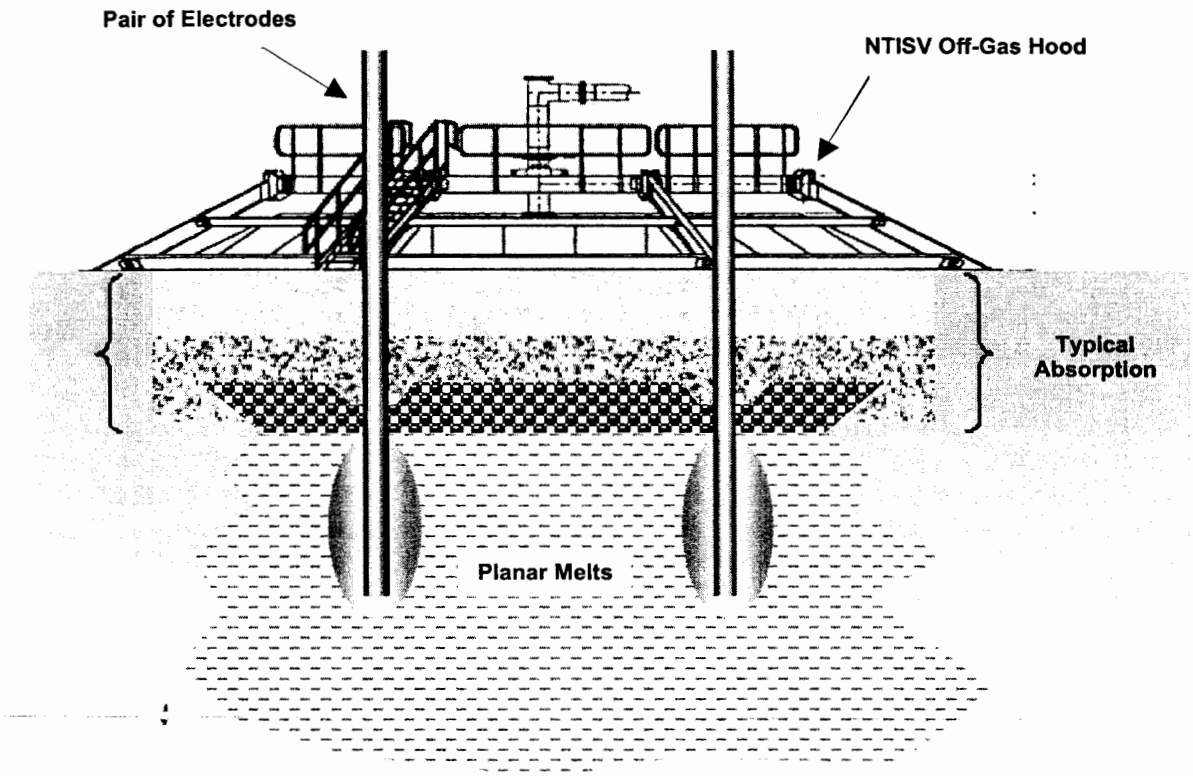


Figure 4-3. Illustration of planar melting

The cold demonstration will occur in a location north of MDA V. This location was selected for the following technical and logistical reasons.

- Remobilization of the NTISV system following the cold demonstration will not be necessary, the off-gas hood will require minimal disassembly and reassembly to move to the hot deployment site, and relocation of electrical connections and power drops following the cold demonstration will not be necessary. This will reduce the schedule and cost associated with performing the cold demonstration and hot deployment.
- The stratigraphy and chemistry of the area will be similar to that around and below the MDA V absorption bed. This increases confidence that the conditions present in the hot deployment will be similar to those experienced in the cold demonstration, and the data produced will be accurate in identifying the expected matrix quality for the hot deployment.

The cold test pit was designed to represent an absorption bed in MDA V both in physical appearance and in the chemical composition of the different layers (LANL 1996, 54969.2). Whole rock analysis of the tuff and fill material have been performed and evaluated. These results were used in designing and optimizing the cold demonstration.

To evaluate the product quality of the cold demonstration, two nonhazardous, nonradioactive surrogates will be added to the cobble layer of the pit. The two surrogates, cesium carbonate (Cs_2CO_3) and cerium oxide (CeO_2), have been selected for their ability to behave similarly to a large population of the radioactive species present within the MDA V absorption beds. Cesium is a semivolatile metal that has a slightly higher vapor pressure than most metals and thus is slightly more volatile. Cesium has been demonstrated at full-scale to remain in the vitrified product at a level of 99.998% (ORNL 1996, 63040). Cerium will be used as it is an representative for stable species such as plutonium and uranium. After the demonstration is complete and the vitrified product has sufficiently cooled, samples will obtained of the glass/crystalline product and analyzed. These results will be used to assess the performance of the cold demonstration.

4.3.1 Baseline Sampling

Before excavation of the cold test pit for NTISV, baseline samples were collected from the estimated location of the pit. Four samples were collected from two locations at approximate depths of 3 ft and 6 ft bgs (Figure 4-2). The samples were analyzed for VOCs; SVOCs; TAL metals; pesticides/PCBs; and gross alpha, beta, and gamma (Table 4-1). Samples were collected according to applicable ER SOPs.

Analytical results indicated that inorganic analytes detected were within the Laboratory background range for area soils. The range of gross alpha, beta, and gamma activities detected was within the Laboratory background, and tritium was not detected. The detected organics were toluene, acetone, methylene chloride, chloroform, and xylene (total). The results for acetone, methylene chloride, chloroform, and xylene (total) were regarded as nondetected because the sample results were less than five times the concentration of the analyte in the blank, which indicates the detected results are indistinguishable from blank contamination. Toluene was not found in the blanks associated with the analysis. Toluene concentrations ranged between 0.26 mg/kg and 0.33 mg/kg.

4.3.2 NTISV

4.3.2.1 Equipment

The NTISV system consists of two major subsystems: the power supply system and the off-gas treatment system. The basic features and capabilities of these subsystems are described in this section.

4.3.2.1.1 Electrical Power Supply System

The heart of the NTISV power supply system is the Scott-Tee transformer. It is designed to accept standard nominal input voltages in the range of 12.47 kV to 13.80 kV. The transformer is rated at 3750 kW and can deliver voltages in the range of 400 to 4160 volts. The corresponding AC current range is 4000 to 400 amps. This transformer converts the three-phase power supply to two single-

phase outputs on the secondary side of the transformer. The voltage and current generated on the secondary side are supplied to the electrodes through a set of 1000-MCM electrical cables. Each cable is rated at 1000 amps. Typically, four cables can be connected to each electrode. These four cables can therefore accommodate the peak current draw of 4000 amps. The current from the electrodes provides the electrical energy to melt the soil/constituent matrix.

During the NTISV process, the increasing melt volume and temperature cause the net electrical resistance to decrease. The decrease in the melt resistance likewise results in a gradual drop off in power being input to the melt. To compensate for this, the transformer is equipped with 16 voltage taps that allow adjustment of the voltage and current and maintain a constant power input. This ensures optimal performance of the transformer.

The electrode system consists of four graphite electrodes and their associated electrode feeder assemblies. The electrodes consist of four vertical rods projecting above the NTISV hood (Figure 4-3). Each individual electrode is composed of three or more electrode segments; each segment has a diameter of 12 in. and a length of approximately 6 ft. The segments have threaded couplings on each end; each coupling receives a threaded nipple. This allows a number of electrode segments to be joined together to form the desired overall length. The electrodes are typically gravity fed into the melt. Therefore, additional electrode segments can be added to each electrode stem to accommodate this feeding process.

The electrodes are held in position by electrode feeders. Each feeder maintains the vertical orientation of the electrode during processing and provides the electrical connection between the power supply cables and the electrode. The electrical connection is a set of copper contactor pads, which have mounting plates to accept the lug on each electrical cable and are spring loaded to ensure that contact between the contactor and electrode is maintained during operation.

Each electrode feeder assembly includes a set of pneumatic grippers. These grippers control the insertion depth of the electrode. When the gripper is open, the electrode is allowed to gravity feed into the developing melt. Actuating the gripper arrests the downward progression of the electrode. A crane and lifting bail affixed to the top segment of the electrode (with power off) raises the electrodes. This method of raising the electrodes is used sparingly, however. Typically, the electrodes are held slightly off the bottom of the melt and allowed to feed as the melt grows downward and outward using a controlled slip-and-grip technique.

4.3.2.1.2 Off-Gas Treatment System

The off-gas treatment system is composed of two modular subsystems: the off-gas hood and off-gas processing system. The off-gas hood is typically placed over the vitrification area before processing. The hood is composed of a skin of stainless steel panels supported by a steel superstructure. This structure also supports the electrode feeders and associated electrode loads. The off-gas hood collects the gases and routes them to the off-gas processing system, which removes any potentially hazardous constituents present in the off-gas stream. These can be volatile, semivolatile, nonvolatile, or particulate in nature. A schematic of the off-gas treatment system is provided in Figure 4-4.

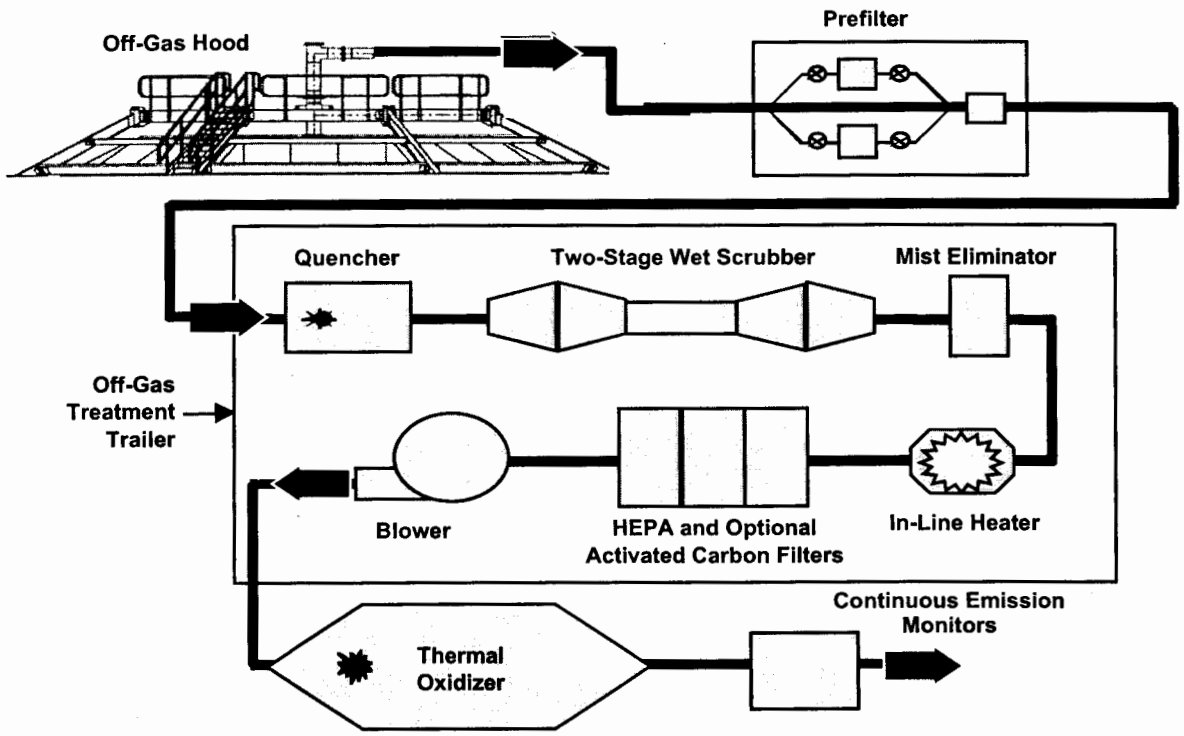


Figure 4-4. NTISV off-gas treatment system

During operation, a slight vacuum is maintained in the plenum space beneath the off-gas hood to prevent the release of any gases generated during processing. The vacuum is established by a blower in the off-gas processing portion of the system. The blower is capable of pulling 50 m^3/min of air into the hood and through the off-gas treatment system. A backup blower maintains the vacuum within the off-gas hood if the main off-gas blower fails. The backup blower provides approximately the same volumetric flow rate as the main blower.

The off-gas processing system consists of several components: a prefilter, quencher, hydrosonic scrubber, mist eliminator, heater, and a final high-efficiency particulate air (HEPA) filter subsystem. A thermal oxidizer will be available for supplementary processing. Flow from the off-gas hood through each of the components of this system is initialized and maintained by the high-volume blower located near the end of the off-gas treatment system. (This blower also develops the slight vacuum within the off-gas hood). Off gases are routed to the off-gas processing system through a 12-in.-diam. stainless steel line.

The off-gas first enters a prefilter. The purpose of the prefilter is to remove radionuclide-containing particulates before they enter the main off-gas treatment trailer. The prefilter consists of two parallel HEPA filters (four total) and a bypass. Duplicate banks of HEPAs make continuous filtering possible during periods of filter change-out. HEPA filters possess a removal efficiency of 99.97% for particulates 0.3 micrometers or larger.

The quencher, which is the next component, is contained within the off-gas treatment trailer. Water spray from nozzles inside the quencher cools the incoming off-gas flow. The spray pattern promotes good mixing, condensation, and heat transfer between the spray and off-gas flow streams. In addition to removing particulates from the off-gas flow, the water spray inside the quencher removes soluble contaminants (e.g., fluoride and chloride) and any trace concentrations

of semivolatile contaminants still present in the off-gas stream. Condensate from the quencher is further cooled with a water-to-glycol heat exchanger during its transfer to the scrub tanks.

A tandem nozzle hydrosonic scrubber is located just downstream of the quencher. The cooled gases leaving the quencher enter the first stage of the hydrosonic scrubber system. The fine mist produced by the scrubber captures and envelops any entrained dust particles in the off gas at greater than 97% efficiency for particulates in the range between 0.5 micron and larger. A second stage is located just downstream of the first stage to further process the off-gas flow. Mist in these scrubbers also removes soluble components from the flow stream (e.g., fluoride and chloride). Again, any trace concentrations of semivolatile contaminants still present in the off-gas stream are condensed into liquids or particles and are also collected at this stage.

Liquids that have been entrained and/or injected into the flow stream must now be removed to protect the integrity of the HEPA filter portion of the treatment system. A chevron-vane mist eliminator located downstream of the scrubbers removes the liquid. The resulting condensate is transferred for further processing to the scrub tanks. At the off-gas flow rate of 50 std. m^3/min, the mist eliminator removes 99.9% of all water droplets from the off-gas stream.

Condensate that is collected in the quencher, scrubbers, and mist eliminator is routed to two scrub tanks, which can store approximately 1000 gal. each. The pH of this scrub water is maintained between 6.0 and 8.0 to neutralize any acid gases [e.g., HCl (hydrochloric acid)]. A 50 wt% NaOH (sodium hydroxide) solution is used to automatically maintain the pH level. The scrub water is recirculated to provide the water for the quencher and scrubber spray systems. The scrub tanks are equipped with a transfer pump and line to allow transfer of the scrub solution between tanks. It is anticipated that no more than 4000 gal. will be generated.

Following processing by the mist eliminator, the off-gas is then passed through a heater to raise the temperature to above its dewpoint. The output of the heater is automatically controlled to achieve a minimum temperature rise of 15°C in the off-flow gas.

During the next stage, the off gas is filtered through a series of HEPA filters. As Figure 4-4 indicates, additional filter media can be included in the line. This bank will accommodate a redundant set of HEPA filters.

After going through the HEPA filters, the flow is then drawn through the off-gas blower and passed to the thermal oxidizer. The thermal oxidizer is a final polishing step in the processing of off gas to achieve low organic emission, complete conversion of carbon monoxide (CO) to carbon dioxide (CO^2), and the elimination of odor-causing compounds. Concentrations at this point in the process are extremely low and meet air emission criteria.

After the final processing step, the off-gas is monitored for oxygen, carbon monoxide and dioxide, and total hydrocarbons.

All waste (HEPA filters, water filters scrubber water) generated in the off-gas treatment system will be stored and handled according to applicable regulations.

4.3.2.2 Site Setup

4.3.2.2.1 Construction and Configuration

For the cold demonstration, an area 10 ft by 15 ft will be excavated to a depth equivalent to the base of the MDA V absorption beds (~6 ft deep). This excavation will be used to form the cold test

pit. Before the backfilling process, a trench will be excavated adjacent to the pit from ~6 ft below grade (the bottom of the pit) to a depth of 11 ft below grade (Figures 4-5 and 4-6). This trench will facilitate the placement of TCs lateral to and below the cold test pit. The trench will be constructed to maximize safety and minimize the area that is disturbed by heavy equipment. Minimizing the disturbance is necessary for injecting a starter path directly into the underlying tuff and fill material. The behavior and ease at which the starter path material is injected is dramatically different for consolidated versus unconsolidated soils.

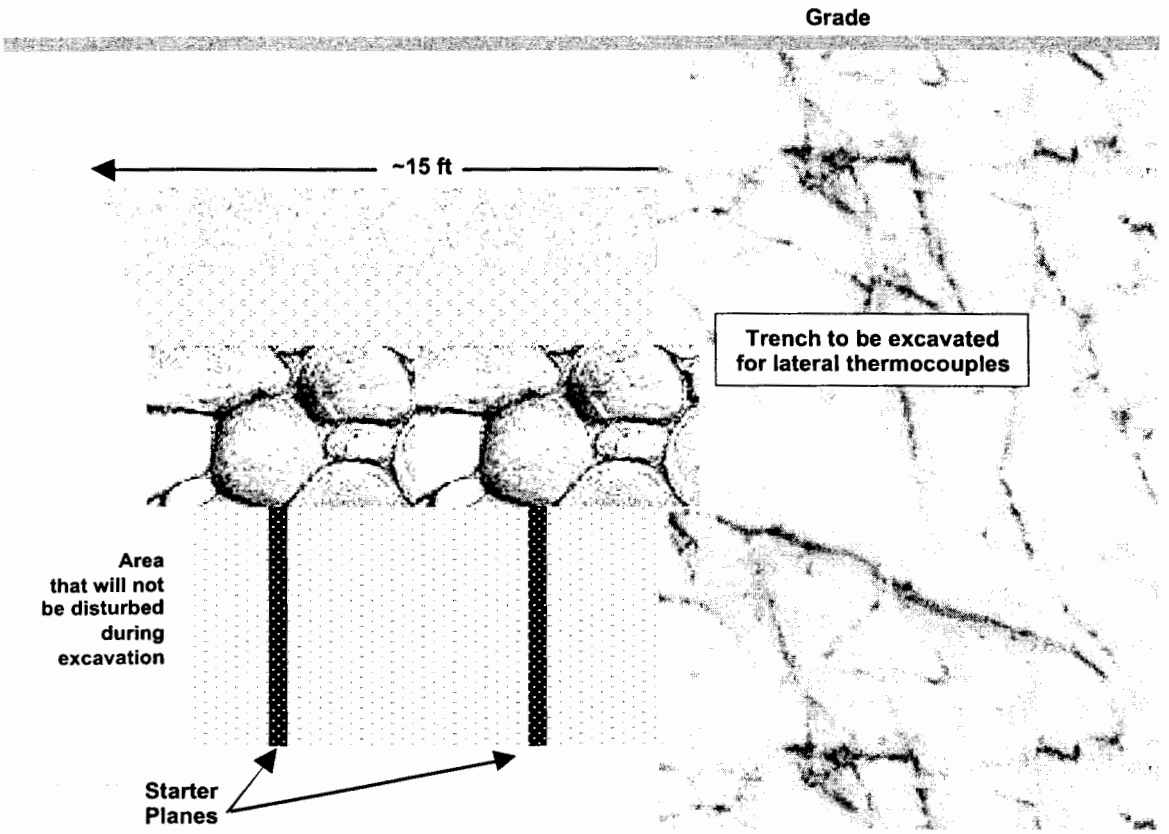


Figure 4-5. Long-dimensional cross-section of the construction of simulated absorption bed and instrument trenches

During the construction of the cold test pit, TCs will be placed to monitor the lateral and vertical growth rate of the melt and its size and shape. The data collected from the TCs will be used to evaluate the melt shape and how the simulated absorption bed is incorporated into the melt, which will then be used to refine the design of the hot deployment. For example, the size and shape of the melt might suggest a more optimum configuration for the hot deployment starter planes. Experience has shown that different soil types exhibit different rates of vertical and lateral melting. The Bandelier Tuff possesses a relatively low, dry density and may exhibit some differences in melting rates compared to other media.

TCs, which can measure continuous temperatures up to approximately 1200°C, will be placed in vertical and lateral bundles, as well as anchored to select cobbles in the cold test pit. TCs are used predominantly to determine the edge of the melt as their failure temperature coincides closely with the temperature at which the soils begin to melt.

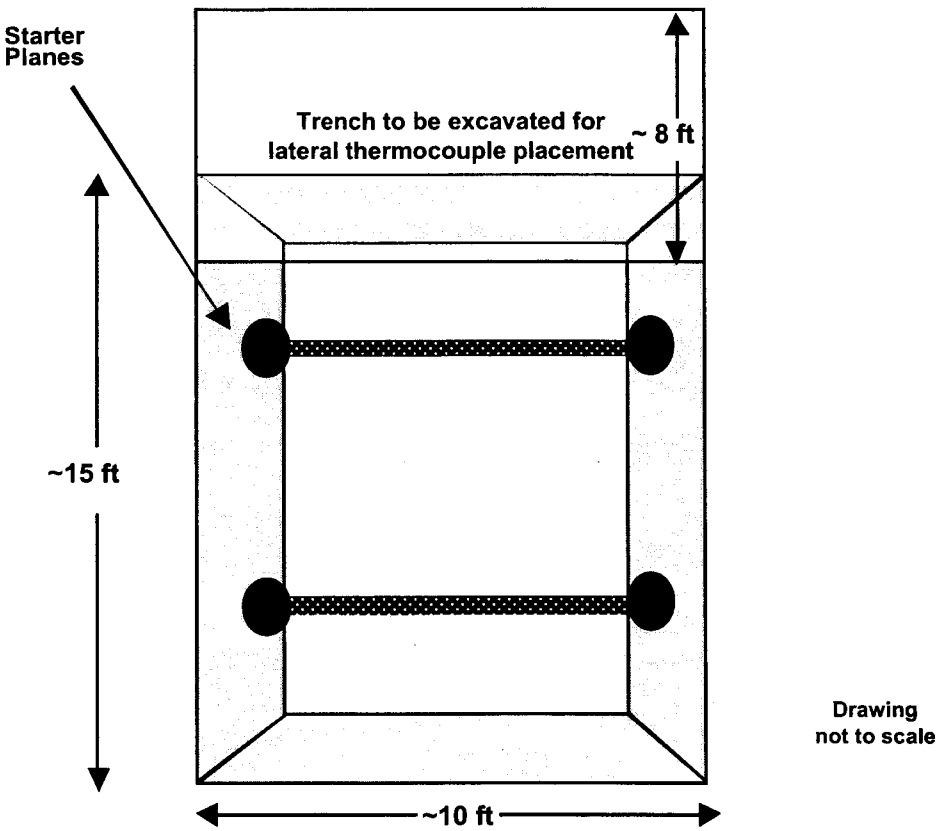


Figure 4-6. Plan view of simulated absorption bed construction

Nine bundles of TCs will be placed on the outer side of one starter plane to monitor the development outward of the melt (Figures 4-7, 4-8, and 4-9). The nine bundles will be located at three different elevations (i.e., three bundles at 1.5 ft below the bottom of the cold test pit, three additional bundles at the bottom of the starter planes or 3 ft below the bottom of the pit, and three bundles 5 ft below the bottom of the pit). The first TC of each bundle, which is nearest the starter plane in each of these nine bundles, will be located 3 ft away from the starter plane. Each TC will be interconnected by way of an instrument cable to a data acquisition system, which will allow the continuous monitoring and recording of data as well as facilitating the data transfer into common spreadsheet and graphing software applications. The TCs in the deepest level will be placed first followed by backfilling with soils up to the next level of TCs. This process will continue until all of the lateral TCs have been placed. The area can then be filled to the bottom of the cold test pit. Soil that was excavated during the construction of the cold test pit will be used as the backfill.

The material used to refill the space around the TCs will be compacted as the area is backfilled. The degree of compaction will be determined in the field and depends upon several parameters such as nominal particle size and level of natural compaction. It is critical that the location and operability of the TCs is not affected by the backfilling or compacting process. The cold test pit is to be filled with materials similar to those found in the MDA V absorption beds (i.e., 2-ft layer of cobble with nominal diameter of 3 to 12 in., a 1-ft layer of gravel, and a 1-ft layer of sand, followed by 2 ft of crushed tuff). Figures 4-5 through 4-6 depict the configuration of the cold test pit.

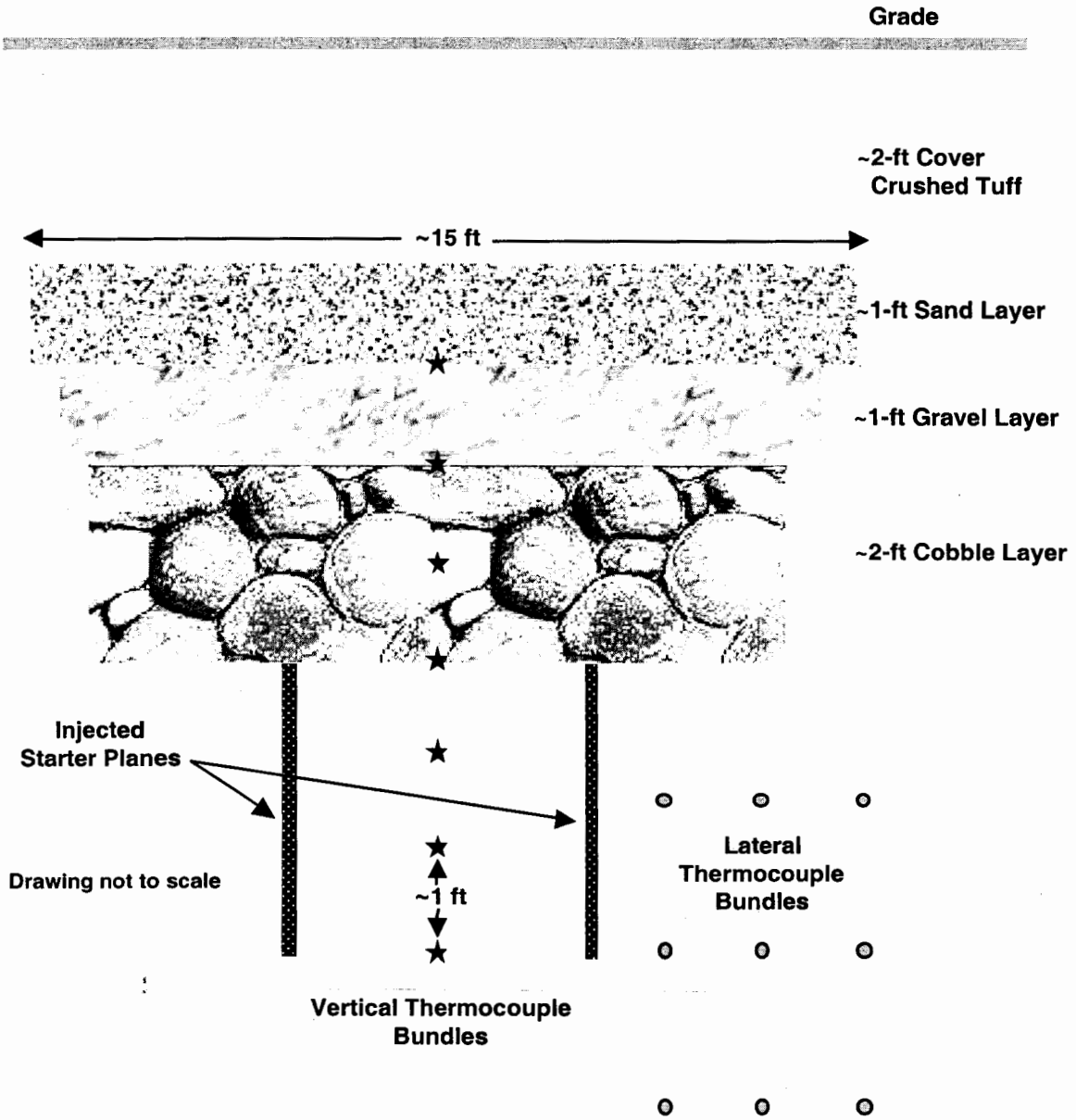


Figure 4-7. Long-dimension cross-section of thermocouple layout plan

Rock in the MDA V absorption bed is believed to be granitic in composition. The Laboratory believes it came from the Totavi quarry. Rock materials for the cold test pit were obtained from the following sources.

- The native soil was obtained from the excavation of the simulated absorption bed.
- Crushed tuff was obtained from the Los Alamos County landfill.
- The gravel was obtained from Cooks in Española, New Mexico.
- The cobbles were obtained from the Totavi quarry. The size of the cobbles ranged between 3 in. and 24 in. in diameter.

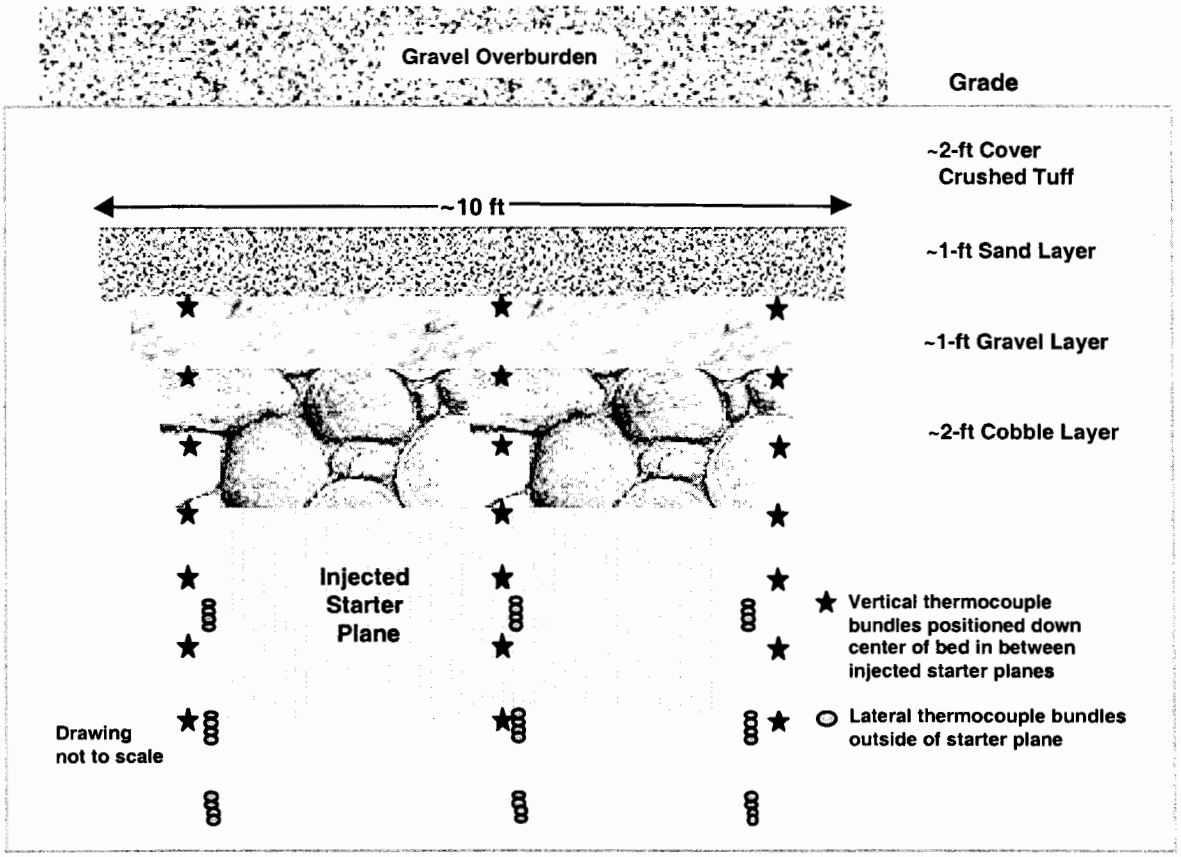


Figure 4-8. Short-dimension cross-section of cold demonstration thermocouple layout

To confirm that the contents of the cold test pit are incorporated into the melt, six TCs will each be securely attached to a different large cobble and placed in the pit. These six cobbles will be distributed in different locations of the pit. As the instrumented cobble moves down and is incorporated in the melt, data will be collected that indicate the rate at which the cold test pit material is being incorporated into the melt.

The cobble region in the cold test pit will contain a quantity of Cs_2CO_3 and CeO_2, which will be spread over the cobbles during construction of the cold test pit; the Cs_2CO_3 simulates the presence of the semivolatile radioactive cesium, and CeO_2 simulates the presence of uranium and plutonium. Because the surrogates added to the pit are homogeneously distributed throughout the resultant melt (which will be a larger volume than the simulated absorption bed), it is necessary to place enough surrogate such that the final melt concentration is significantly above the detection level of the procedure and the background concentration of the native soils. The mass of Cs_2CO_3 and CeO_2 to be placed in the pit is typically 2 to 100 times the inductively coupled plasma mass spectroscopy (ICPMS) detection limit for elemental cesium in the vitrified monolith produced in this demonstration (cesium and cerium detection limit = 0.1 ppm). The amount of $Cs_2CO_3$and CeO_2 to be added to the cold test pit will be 6.5 kg and 30 kg, respectively. The difference in the amount of surrogate added is due to the different background levels (2.5 ppm for cesium and 105 ppm for cerium) of these naturally occurring materials. The background levels of cesium and cerium were determined from samples collected from the excavation for the cold test pit and from tuff samples collected east of MDA V. The resulting concentration of cesium

and cerium in the cold test pit will be greater than the known concentration of radioactive cesium, plutonium, and uranium in the MDA V absorption beds (LANL 1996, 54969.2).

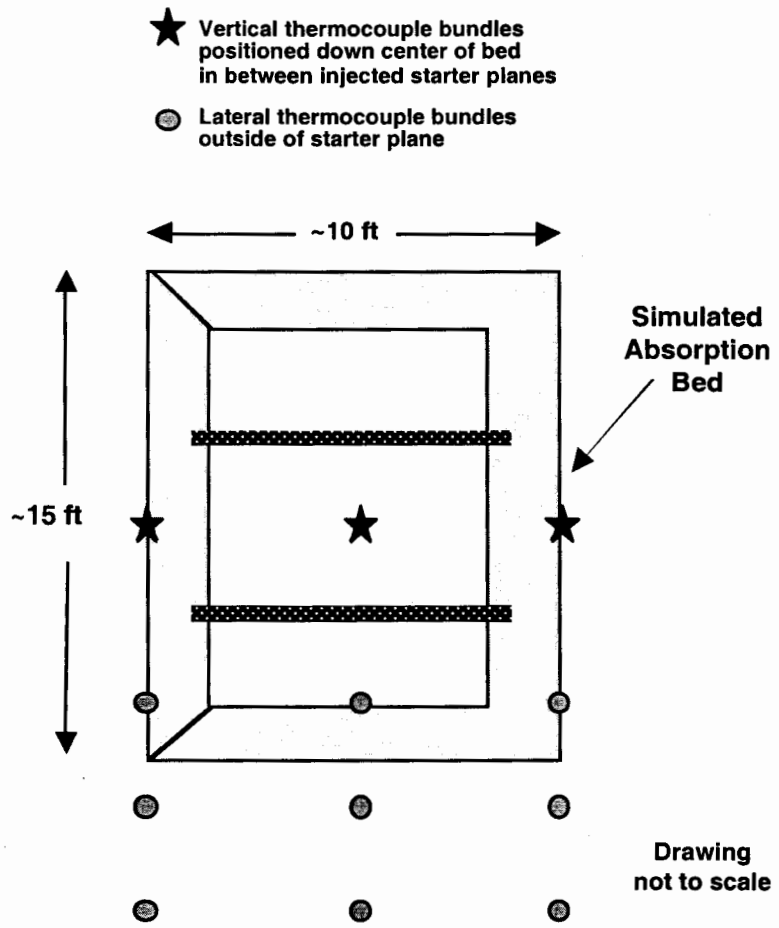


Figure 4-9. Plan view of cold demonstration thermocouple

4.3.2.2.2 Predemonstration Sampling

Cold Test Pit Samples. After it was determined that the NTISV project would be completed as a VCM because of the presence of hydrocarbons, NMED requested that samples be collected from the excavation before construction of the cold test pit. The ER Project collected samples from the bottom and the sidewalls of the excavation to determine hydrocarbon concentrations before the cold demonstration. Five samples were collected from the bottom of the excavation in an X pattern, and one sample was collected from a nonstained area on each side wall (Figure 4-1). In addition, two samples were collected from the stained areas along the north wall and southeast corner of the excavation. A duplicate sample was also collected from the southeast corner. The samples were analyzed for metals, SVOCs, VOCs, TAL metals, and gross alpha, beta, and gamma (Table 4-1). All samples were collected according to applicable ER SOPs.

TABLE 4-2
PREDEMONSTRATION SAMPLING[a]

Samples	Number of Samples Taken[b]	Number of Samples Analyzed	Analytical Method	Detection Limit
Metals Analyses				
Predemonstration tuff/fill material	10	5	EPA SW 846 6010	0.1 mg/kg
Whole Rock				
Tuff	5	5	XRF[c]	100 ppm
Cobble	2	2	XRF	100 ppm
Gravel	2	2	XRF	100 ppm
Sand	5	2	XRF	100 ppm

a. Sample results will be reported in the VCM report.
b. All samples collected may not be analyzed. The samples will be archived for potential future analyses, if required.
c. XRF = x-ray fluorescence

Whole Rock Samples. Before the cold demonstration, Geosafe collected samples from the excavated fill and tuff material, the cobble, the gravel, and the sand used in the construction of the cold test pit (Table 4-2). The samples were sent to Chemex Laboratories in Sparks, NV, for whole rock analysis. An x-ray fluorescence (XRF) analysis (Table 4-2) will quantify the bulk composition of the tuff and fill material to be processed. The analytical results will be used in a geochemical model that numerically mixes the components in the proportions expected in the field and predicts the resultant product composition. The chemical composition of the materials to be vitrified affects melt temperature, melt viscosity, mass of off-gas generated, characteristics of the off-gas (e.g., pH), electrical conductivity of the melt, and approximate crystallization behavior upon cooling. These characteristics are all required to establish proper operational parameters. The temperature/viscosity prediction is made using the method developed by Shaw (1972, 62900). This method is accurate to within 50°C for predicting melt-operating temperatures provided the composition being evaluated is similar to natural magmatic compositions.

A whole rock analysis of the materials to be vitrified will quantify the bulk composition and provide the silica, aluminum, iron, and calcium content. Particular attention is paid to the concentration of glass-forming ions and ions that serve as fluxing agents in the melt. The monovalent alkali cations [Na^+ (sodium), Li^+ (lithium), K^+ (potassium)] provide electrical conductivity in a silicate melt. The conductivity of the melt is generally proportional to the concentration of these ions, but variations occur because of the complexity of multicomponent systems, such as in soil. Experience has shown that if the sum of the monovalent alkali cations ranges between 2 and 5 wt%, NTISV processing proceeds without electrical difficulty. The presence of cations such as Na^+ and Ca^{+2} (calcium) also reduces the viscosity of the melt by physically separating the glass-forming cations and reducing the number of glass-forming bonds in the melt. Therefore, the addition of sodium as an electrical flux also reduces melt viscosity and operating melt temperature.

Ten samples and a split from of the ten samples of the tuff and fill material will be collected during excavation of the cold test pit and will be analyzed for nonradioactive cesium and cerium and total metals (Table 4-2). The sample results will be used to determine if nonradioactive cesium or cerium are present and, if so, to determine baseline values to be used for comparison with the postdemonstration analytical results. After analytical results are received, the sample mean, variance, and 80% confidence intervals will be calculated and verified that five samples are sufficient to calculate the 80 percent confidence interval for metals. No additional samples or analyses are anticipated. One sample will also be analyzed for surrogate compounds. Three samples will be archived until completion of the project, in the event additional analysis of some samples is required. If the statistical variance in the analytical results indicates that a larger sample population size is needed, the required number of additional archived samples will be analyzed and a new mean and variance calculated. The procedures provided above will be continued until the 80 percent confidence interval is obtained, as required to meet project objectives or as directed by project management.

4.3.2.2.3 Melt-Profile Monitoring Wells

Various melt-profile monitoring activities will be performed during and after the cold demonstration. Various instruments inserted down four 50-ft-deep boreholes will perform the monitoring. Each borehole will be 4 in. in diameter and drilled using a pneumatic rotary, which minimizes bringing drill cuttings to the surface. Cuttings will be brought to the surface during the drilling operation by way of a vacuum extraction and HEPA filtration system. All cuttings will be containerized. Each completed borehole will include flush-threaded 2-in. ID PVC well casing sealed at the bottom with a threaded plug and at the top with a plug type cap. The casing will be grouted into the borehole using a cement bentonite grout. Surface completion will consist of a flush-mount monitoring-well cover set into a cement apron.

The borehole locations will be located 360° around the cold test pit. All of the boreholes will be drilled less than 100 ft apart (approximately 25 ft from the center of the cold test pit). MSE-TA will survey borehole locations and elevations.

4.3.2.2.4 Site Preconditioning

The Bandelier Tuff is predominantly a cliff-forming formation and is expected to form vertical walls around the melt as subsidence occurs. It is possible that small sections at the edge of the cold test pit would be left unprocessed if measures are not taken to promote subsidence of the pit edges; therefore, it will be necessary to break up the Bandelier Tuff and the fill material around the edges and below the pit to a depth of 10 ft using a vibrating beam. This will promote subsidence of all the pit walls into the melt. Because this approach is the desired method to ensure complete processing of a portion of absorption bed 1 at MDA V during the hot deployment, this approach will be used during the cold demonstration. The tuff will be broken up on three sides and down the middle of the pit. The fourth side will have already been disturbed during the excavation for TC placement. The inner portion of the pit and below the pit will have been disturbed during vibratory placement of the electrode casings and installation of the starter plane. For this demonstration, a crane-supported hydraulic vibrator and steel probe or I-beam will be used. Penetrations will be made every 2 to 4 ft in the area around the pit. The amount of subsidence and the angle of repose or the degree at which the edge sloughs in will be determined and used in the evaluation for application to the hot deployment. Figure 4-10 depicts a typical preconditioning pattern.

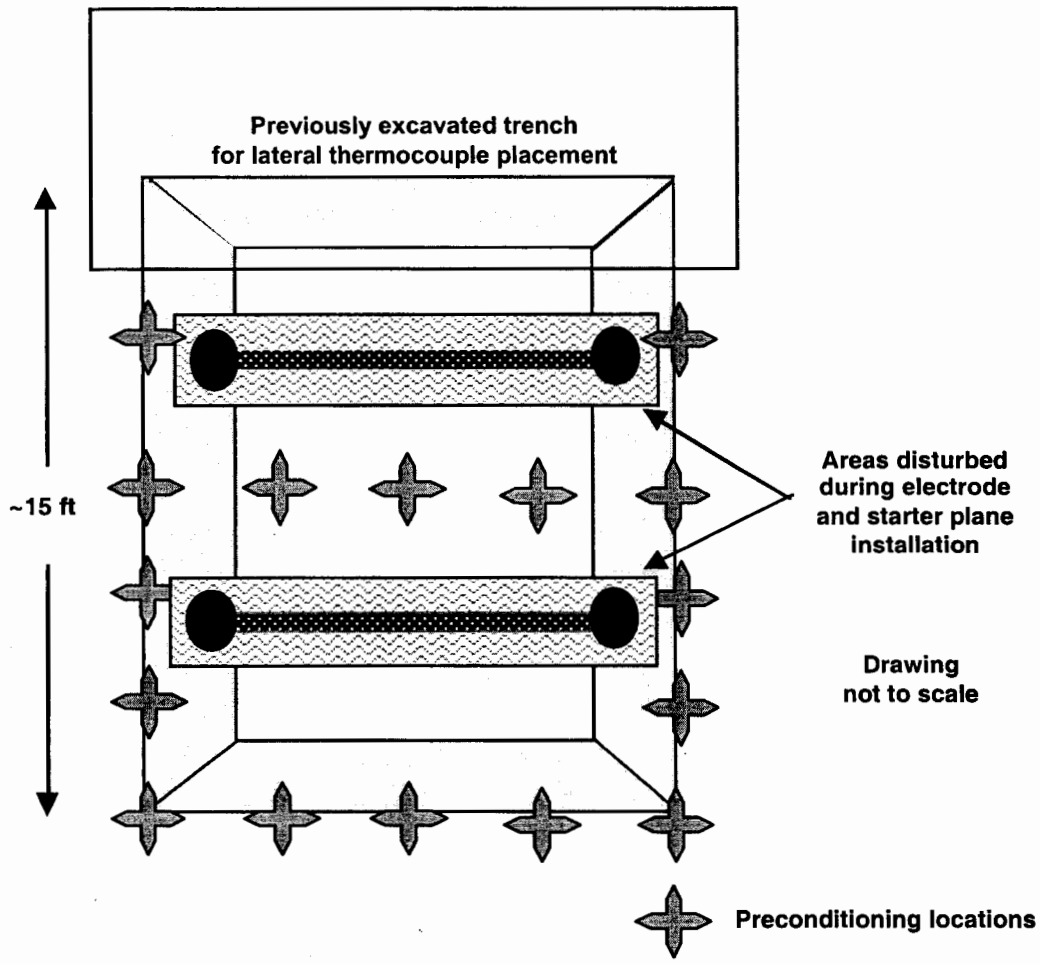


Figure 4-10. Plan view of the typical preconditioning pattern around an absorption bed

When preconditioning is occurring directly down the center of the cold test pit as shown in Figure 4-10, three vertical bundles of TCs will be placed down the resulting void left by the beam footprint. Past experience shows that each hole will stay open until the adjacent area is preconditioned. During the periods that a hole remains open, a bundle of approximately seven TCs each will be inserted down the hole. As the adjacent preconditionings are done, it is expected that these holes will collapse around the TC bundles. A relatively fine-grain material will be used to fill in around the TC bundle in the last hole.

4.3.2.2.5 Electrode Placement in Cold Test Pit

Four steel electrode casings (16-in. diam.) will be vibrated through the cold test pit to a depth of approximately 5 ft below the bottom of the pit. Each casing will be fitted with a nose piece to prevent soil and other materials from entering the end of the casing. After the steel casings have been placed, the nose piece will be knocked off by dropping a steel I-beam down the inside of each casing so that it contacts the inside of the nose piece and breaks the spot welds that secure it to the casing. The casings will be withdrawn slightly to ensure that the nose piece is free. Then graphite electrodes will be positioned into and centered within the steel casings. Initially, just two

sections of electrodes will be threaded together and placed in the casing. This will allow approximately 2 ft of electrode to stand above grade. Care will be taken to ensure that the electrodes are positioned very close to vertical within the casings. The annular spaces between the electrodes and the casings will be backfilled with graphite starter material to a depth of 3 ft below grade, and the casings will be pulled out vertically over the top of the electrodes. The starter material within the casing will be compacted periodically as the casing is pulled upward. This is to ensure that good contact between the starter material and the electrode is obtained. After the casings are removed, visual observations of the annular space will be made by looking down around each electrode. A complete uniform column with a height of approximately 5 ft will be installed 360° around each electrode. The small areas of void near the surface will be filled to grade with native soil/sand.

4.3.2.2.6 Starter Plane Injection in Cold Test Pit

Field testing of the injection method will determine the optimum parameters to achieve proper penetration and placement of the starter material in the soil/tuff at MDA V. Although the injection system has been used extensively, the specific performance parameters have not been established for the Bandelier Tuff and other fill materials. Based upon past experience with other soil types however, injecting the starter material should be an efficient process. To determine how far the starter material can be injected away from the injection nozzles, a test will be performed. Starter material will be injected into the test trench in the vicinity of the cold demonstration location; the injected area will then be excavated to inspect placement and homogeneity of the starter material. In this way, the proper spacing and pressures to be used during injection of starter planes can be determined. The postdemonstration monolith examination will also help identify if and how the starter planes for the hot deployment can be configured in a manner that results in optimum processing of the area.

A high-pressure injection system will inject the conductive starter planes into the subsurface. This system can inject a variety of solid materials radially out into soil up to 6 ft from the injection nozzle. The purpose of the starter planes is to establish conductive paths connecting the electrodes. These conductive paths carry the initial electrical current and initiate the joule heating process in the subsurface.

The injection materials are prepared for introduction into the soils by first performing vortex colloidal mixing of the bulk components (graphite starter material and sodium silicate carrier solution). A triplex diesel mechanical pump or a diesel hydraulic piston pump will then pump (ultra-high-pressure, up to 10,000 psi) the resulting slurry to injection nozzles by way of uniaxial or coaxial drilling pipe. The slurry will pass through a small diameter orifice into the soil column; this induces cutting and displacement of tuff/fill material followed by injection of starter path solution into the void area.

After the electrodes are in place, the injection nozzle will be vibrated into the soil vertically to 9 ft bgs. The injection nozzle locations will be positioned on approximately 1-ft centers (depending upon the results of the parameter evaluation) and will connect the two pairs of electrodes parallel to the long axis of the cold test pit. High-pressure injection will occur as the nozzle is pulled upward. The nozzle will form a vertical bow tie configuration as it is pulled up to the 6-ft-bgs depth; at this time injecting will stop. Each bow tie between the electrodes will be joined with the previous injection. After each injection, the conductivity will be tested to confirm the pathway is continuous and conductive. If the conductivity between the electrodes is not adequate to initiate a melt, then additional starter material will be injected until an electrical connection has been established. All

starter path flush water generated during this process will be stored and handled according to applicable regulations.

4.3.2.2.7 NTISV Equipment Setup Completion

After the melt-monitoring wells, electrodes, and starter planes are installed, a 2-ft layer of 7/8-in. gravel will be placed over the cold test pit. This material will be used as overburden to feed into the subsided area as the underlying pit materials are incorporated into the melt. The overburden helps increase the efficiency of the process by reducing heat loss. The overburden layout can be seen in Figure 4-8.

In parallel with the installation of the starter planes, the off-gas hood assembly will begin in a level location adjacent to the cold demonstration site. After the hood is assembled and aligned over the test area, the off-gas piping and electrical and instrument cables will be connected, and each component tested for operability. Then a complete system checkout coupled with a management walk through will be performed to ensure readiness. Following approval to proceed, the melting process will be initiated. A graduated power-up schedule will be employed that allows the starter planes to heat up and begin melting soil and materials in a controlled fashion. As the melt volume grows, the power level is increased to continue the melting process. The cold demonstration power-up schedule will continue over an estimated 30-hr time period. Table 4-3 shows a typical power-up schedule for this scale of test. The size of the cold demonstration has been scaled down compared to the hot deployment in order to save costs. As a result, the power levels applied will also be scaled back (anticipated at ~2MW total power input).

4.3.2.3 Melt Process

The estimated size of the vitrified product will be 20 ft by 20 ft by 22 ft depth. During the melting process, the size of the melt will be monitored by temperature profiling and tomography, which are discussed below.

4.3.2.3.1 Melt-Monitoring Methodologies

4.3.2.3.1.1 Temperature Profiling

During the melting process, temperature data from the TCs, power level and consumption data, and process observations will be recorded. The TC temperature data will be recorded by an Advantech Adam 5000 data acquisition system at 5-min. intervals throughout the demonstration. Electrical data (primary and secondary voltage, current, and power), off-gas system data (pressures, temperatures, scrub water parameters, and stack gas concentrations), and hood data (temperature and vacuum levels) will be electronically recorded by the DataVue data collection system at 10-sec. intervals throughout the demonstration. These data will also be recorded manually at 1-hr intervals for the duration of the demonstration. Electrode depth measurements will also be taken and manually recorded at 1-hr intervals.

TABLE 4-3
COLD DEMONSTRATION POWER SCHEDULE

Time Schedule (hr)	Power Input Per Phase (kW/phase)	Time Schedule (hr)	Power Input Per Phase(kW/phase)
0.0 to 0.5	5	15.0 to 15.5	355
0.5 to 1.0	10	15.5 to 16.0	370
1.0 to 1.5	20	16.0 to 16.5	390
1.5 to 2.0	25	16.5 to 17.0	420
2.0 to 2.5	35	17.0 to 17.5	440
2.5 to 3.0	45	17.5 to 18.0	460
3.0 to 3.5	55	18.0 to 18.5	480
3.5 to 4.0	65	18.5 to 19.0	500
4.0 to 4.5	75	19.0 to 19.5	520
4.5 to 5.0	85	19.5 to 20.0	540
5.0 to 5.5	95	20.0 to 20.5	560
5.5 to 6.0	105	20.5 to 21.0	580
6.0 to 6.5	120	21.0 to 21.5	600
6.5 to 7.0	130	21.5 to 22.0	620
7.0 to 7.5	145	22.0 to 22.5	640
7.5 to 8.0	155	22.5 to 23.0	660
8.0 to 8.5	175	23.0 to 23.5	680
8.5 to 9.0	180	23.5 to 24.0	700
9.0 to 9.5	190	24.0 to 24.5	720
9.5 to 10.0	205	24.5 to 25.0	740
10.0 to 10.5	220	25.0 to 25.5	760
10.5 to 11.0	230	25.5 to 26.0	780
11.0 to 11.5	245	26.0 to 26.5	800
11.5 to 12.0	260	26.5 to 27.0	830
12.0 to 12.5	275	27.0 to 27.5	860
12.5 to 13.0	285	27.5 to 28.0	890
13.0 to13.5	300	28.0 to 28.5	920
13.5 to 14.0	310	28.5 to 29.0	950
14.0 to 14.5	325	29.0 to 29.5	980
14.5 to 15.0	340	29.5 to 30.0	1010

* Time counted from initial startup

4.3.2.3.1.2 Tomography

Tomography is the process of forming images of the interior of an object from measurements made outside the object along rays passed through the object (Menke 1989, 62929). The methods of tomography that will be utilized include seismic tomography, ground-penetrating radar (GPR), and electrical resistance tomography (ERT) (MSE-TA 1999, 62906). The data will be acquired to determine seismic velocity, GPR velocity, and electrical resistance distribution and will make it possible to determine if anomalies are a result of the melt process or original features.

Before and after the cold demonstration, a set of baseline geophysical data will be acquired for the trench and the cold test pit. The set will include surface to borehole seismic data, borehole to borehole ERT data, and borehole to borehole and surface to borehole GPR data. The measurements will be made from within 50-ft deep boreholes installed outside of the melt area (Section 3.3.2.2.3) and from the ground surface.

These methods may also be used to monitor the progress of the vitrification process during the demonstration. Monitoring will depend on the site conditions, such as

- extents of the exclusion zone;
- access to monitoring wells;
- amount of physical noise (trucks, heavy equipment, construction activities); and
- amount of electrical noise (generators, power lines).

Seismic Velocity Tomography. To obtain seismic data, each borehole will be filled with potable water to ~2 ft bgs; then receivers spaced 1 ft apart will be placed in the boreholes. The water provides a coupling between the receivers and the surrounding formation. A seismic source will be positioned in an area on a line between the boreholes, and the receiver will record travel time from source for the seismic energy. The source will be moved at 5-ft increments and the process repeated until a sufficient number of travel times have been recorded along ray paths through the area of interest. Source locations will be surveyed for x, y, and z coordinates to provide accurate distances from source to receivers.

Baseline seismic velocity data will be processed as two profiles. Travel time and distances will be determined for each source/receiver pair to create the tomography data set. The data will be processed using GEOTOMAN, a computer program developed for three-dimensional tomographic imaging. Straight-ray and curved-ray processing will be employed in the inversion of the travel time data. When the inversion process is completed, a tomographic section, showing seismic velocity distribution, will be produced for each profile.

Ground-Penetrating Radar Tomography. To obtain GPR data, any water in the boreholes will be removed, stored, and managed appropriately.

For borehole to borehole GPR data, a transmitting antenna will be placed at a fixed depth in one borehole; a receiver antenna will be placed in the opposite borehole and moved along the borehole in 3.28-ft increments. When all data are recorded, the transmitting antenna will be lowered 3.28 ft, and the process will be repeated. Travel time will be recorded for each transmitting and receiver antenna position.

For surface to borehole data, a transmitting antenna will be positioned along the lines between opposite boreholes and will be moved in 5-ft increments. Antenna positions will be surveyed for x, y, and z coordinates. A receiver antenna will be placed in each borehole and moved in increments

of 3.28 ft along the length of the borehole. Travel time will be recorded along the length of the boreholes for each surface antenna position.

Baseline GPR velocity data will be processed as two profiles. Travel time distances will be determined for each surface to borehole and borehole to borehole source/receiver pair to create the data set. GPR data will be processed using GEOTOMAN. When the inversion process is completed, a tomographic section showing the GPR velocity distribution will be produced for each profile.

Electrical Resistance Tomography. Borehole to borehole ERT data will be acquired to establish the electrical resistance distribution in the subsurface and the simulated absorption bed. This baseline data will be used to assess electrical resistivity anomalies during the melt process.

Electrodes placed within the boreholes will be used to inject electrical current into the subsurface. Receivers will measure the resulting electrical potentials. Electrode source and receiver pair configurations will be varied, based on the forward ERT modeling results, until a sufficient data set is acquired.

Baseline ERT data, including current measurements, potential measurements, and dipole locations, will be inverted, and two tomographic sections will be generated from the data set.

4.3.2.3.2 Duration and Shutdown Criteria

The demonstration will conclude when the electrodes reach a depth of 22 ft below grade; the ending depth will be determined by monitoring the electrode insertion depth. Power to the melt will then be terminated and the system shut down. The cold demonstration will require up to 192 hours (8 days) of operation. The off-gas treatment system will be operated for an additional 2 hr or as specified by the project manager.

4.3.2.3.3 Off-Gas Sampling

Air pulled through the hood and processed with the off-gas treatment system will be monitored before releasc to the environment. The air will be sampled during the demonstration for temperature and the following parameters:

- CO,
- CO_2,
- oxygen (O_2), and
- total hydrocarbons

During the cold demonstration, off-gas sampling will not be performed for contaminants, radionuclides, or the surrogate compounds.

4.3.3 Postmelt Sampling

4.3.3.1 Vitrified Mass

Approximately one week after the completion of the cold demonstration, the surface of the vitrified mass will be uncovered to accelerate the cooling process. After adequate cool-down time, a

portion of the NTISV block will be exposed to allow visual and photographic examination and evaluation of the melt. No personnel will be in close proximity of the hot surfaces or soils during this work. Sampling will consist of breaking the vitrified product with heavy equipment and bringing large sections to grade. A hammer or a similar tool will be used to make smaller pieces. Only pieces that have not touched the tool will be collected as samples. Samples will be collected from various locations in the southeast portion of the vitrified monolith; locations will be selected in the field. Five samples and a blind sample will be collected, all of which will be located greater than 1 ft from the edge of the monolith and greater than 2 ft from any other sampling location. The sampling procedure is a random sampling scheme adopted from the EPA's SW-846 Test Methods for Evaluating Solid Waste (EPA 1993, 40070). The samples will be sent to Chemex Laboratories in Sparks, NV, for analyses. Samples will be analyzed using various techniques including chemical analysis and leach testing (for the surrogate metals), electron microprobe analysis, and physical inspection (Table 4-4). The blind sample will be analyzed for total metals and for melt-volume determination. The analytical protocol listed in Table 4-4 defines the number of samples, the analysis parameters, and the EPA methods to be used.

TABLE 4-4
POSTDEMONSTRATION SAMPLING

Samples	Number of Samples Taken[a]	Number of Samples Analyzed	Analytical Method	Detection Limit
Metals Analyses				
Vitrified product	5	4	XRF[b], ICPMS[c]	0.1 mg/kg
Product Volume Determination (x and y Analyses)				
Vitrified product	2	2	XRF	0.1 mg/kg
Leach Testing				
Vitrified product	5	5	TCLP[d], PCT[e]	0.1 mg/kg

a. All samples collected may not be analyzed. The samples will be archived for potential future analyses, if required.
b. XRF = x-ray fluorescence
c. ICPMS = inductively coupled plasma mass spectroscopy
d. TCLP = toxicity characteristic leaching procedure
e. PCT = product consistency test

There will be several techniques employed to assess the mass of the vitrified block.

- Partial excavation will be performed to estimate block dimensions.
- Energy usage and electrode depth can provide an estimate of mass.

- Postdemonstration samples of the vitrified block material will determine the concentration of surrogate materials. If the assumption of homogeneous mixing is made (and the years of previous testing support this hypothesis), one can use this concentration, together with the known quantity of material staged, to estimate the volume of the block produced. The corresponding block mass can then be estimated assuming an appropriate density for the vitrified material.
- Tomography will be utilized to map the size, shape, and extent of the vitrified mass. Tomographic methods include seismic tomography, GPR, and ERT; the same configurations and procedures described in Section 3.3.2.3.2.2 will be used. Data will be acquired to determine seismic velocity, GPR velocity, and electrical resistance distribution. Results will be compared to baseline results, and a difference tomogram will be generated for examining changes in the subsurface resulting from the NTISV process. Each method will be evaluated to determine if it is a valid method for nondestructively mapping the vitrified block. If the estimated dimensions of the monolith, as determined by tomographic imaging, are within 20% of the estimated dimensions of the monolith as determined by excavation, the tomography will be considered successful.

4.3.3.2 Soil/Fill

After the cold demonstration, the ER Project will collect three samples from soils adjacent to a portion of the vitrified product to document the levels of hydrocarbons and other potential contaminants in the soil (Table 4-1). The samples will be collected at the approximate depth of the bottom of the pit excavation, at the soil/tuff interface, and approximately 20 ft bgs. The samples will be analyzed for VOCs, SVOCs, metals, TPH (diesel range), and gross alpha/beta/gamma. All samples will be collected according to applicable ER SOPs.

4.3.4 Site Restoration

Site restoration includes leveling, erosion control, and eventually revegetation. The heat that is slowly released from the subsurface monolith keeps the surface soil dry (but not hot) for a period of four to six months. Therefore, it is necessary for the area to cool to the point where surface soils can maintain adequate moisture to support plant life. At that time, the demonstration area can be revegetated. The area will be reseeded with a local grass or ground cover mixture.

5.0 WASTE MANAGEMENT

Potential wastes generated during the VCM characterization and demonstration activities are summarized in Table 5-1.

TABLE 5-1
ANTICIPATED WASTE TYPE AND VOLUME FOR VCM

Item	Waste Type*	Anticipated Volume
HEPA filters	Solid, nonhazardous, low-level radioactive	<5 yd^3
Water filters	Solid, nonhazardous, low-level radioactive	<5 yd^3
Air emission scrubber water	Liquid, nonhazardous, low-level radioactive	~4000 gallons
Flush water	Liquid, nonhazardous, low-level radioactive	~4000 gallons
Sample preparation and wash water from immunoassay test kits	Liquid, hazardous	<5 gal.
PPE, plastic, material packaging	Solid, nonhazardous, low-level radioactive	<10 yd^3
Excavated soil and drill cuttings	Solid, special waste (hydrocarbons)	~60 yd^3

* All waste associated with the off-gas treatment system has the potential to be low-level waste because components are radioactively contaminated. The components were received from Oak Ridge National Laboratory.

A Waste Characterization Strategy Form (LANL 1999, 62899) has been approved and submitted to EM-SWO and ESH-19. All waste will be characterized, managed, and disposed of according to applicable regulations.

6.0 SCHEDULE

A schedule for the NTISV cold demonstration is included in Appendix C.

7.0 REFERENCES

Canepa, J. and T. Taylor, March 8, 1999. "Notification of the Rediscovery of AOC Associated with the NTISV Cold Test at TA-21," Los Alamos National Laboratory memorandum EM/ER:99-051 to B. Garcia, Los Alamos, New Mexico. (Canepa and Taylor 1999, ER ID 62883)

Dinwiddie, R., December 10, 1996. "Notice of Determination Requests for Permit Modification Units Proposed for No Further Action March and September 1995," New Mexico Environment Department memorandum to T. Taylor and J. Jansen, Santa Fe, New Mexico (Dinwiddie 1996, ER ID 55815)

DOE (US Department of Energy), October 1987. "Phase I: Installation Assessment, Los Alamos National Laboratory," Volumes 1 and 2, (draft), Comprehensive Environmental Assessment and Response Program, Albuquerque Operations Office, Albuquerque, New Mexico. (DOE 1987, ER ID 8657)

EPA (US Environmental Protection Agency), April 1993. "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," Volume II, SW-846, Third Edition, Final Update 1, Office of Solid Waste and Emergency Response, Washington, DC. (EPA 1993, ER ID 40070)

Francis, W., February 16, 1999. "Fuel Tank for the DP Laundry Building (TA-21-20) Steam Boiler," Los Alamos National Laboratory memorandum EM/ER-RAFA:99-008 to J. Jones, Los Alamos, New Mexico. (Francis 1999, ER ID 62745)

Geosafe Corporation, February 8, 1999. "Non-Traditional In Situ Vitrification Demonstration Plan for the MDA-V Site at the Los Alamos National Laboratory," Revision 1, Geosafe Corporation report, Richland, WA. (Geosafe Corporation 1999, ER ID 63039)

LANL (Los Alamos National Laboratory), September 1989. "Release Site Database, Task 9, TA-21 (DP Site)," prepared by Roy F. Weston, Inc., for the Department of Energy, Los Alamos, New Mexico. (LANL 1989, ER ID 11941)

LANL (Los Alamos National Laboratory), November 1990. "Solid Waste Management Units Report," Volume I, Los Alamos National Laboratory report LA-UR-90-3400, prepared by International Technology Corporation under Contract 9-XS8-0062R-1, Los Alamos, New Mexico. (LANL 1990, ER ID 7511)

LANL (Los Alamos National Laboratory), May 1991. "TA-21 Operable Unit RFI Work Plan for Environmental Restoration," Volume II, Los Alamos National Laboratory report LA-UR-91-962, Los Alamos, New Mexico. (LANL 1991, ER ID 07529)

LANL (Los Alamos National Laboratory), February 28, 1994. "Phase Report 1C, TA-21 Operable Unit RCRA Facility Investigation, Outfalls Investigation," Los Alamos National Laboratory Report LA-UR-94-228, Los Alamos, New Mexico. (LANL 1994, ER ID 31591)

LANL (Los Alamos National Laboratory), March 1995. "Request for Permit Modification, Units Proposed for NFA," Los Alamos National Laboratory report LA-UR-95-767, Los Alamos, New Mexico. (LANL 1995, ER ID 45365)

LANL (Los Alamos National Laboratory), August 1996. "RFI Report for Potential Release Sites in TA-21, 21-018(a), Material Disposal Area V (Located in Former Operable Unit 1106) Field Unit 1," Los Alamos National Laboratory report LA-UR-96-2735, Los Alamos, New Mexico. (LANL 1996, ER ID 54969.2)

LANL (Los Alamos National Laboratory), March 1998. "Environmental Restoration Health and Safety Plan (HASP)," Revision 1, Los Alamos, New Mexico. (LANL 1998, ER ID 58714)

LANL (Los Alamos National Laboratory), January 14, 1999. "Waste Characterization Strategy Form," Los Alamos, New Mexico. (LANL 1999, ER ID 62899)

LANL (Los Alamos National Laboratory), February 16, 1999. "Los Alamos National Laboratory Environmental Restoration (ER) Site-Specific Health & Safety Plan (SSHASP), Non-Traditional In Situ Vitrification (NTISV) Demonstration at TA-21 MDA-V Site," SSHASP No. 230, Los Alamos National Laboratory, Los Alamos, New Mexico. (LANL 1999, ER ID 63038)

LASL (Los Alamos Scientific Laboratory), 1945. "D.P. Diesel Plant," Los Alamos Scientific Laboratory photograph, Los Alamos, New Mexico. (LASL 1945, ER ID 62919)

LASL (Los Alamos Scientific Laboratory), July 2, 1948. "Bldg. DPW-33, Industrial Waste Studies Lab, T. A. 21 Plot Plan," LASL Engineering Drawing A5-C142, Los Alamos, New Mexico. (LASL 1948, ER ID 24368)

LASL (Los Alamos Scientific Laboratory), July 14, 1948. "Dike and Pump House DPW-43, T. A. 21, for D. P. Laundry DPW-20," LASL Engineering Drawing A5-C161, Los Alamos, New Mexico. (LASL 1948, ER ID 62912)

Menke, W., 1989. *Geophysical Data Analysis: Discrete Inverse Theory*, Revised Edition, Academic Press, San Diego, California. (Menke 1989, ER ID 62929)

MSE-TA (MSE Technology Applications), Los Alamos National Laboratory, and Geosafe Corporation, November 1998. "Demonstration and Deployment of a Non-Traditional *In Situ* Vitrification (NTISV) Process at Los Alamos National Laboratory," Program Plan Rev. 5, Los Alamos, New Mexico. (MSE-TA et al. 1998, ER ID 62930)

MSE-TA (MSE Technology Applications), February 26, 1999. "Geophysical Verification and Monitoring Work Plan for In Situ Vitrification (ISV) Cold Demonstration at Los Alamos National Laboratory (LANL) Draft 03," MSE-TA report, Butte, Montana. (MSE-TA 1998, ER ID 62906)

NMED (New Mexico Environment Department), 1996. "Underground Storage Tank Regulations, State of New Mexico Environmental Improvement Board," EIB/USTR-1 through 14, Santa Fe, New Mexico (NMED 1996, ER ID 58202)

ORNL (Oak Ridge National Laboratory), August 1996. "Technical Evaluation of the In Situ Vitrification Melt Expulsion at the Oak Ridge National Laboratory on April 21, 1996, Oak Ridge, Tennessee," Oak Ridge National Laboratory report ORNL/ER-377, Oak Ridge, TN. (ORNL 1996, ER ID 63040)

Shaw, H., November 1972. "Viscosities of Magmatic Silicate Liquids: An Empirical Method of Prediction," in *American Journal of Science*, Vol. 272, pp. 870–893. (Shaw 1972, ER ID 62900)

Taylor, T., October 11, 1995. "NFA Permit Modification," Department of Energy memorandum to H. Jansen, Los Alamos, New Mexico. (Taylor 1995, ER ID 50023.1)

APPENDIX A
ECOLOGICAL SCOPING CHECKLIST

This checklist is in preparation and will be forwarded upon completion.

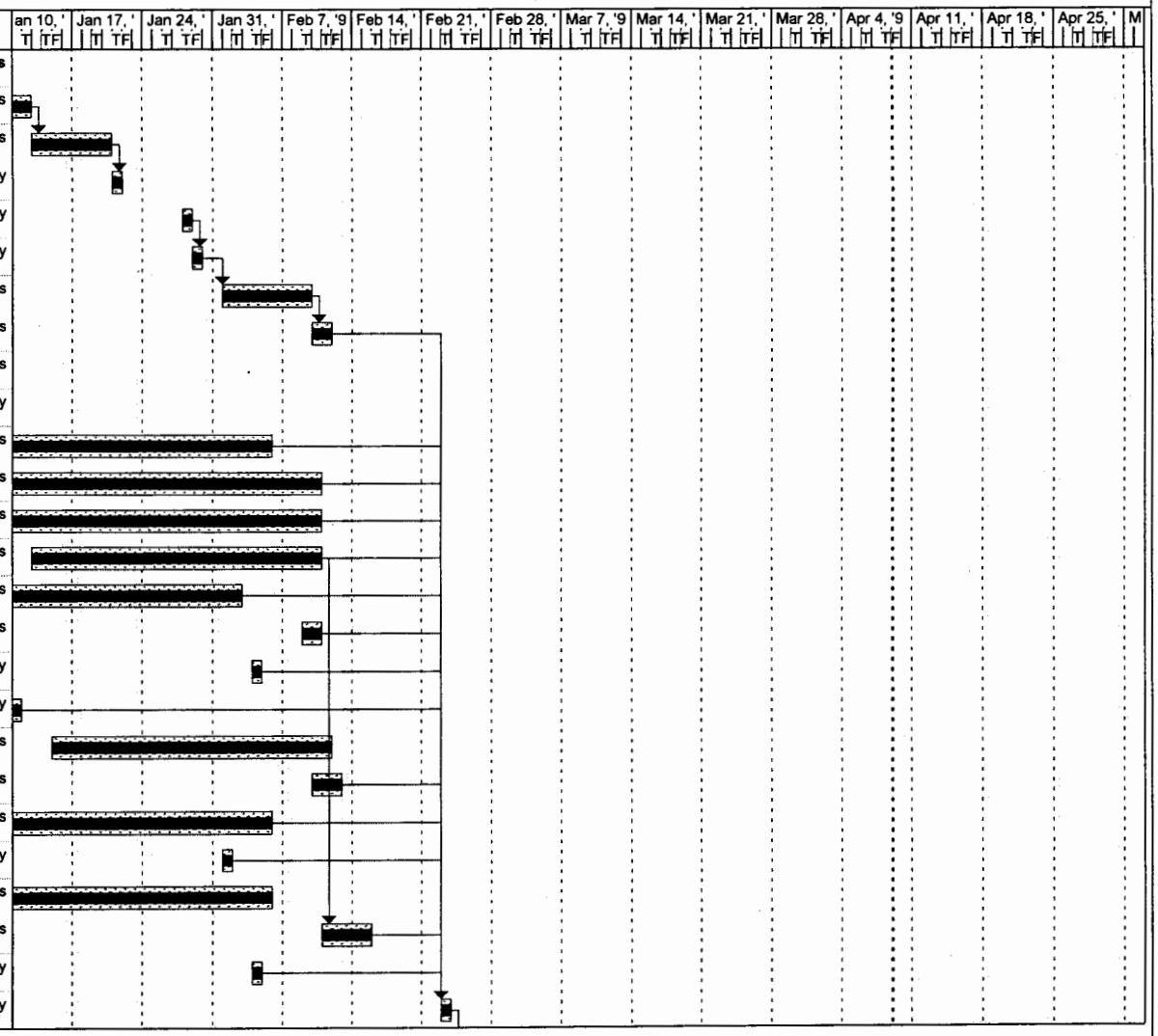
APPENDIX B
SURFACE WATER ASSESSMENT (FORMERLY KNOWN AS 4.5 ASSESSMENTS)

This assessment is in preparation and will be forwarded upon completion.

APPENDIX C
NTISV PROJECT SCHEDULE

Non-Traditional In-situ Vitrification Demonstration Project

ID		Task Name	Duration
1	✓	**Baseline Samp. Approval**	**0 days**
2	✓	SSHASP Mod Approval	2 days
3	✓	Facility-Tenant Agreement	6 days
4	✓	Sampling Approval Mtg.	1 day
5	✓	Baseline Sampling	1 day
6	✓	Rad Screening Lab & Ship	1 day
7	✓	Laboratory Analytical	7 days
8	✓	Preliminary Data Review	2 days
9	✓	**Readiness Review-Cold**	0 days
10	✓	ESHID Approval	1 day
11	✓	- Air Quality Approval	20 days
12	✓	- NEPA Approval	23 days
13	✓	WCSF Approval	23 days
14	✓	SSHASP Approval	21 days
15	✓	SG Western S/C in place	17 days
16	✓	Training Records (MK+SG)	2 days
17	✓	Site Specific Training	1 day
18	✓	Excavation Permit 1	1 day
19	✓	Excavation Permit 2	20 days
20	✓	RWP	3 days
21	✓	GeoSafe Test Plan Concurrence	20 days
22	✓	SMO Notified	1 day
23	✓	Geosafe H&S Prog App.	20 days
24	✓	Facility Coord. Approval	3 days
25	✓	Informal Notifications	1 day
26	✓	Readiness Review Meeting	1 day

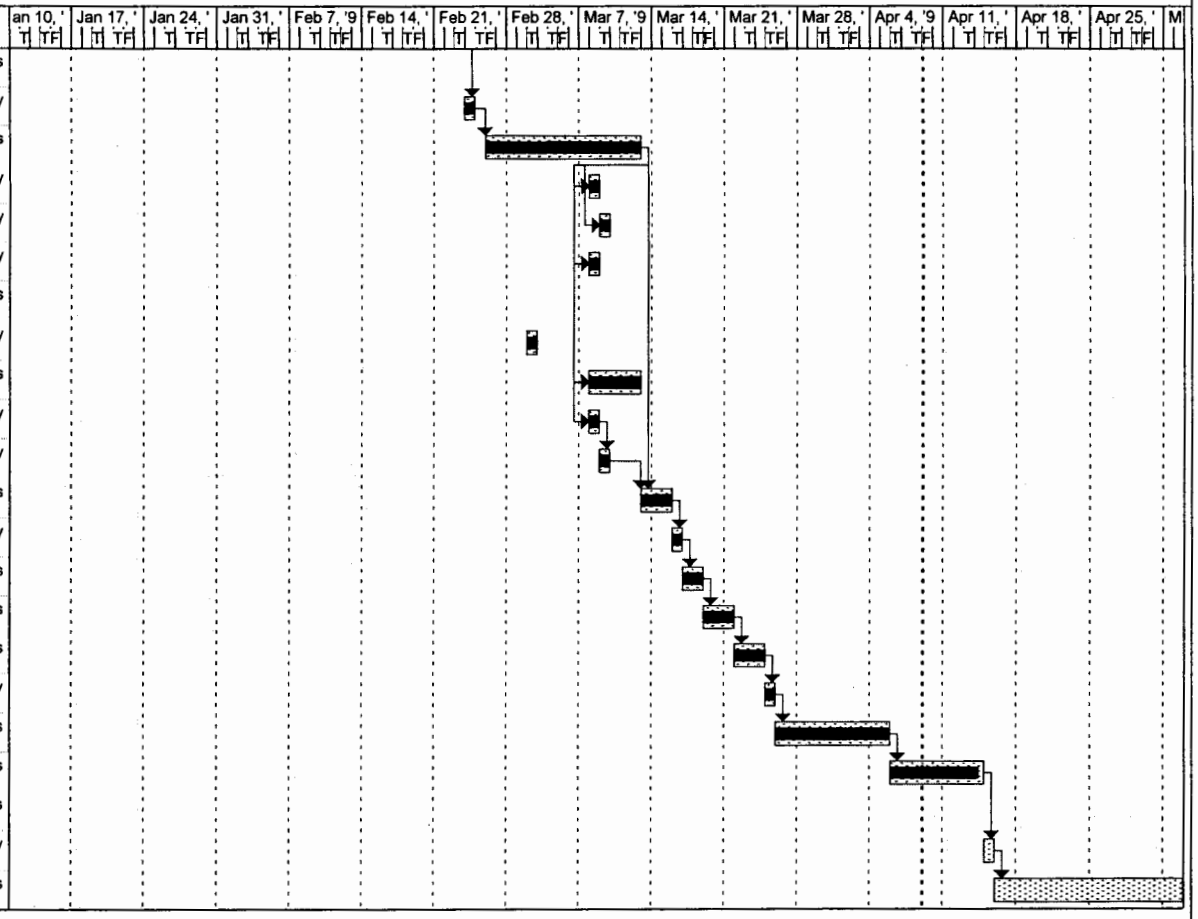


Project: ISV Schedule
Date: Fri 4/9/99

Task		Milestone		Rolled Up Split		External Tasks	
Split		Summary		Rolled Up Milestone		Project Summary	
Progress		Rolled Up Task		Rolled Up Progress			

Non-Traditional In-situ Vitrification Demonstration Project

ID		Task Name	Duration
27	✓	**Mockup Bed Construction**	0 days
28	✓	Mobilize for bed constr.	1 day
29	✓	Construct Bed	15 days
30	✓	Collect samples from open ex	1 day
31	✓	Load/transp. Waste	1 day
32	✓	Ex/remove/sample VCP pipe	1 day
33		**Install Monitoring Equip**	0 days
34	✓	Install 6 Electrical Outlets	1 day
35	✓	MSE/Geosafe Mobilization	5 days
36	✓	Site Specific Training	1 day
37	✓	Training Record Verification	1 day
38	✓	Instrument Well Installation	3 days
39	✓	Dynamic Disruption of soil	1 day
40	✓	Setup & Inj Param Test	2 days
41	✓	Electrode Casing Install	3 days
42	✓	Starter Planes Install	3 days
43	✓	Move Hood over Cell	1 day
44	✓	Complete Hood Assy.	11 days
45		System Checkout	7 days
46		**Cold Demo**	0 days
47		Onsite Briefing	1 day
48		Cold Demo	12 days



Project: ISV Schedule
Date: Fri 4/9/99

Task		Milestone		Rolled Up Split		External Tasks	
Split		Summary		Rolled Up Milestone		Project Summary	
Progress		Rolled Up Task		Rolled Up Progress			