MOA AB

Department of Energy
Field Office, Albuquerque
Los Alamos Area Office
Los Alamos, New Mexico 87544

ENTERED

AUG 10 1993

KS

Ms. Barbara Driscoll
RCRA Permits Branch
U. S. Environmental Protection Agency
Region 6
1445 Ross Avenue
Dallas, Texas 75202-2733

LANL

Dear Ms. Driscoll:

Enclosed are two copies of the drilling plan for Operable Unit (OU) 1144. The drilling plan is in response to ~~a Notice of~~ Deficiency received from your office regarding the OU 1144 Resource Conservation and Recovery Act Facility Investigation Work Plan. The work plan has been approved; however, more information was requested by your office regarding the drilling planned for late this summer at OU 1144. Your review of this drilling plan, prior to initiating the drilling, is requested.

Because it is important for this work to begin in late August or early September, we request you make this a priority for review. We understand your review of the Environmental Restoration Program's Installation Work Plan will be delayed slightly due to this request.

Sincerely,

Theodore J. Taylor
Program Manager
Environmental Restoration Program

LESH:9SS-011

Enclosure:

cc:
See Page 2

TL

3959

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Drilling Implementation Plan for Subsurface Investigations at MDA AB, OU 1144

I. Objectives

This drilling implementation plan is based on Chapter 7 of the RFI Work Plan for OU 1144; the description of the drilling procedures to be utilized has been expanded for field implementation.

The subsurface investigations at the MDA AB of OU 1144 are designed to address the following decision-based questions:

(1) ***Have wastes migrated from the subsurface zones of contamination created in the original hydronuclear experiments?***

(2) ***Are the site geotechnical properties adequately known to allow predictions of future waste migration?***

(3) ***What is the source and significance of water in Core Hole 2?***

(4) ***What is the distribution of contaminants beneath the asphalt pad at Area 2?***

According to the observational approach and the assumed future use scenario for MDA AB (institutional control), only those data that address these questions need to be collected. If satisfactory answers to these questions do not result from Phase I investigations, a Phase II study is likely to be triggered. Otherwise, it may be possible to proceed directly to a corrective measures study.

The following deep vertical boreholes are planned for the MDA AB site: a 150-ft and 700-ft borehole in Area 1; two 150-ft and one 700-ft borehole in Area 2; a 150-ft borehole in Area 3; and a 150-ft borehole in Area 4. These vertical boreholes are intended primarily to address questions 1, 2, and 3 listed above. These investigations also will provide some information pertaining to question 4. The vertical boreholes will be used to characterize geotechnical properties related to potential waste migration in the vadose zone beneath the MDA experimental areas. In addition, chemical analysis of cores from these holes will test the critically important hypothesis that movement of contaminants beyond the assumed radius of about 10 to 15 feet has not occurred in the three decades since the hydronuclear experiments that created the wastes.

One lateral borehole is proposed for installation under Area 2. A similar borehole is proposed for Area 1. The main purposes of these holes are to detect downward movement (if any) of water and contaminants through the shaft areas of MDA AB and to provide data on geologic structure under the MDA.

Four shallow boreholes (about 9 feet) will be emplaced through the Area 2 pad in order to address question 4; questions 2 and 3 will be addressed secondarily.

II. Drilling to be Performed

A. Deep Boreholes

150-ft Vertical Boreholes in Area 2

The existing moisture monitoring holes around Area 2 (see Figure 7.3-3) will be augmented by 150-ft deep holes drilled through the Area 2 pad at previously unused grid locations 2-G and 2-R [see Figures 7.2-1(b) and 7.5-2]. Locations 2-G and 2-R were selected in part because historical information indicates that they do not contain subsurface contaminants, thus simplifying drilling operations. In addition, boreholes at these locations provide a good distribution of sampling locations around Core Hole 2 and Experimental Hole 2-M, and these locations are surrounded by adjacent holes containing plutonium and uranium. The uppermost

core sections also will provide information on the distribution of contaminants (if any) in the fill material under the asphalt pad and confirm the thickness and composition of the fill.

The 150-ft holes will be continuously cored to maximize the probability of recovering intact core sections that can be characterized for excess moisture, lithology, and other subsurface characteristics. Three-foot core sections will be collected down to the level of the intact tuff (about 8 to 10 feet below the surface) and 5-ft core sections will be collected below the tuff interface. Core geotechnical properties and borehole logging will be carried out as outlined in Section 7.4 of the OU 1144 work plan and summarized in Table 7.4.1. Chemical and radiochemical analysis will be performed as described in Subsection 7.5.4 of the OU 1144 work plan. Gross alpha, gross beta, and gamma spectrometry measurements will be conducted for all samples collected. One half of these samples plus all samples for which above-background levels of these analytes are indicated, also will be analyzed in an analytical laboratory for isotopic plutonium, total uranium, and RCRA metals.

150-ft Vertical Borehole in Areas 1, 3, and 4

During Phase I, a 150-ft borehole will be drilled in Areas 1, 3, and 4. Characterization of these boreholes and core sections recovered from them will be carried out as described for the 150-ft vertical boreholes in Area 2.

In Area 1, a 150-ft borehole will be installed at the unused grid location 1-H [(see Figures 7.2-1(a) and 7.5-1]. This drilling location was selected because it is adjacent to a number of plutonium contaminated shafts.

In Area 3, a 150-ft borehole will be installed at unused grid location 3-H, which is adjacent to several tracer and containment shot holes [see Figures 7.2-1(d) and 7.5-3].

In Area 4, a 150-ft borehole will be installed at unused grid location 4-N, which is adjacent to a number of plutonium contaminated shafts [see Figures 7.2-1(e) and 7.5-4].

700-ft Vertical Borehole in Areas 1 and 2

During Phase I, one 700-ft vertical borehole is proposed for Area 1 and another for Area 2. These holes will allow the characterization of geotechnical properties beneath MDA AB to a depth below the Tshirege-Otowi contact and will detect perched water (if any) beneath these areas. Logging of these holes, in combination with surface geologic studies outlined in Section 6.1 of the OU 1144 work plan, will facilitate the identification of north-south fault zones that may exist within MDA AB (Subsection 4.5.2 of the OU 1144 work plan addresses this point in greater detail). Characterization of these boreholes and core sections recovered from them will be carried out as described for the 150-ft vertical boreholes in Area 2 .

If the 150-ft boreholes drilled in Areas 1 and 2 are found to be uncontaminated, coring probably will be continued to the 700-ft depth in one of the 150-ft holes in each area. However, the 700-ft vertical borehole also might be sited immediately adjacent to the experimental areas, depending upon assessment of the situation after the 150-ft vertical boreholes are completed.

Chemical and radiochemical analysis of recovered core samples will be discontinued below the 150-ft level or when contaminants no longer are detected in two consecutive core samples, as per the borehole stopping criterion described in Subsection 7.4.6 of Chapter 7 of the OU 1144 work plan.

Lateral Borehole Under Areas 1 and 2

A lateral borehole is proposed for installation under Area 2, as indicated in Figure 7.5-5. The east-west orientation was chosen to maximize the likelihood of intersecting any tectonic

structure that may be present because regional tectonic features are oriented predominantly north-south. The locations of the drilling platform and the inclination of the hole were selected to provide a reasonably low borehole inclination under Area 2 while limiting the borehole to a reasonable length.

The lateral borehole under Area 2 will be directed between the lines defined by two pairs of experimental holes, 2-P/2-T and 2-K/2-O [see Figures 7.2-1(b) and 7.5-2]. This alignment was selected to be reasonably close to Core Hole 2 while underlying several plutonium-contaminated shafts. A vertical clearance of 20 ft (minimum) below the deepest shaft in Area 2 and 2A (Hole 2-Y, 78 ft deep) is planned. The 20-ft clearance was selected to be outside the 10-to 15-ft radius expected for the original explosive dispersal of contaminants, but close enough to detect with reasonable confidence any contaminant transport that may have occurred thereafter. This borehole will be installed after evaluation of results from the 150-ft vertical boreholes in Area 2.

Borehole characterization will be carried out as described for the 150-ft vertical shafts to be installed in Area 2 (see section 7.6 of the OU 1144 work plan). Beginning 50 feet from the shaft area and extending 50 feet beyond the opposite side, 5-ft core sections recovered from the lateral boreholes will be collected for chemical and radiochemical analysis. Core sampling and analysis will be continued until the last two samples from the borehole show background levels of contaminants, as per the borehole stopping criterion discussed in Subsection 7.4.6 of the OU 1144 work plan.

Installation and sampling of the Area 1 lateral core hole will occur after the initial evolution of results from the Area 2 lateral borehole because specific refinement of borehole alignment and depth might be suggested. It is likely that the Area 1 lateral borehole will be very similar to that in Area 2, except that it probably will be emplaced from west to east rather than from east to west (for operational convenience). The borehole will be directed to pass between the lines established by Experimental Holes 1-F/1-J and 1-K/1-O [see Figure 7.2-1(a)]. This alignment was selected because it lies near the center of the Area 1 shaft complex and underlies a high density of shafts containing plutonium.

If the proposed lateral drilling scheme is not feasible for technical reasons, alternatives will be proposed. An alternative to the proposed scheme, for example, might be emplacement of two shorter, more steeply angled holes from each side of Area 1 and Area 2.

B. Shallow Boreholes Through the Area 2 Pad

Four shallow boreholes will be emplaced through the Area 2 pad to quantify the distribution of moisture in the fill and soil underlying the asphalt pad. These holes will be located symmetrically with respect to the asphalt pad (see Figure 7.5-2). Besides information on moisture in the fill material, the boreholes through the Area 2 pad will provide information on the thickness, composition, and contaminant distribution.

The shallow boreholes will be drilled until intact tuff is encountered (expected at a depth of about 9 ft). Three-ft core sections will be collected for analysis as described above for recovered core samples from the 150-ft vertical holes.

Soil moisture in the boreholes will be measured with a neutron moisture probe on a quarterly basis during Phase I, and more often if anomalous conditions are detected.

III. Drilling Methods

A. Site Preparation and Field Operation

Site preparation and mobilization of drilling equipment shall follow LANL-ER-SOP-01.01, R0 "General Instructions for Field Investigation." Wastes generated during drilling investigations

shall be managed in adherence with LANL-ER-SOP-01.06.R0 "Management of RFI-Generated Waste." Decontamination procedures for personnel, equipment, and vehicles are described in Section 3.6.2 of the Health and Safety Project Plan for the OU 1144 work plan.

B. Deep Boreholes

To meet the requirements for completely dry coring, sampling, and hole stabilization, the 150-ft and 700-ft deep boreholes shall be drilled by using air rotary drilling/coring and installation of casing with an underreamer/casing installation system such as ODEX or equivalent. This system will allow coring ahead of the casing with diamond core barrels and follow up with the casing as hole protection. The casing will stabilize the borehole and prevent the spread of contamination.

The ODEX drilling system will advance steel casing into the hole by means of percussion energy or rotation while simultaneously reaming the hole slightly larger than the casing via the ODEX driver. When drilling, the reamer of the ODEX bit will swing out and drill a hole larger than the external diameter of the casing tube. When the casing has advanced to the depth of coring, the drill is reversed and the reamer swung in to its minimum diameter, allowing the bit to be lifted up through the casing a distance of 20 ft.

A drill rig and supporting equipment to drill, core and advance casing to a depth of 1,000 feet will be used. The rig will be an Ingersoll Rand T4 with a deephole package (or equivalent). The drill sites can be accessed by a drill rig that is mounted on a conventional truck chassis.

Air will be the only drilling fluid. The air compressor will be rig mounted and will provide adequate velocities to lift cuttings to the surface and clean the borehole. A trailer mounted dust suppression/air purification system will include a cyclone with a splitter to a mini-cyclone for collection and containment of drill cuttings, and a mechanical air filtration system to remove dust and fine particles.

An auger drill rig will be used to emplace surface casing to a depth of 20 feet before initiation of air rotary drilling. The annular space between the casing and the borehole wall will be filled with a cement/bentonite seal using procedures in LANL-ER-SOP-05.01-R0 - "Monitor Well Construction". The surface casing will prevent surface water from entering the borehole and will also prevent air blow out during initiation of air rotary drilling.

150-ft Boreholes

An ODEX 140 system or equivalent will be used to install temporary casing during air rotary drilling of the 150 ft boreholes. This system installs 6.73 inch outside diameter casing in a borehole that has a diameter of 7.36 inches. Continuous core will be collected using core barrels retrieved on a wire line system. Core with a diameter of 2.4 inches will be collected in 5-ft core barrels. Coring will alternate with advancement of the ODEX casing. Coring will not proceed ahead of casing a distance greater than 20 feet.

After reaching total depth, the ODEX casing will be removed, and the suite of borehole geophysical logs will be collected. Following completion of the geophysical logging, the boreholes will be sealed with cement grout from total hole depth to land surfuce using a tremie pipe.

700-ft Boreholes

The 700-ft boreholes are too deep to drill with one ODEX system because friction between the steel casing and the wall of the borehole. Therefore, these holes will be drilled with telescoped casing. Drilling will begin with an ODEX 190 system or equivalent to a depth of approximately 400 feet, and then change to an ODEX 140 system or equivalent to the total depth. The boreholes will be drilled to below the Tshirege - Otowi tuff contact which is estimated to be at a depth of 700 feet below ground surface. The ODEX 190 system installs

8.74 inch outside diameter casing in a borehole that has a diameter of 9.33 inches. Continuous core will be collected in the 700-ft boreholes as described above for the 150-ft boreholes.

After the boreholes are drilled to total depths, the ODEX casing will be retracted to a depth of 100 feet for performance of the suite of borehole geophysical logs and the straddle packer air permeability tests. The casing will be left in the upper 100 feet of the borehole during these tests to prevent the spread of contamination that may be present in the vicinity of the shaft. If perched water is not encountered in the borehole, the borehole will be sealed with grout cement from total depth to ground surface using a tremie pipe. The remaining ODEX casing will be removed during grouting.

If perched water is encountered in the borehole, a monitor well will be installed after completion of the open hole tests. The borehole will be reamed to a diameter of 8.5 inches for installation of 4.5 inch outside diameter screen and casing. A 20 foot section of stainless steel screen will be installed across the surface of the perched water. The well screen slot size will be determined from geologic characteristics of the rock in the well screen interval. If fine-grained materials are present, the well screen will be a 0.01 inch slot size, and an appropriate sand pack will be used. A 20 foot section of stainless steel casing will be above the screen; the remainder of the well will be completed with PVC casing. A sand pack will be installed to a depth of 2 feet above the screen. A 2 ft layer of bentonite pellets will be placed above the sand pack. A tremie pipe will be used to seal above the sand pack annular space with grout cement to ground surface. Construction of the monitor well will follow LANL-ER-SOP-05.01, R0 "Monitor Well Construction."

Lateral Boreholes

A schematic for placement of the Area 2 lateral boreholes is shown in Figure 7.5-5 of the OU 1144 work plan. The lateral borehole proposed for Area 1 will be a similar emplacement. Both boreholes will be drilled with air rotary / ODEX systems as described above with the exception that the drill rig will be a Longyear Model 44 or equivalent that is mounted on a low profile skid so that the drill head is near ground surface. A pilot casing will be installed to a depth of 10 feet to serve as a guide for the low angle drilling. An ODEX 115 system or equivalent will be used to install temporary casing during air rotary drilling and coring. The ODEX 115 system installs 5.59 inch outside diameter casing in a 5.98 inch diameter borehole. Continuous core will be collected in 5-ft core barrels. The coring will advance no greater than 20 feet forward of the ODEX casing. Coring and casing advance will be sequential operations to the total reach of the boreholes. Deviation surveys will be conducted approximately every 20 feet to ensure the borehole is kept on track. Stopping criteria is described in Section 7.4.6 of the OU 1144 work plan. After completion of drilling and sampling, a borehole deviation survey will be performed to determine the trajectory of the borehole.

The ODEX casing will be left in the boreholes pending the decision to use the lateral holes for long term monitoring.

C. Shallow Boreholes

The shallow boreholes will be drilled through asphalt and underlying fill materials until intact tuff is encountered. The total depth for the boreholes is not expected to be greater than 10 feet. The drilling method will be a drive casing/thin wall sample system. The drive casing has a cutting shoe lead assembly which provides a seat for a thin wall sampler that is sleeved inside the drive casing. The sampler collects a three foot long sample and is retrieved without removing the drive casing. The drive casing and sampler are advanced together by a drop hammer operated at the surface. The advantage of this drilling system is that samples are collected without generating cuttings at the ground surface. The drive casing also stabilizes the hole and prevents the spread of contamination during drilling. After sampling to the required depth, the borehole will be sealed with grout cement as the drive casing is retracted.

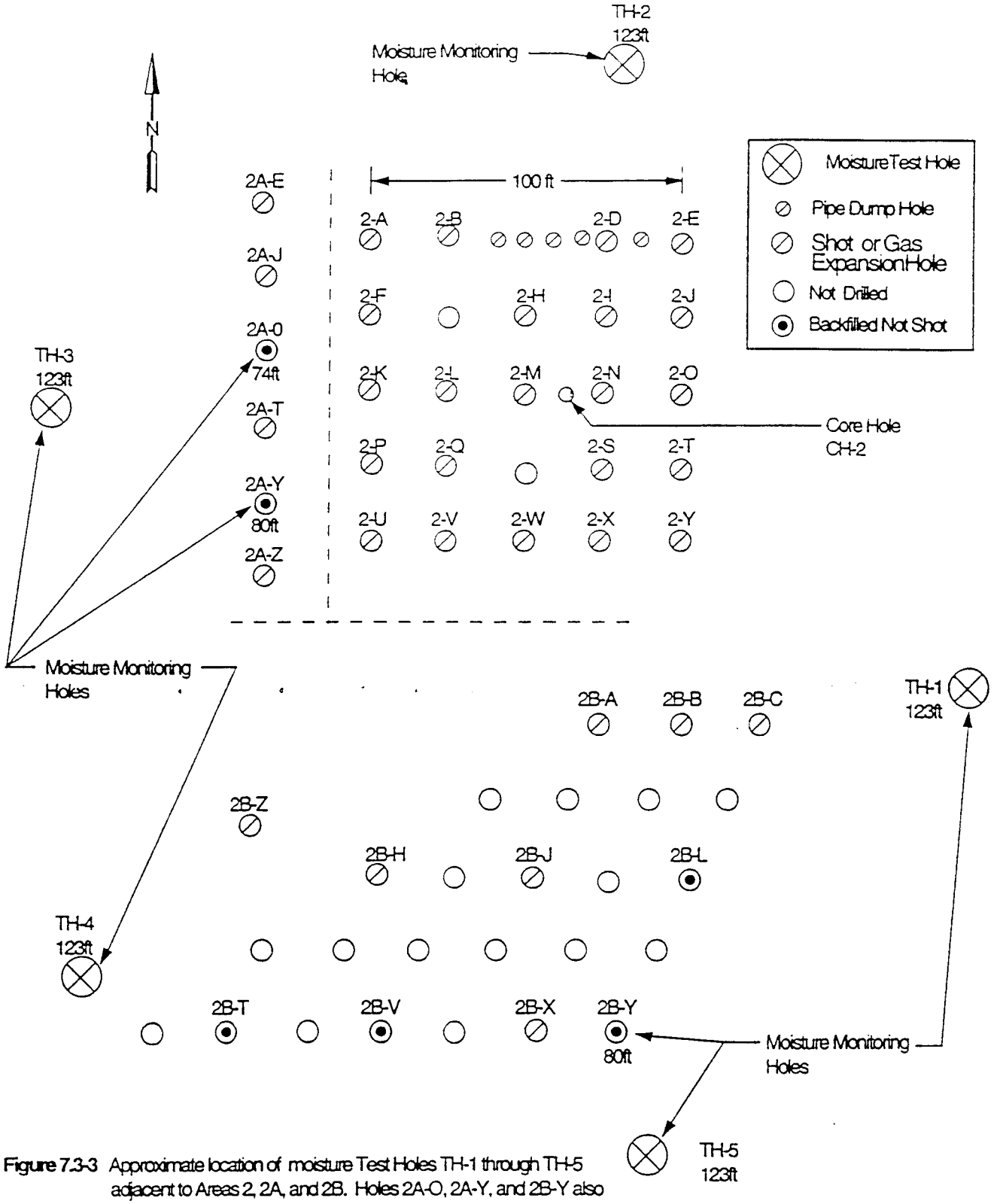
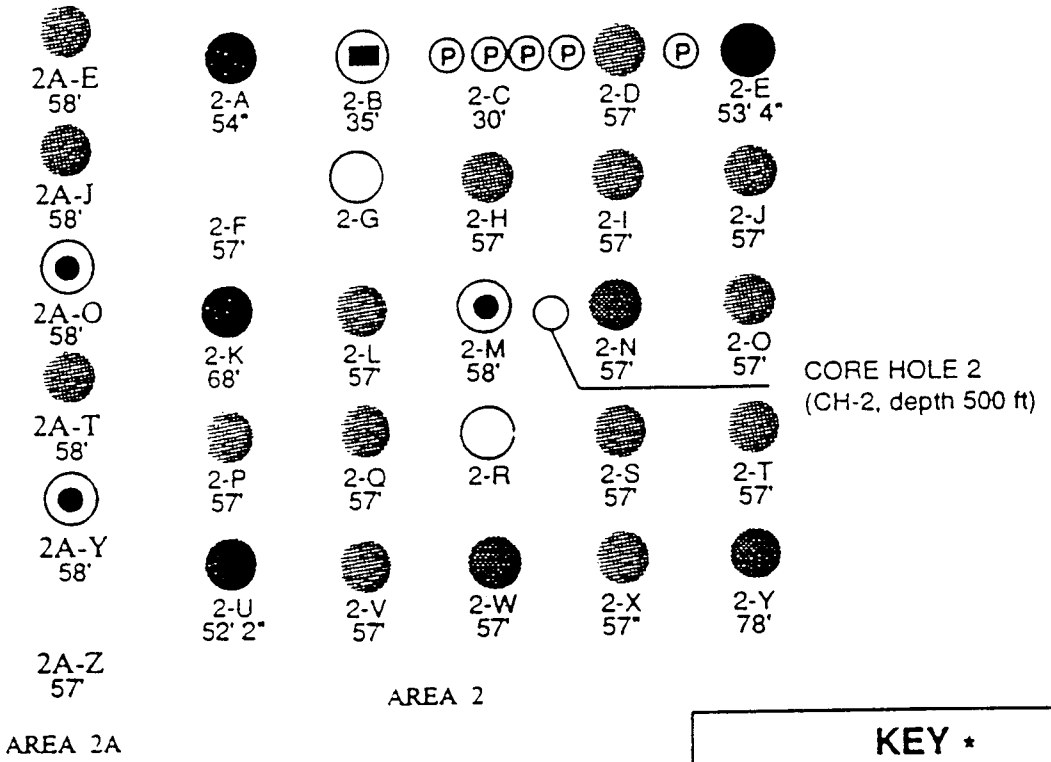


Figure 7.3-3 Approximate location of moisture Test Holes TH-1 through TH-5 adjacent to Areas 2, 2A, and 2B. Holes 2A-O, 2A-Y, and 2B-Y also were used for subsurface moisture measurments. Test hole depths are indicated.

FIGURE 7.2-1 MDA AB SHOT HOLE PATTERNS &DEPTH

(b) AREA 2 & 2A



HOLES MAPPED (AREA 2) : A, E, K, V, Y

HOLES DESCRIBED IN RECONNAISSANCE NOTES (AREA 2) : D, F, H, J, L, O, S, V, W, X
(WEIR AND PURTYMUN, 1962)

* SHOTS WITH PLUTONIUM MAY HAVE ALSO HAVE INCLUDED URANIUM -235 AND/OR -238.
SHOTS WITH URANIUM -235 MAY HAVE INCLUDED URANIUM -238.

HOLE 2-M WAS CONTAMINATED BY SURROUNDING SHOTS

KEY *

- SHOT WITH PLUTONIUM
- SHOT WITH URANIUM -235
- SHOT WITH URANIUM -238
- SHOT WITH TRACER
- CONTAINMENT SHOT
- GAS EXPANSION HOLE
- (P) PIPE DUMP HOLE
- PROPOSED - NOT DRILLED
- BACKFILLED - NOT SHOT

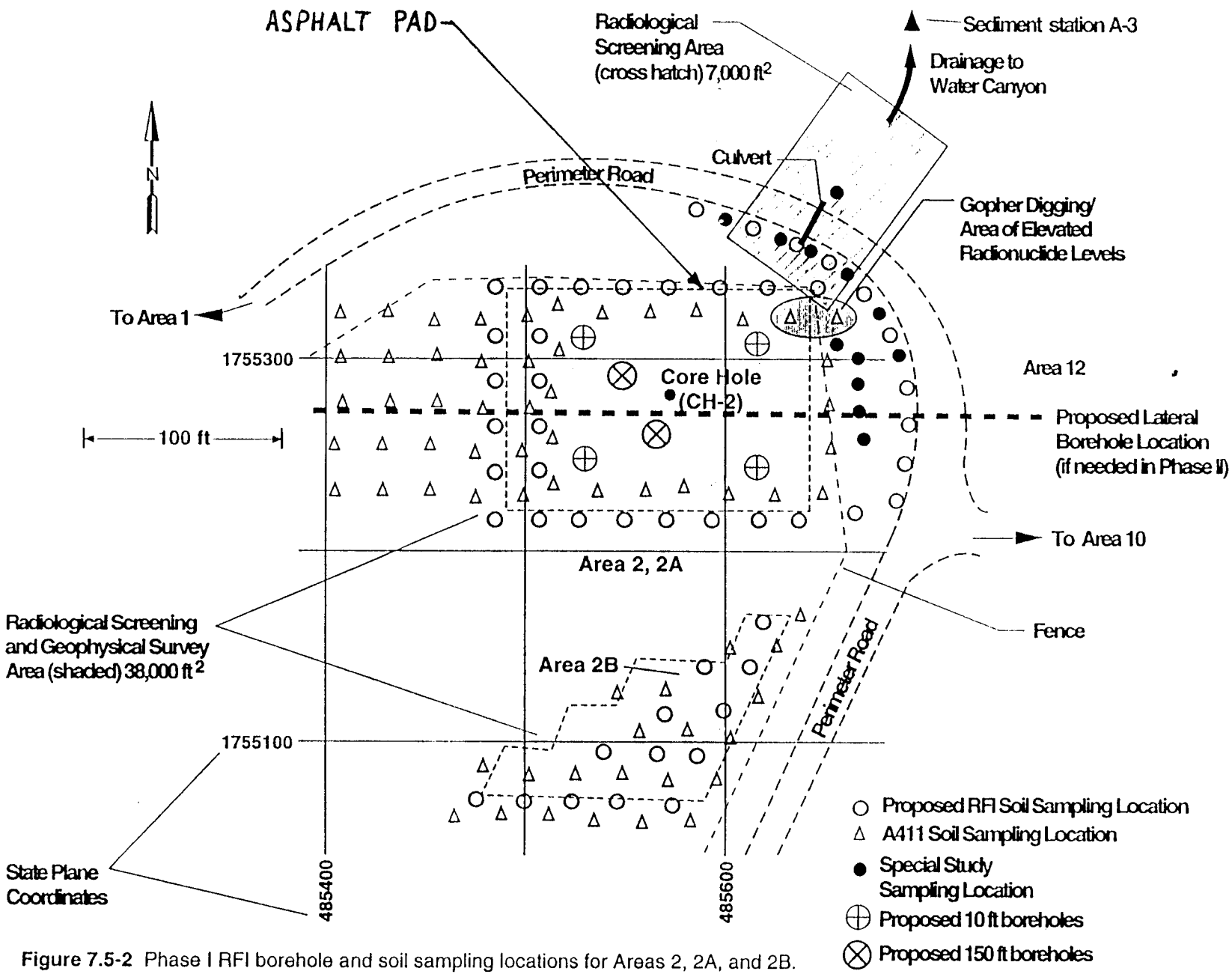


Figure 7.5-2 Phase I RFI borehole and soil sampling locations for Areas 2, 2A, and 2B.

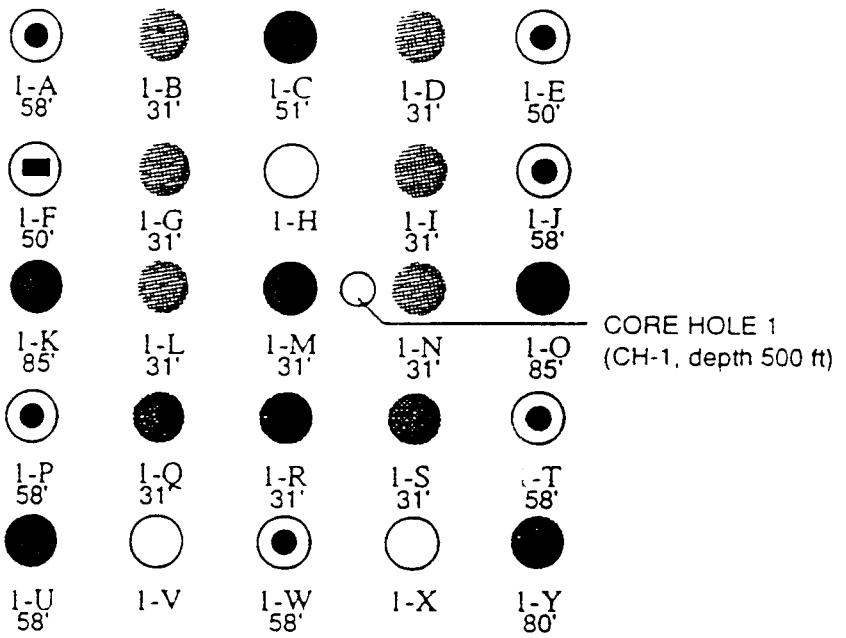
TABLE 7.4-1

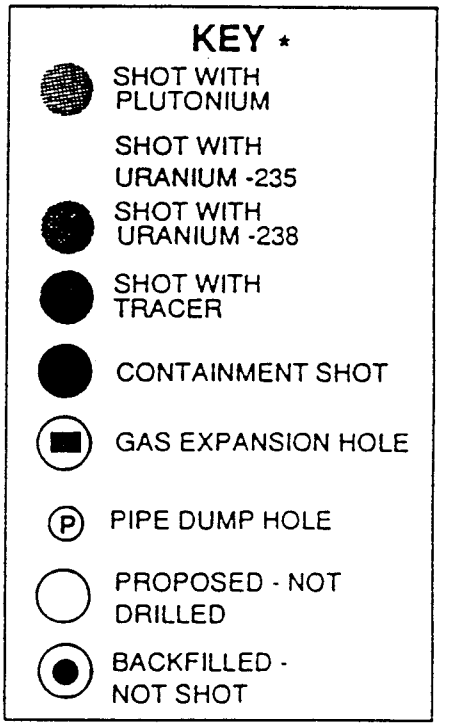
GEOPHYSICAL LOGS TO BE COLLECTED IN MDA AB BOREHOLES

Open Hole	Parameter Measured
Thermal neutron (moisture)	percent moisture, perched water zones
Gamma gamma (density)	bulk density of rocks
Caliper	borehole dimensions
Borehole video	fracture orientation
EM induction (Geonics EM-39)	stratigraphic correlation; perched water zones
Magnetic susceptibility (Romulus)	stratigraphic correlation
Natural gamma	stratigraphic correlation; radioactive contamination
Spectral gamma (U, TH, K)	stratigraphic correlation; radioactive contamination
Prompt fission neutron	radioactive contamination by fissionable isotopes
Geochemical (Californium-252)	chemical contamination by 8 to 10 elements that undergo neutron activation and elastic scattering
Temperature gradient	temperature profile
Cased Hole	
Thermal neutron (moisture)	percent moisture; perched water zones
Gamma-gamma (density)	percent moisture; perched water zones
EM induction (PVC casing)	perched water zones

FIGURE 7.2-1 MDA AB SHOT HOLE PATTERNS &DEPTH

(a) AREA 1





HOLES MAPPED: A, C, E, K, O, U, Y

HOLES DESCRIBED IN
RECONNAISSANCE NOTES: J, P, T, W
(WEIR AND PURTYMUN, 1962)

* SHOTS WITH PLUTONIUM MAY HAVE ALSO HAVE INCLUDED URANIUM -235 AND/OR -238.
SHOTS WITH URANIUM -235 MAY HAVE INCLUDED URANIUM -238.

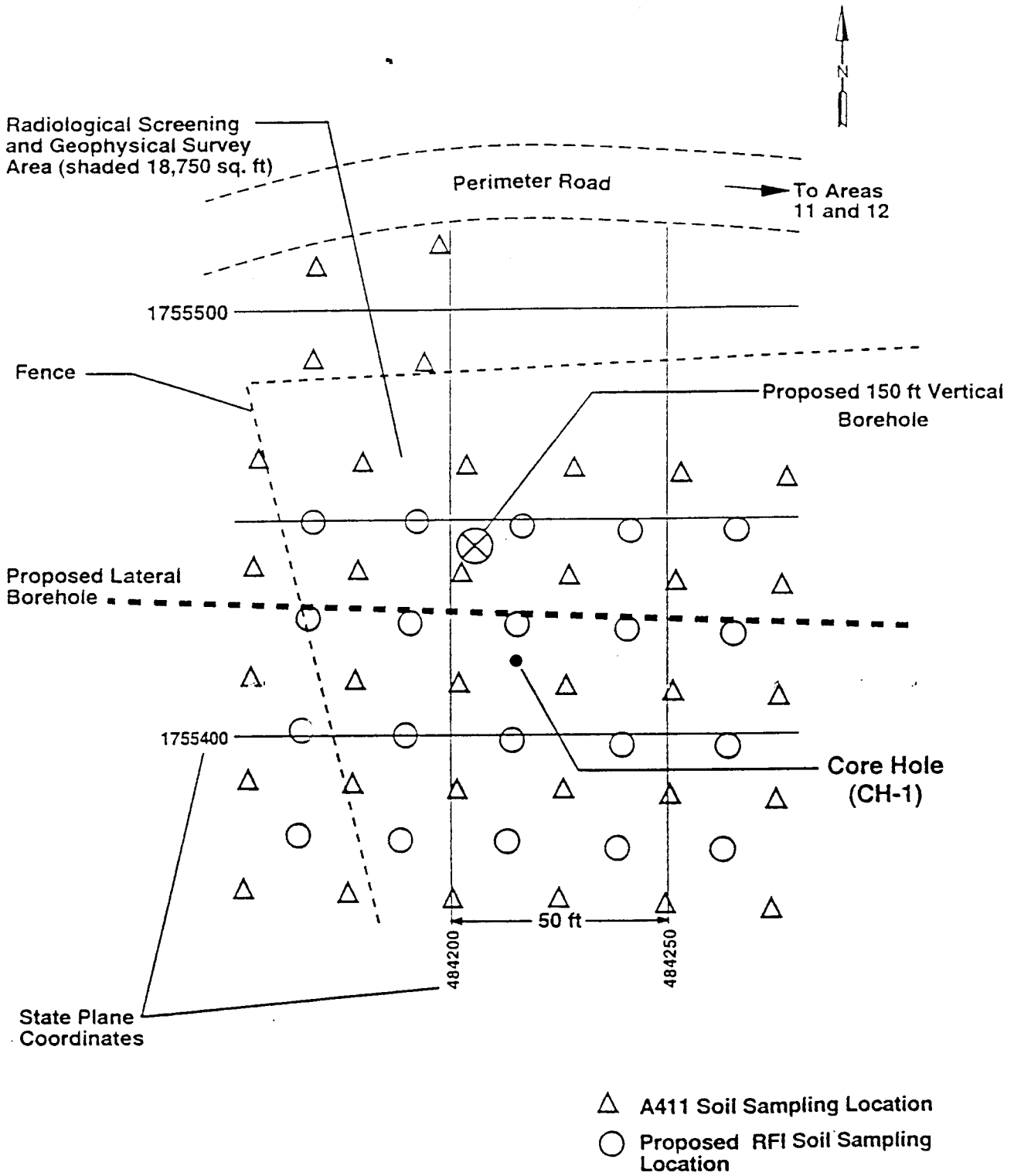
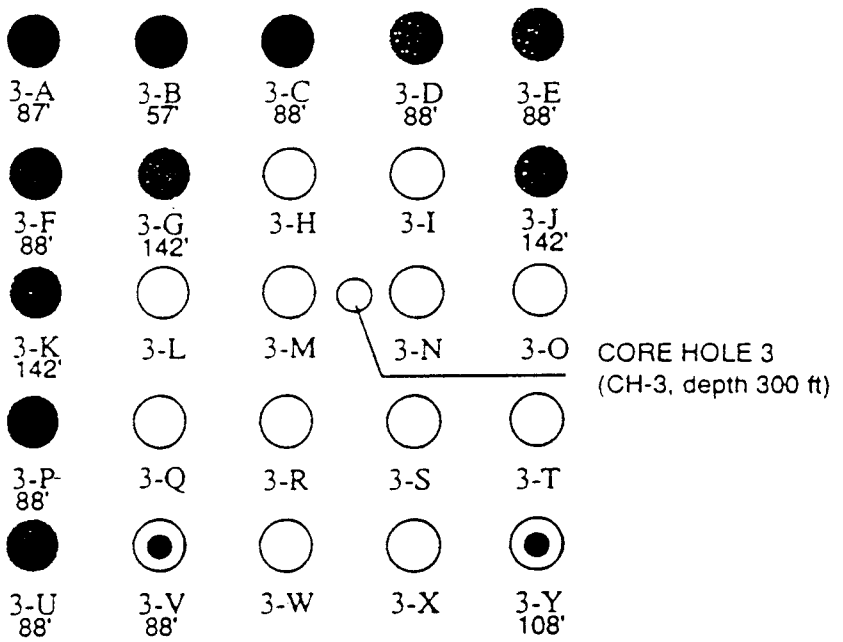


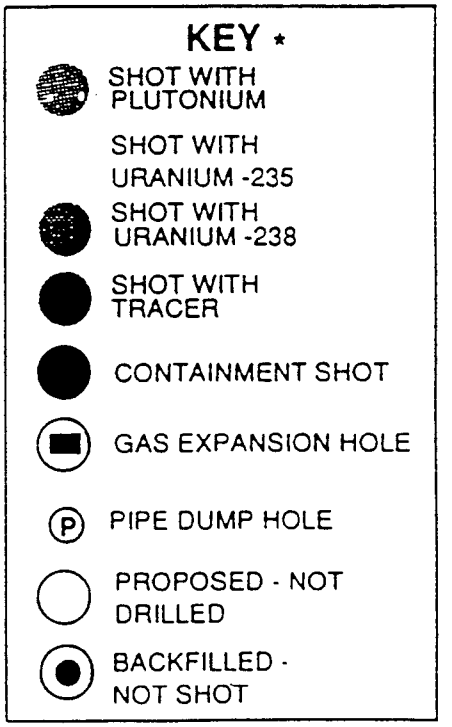
Figure 7.5-1 Phase I RFI borehole and soil sampling locations for Area 1.

FIGURE 7.2-1 MDA AB SHOT HOLE PATTERNS &DEPTH

(d) AREA 3



HOLES MAPPED: A, U, Y
HOLE DESCRIBED IN RECONNAISSANCE NOTES: C (WEIR AND PURTYMUN, 1962)



* SHOTS WITH PLUTONIUM MAY HAVE ALSO HAVE INCLUDED URANIUM -235 AND/OR -238.
SHOTS WITH URANIUM -235 MAY HAVE INCLUDED URANIUM -238.

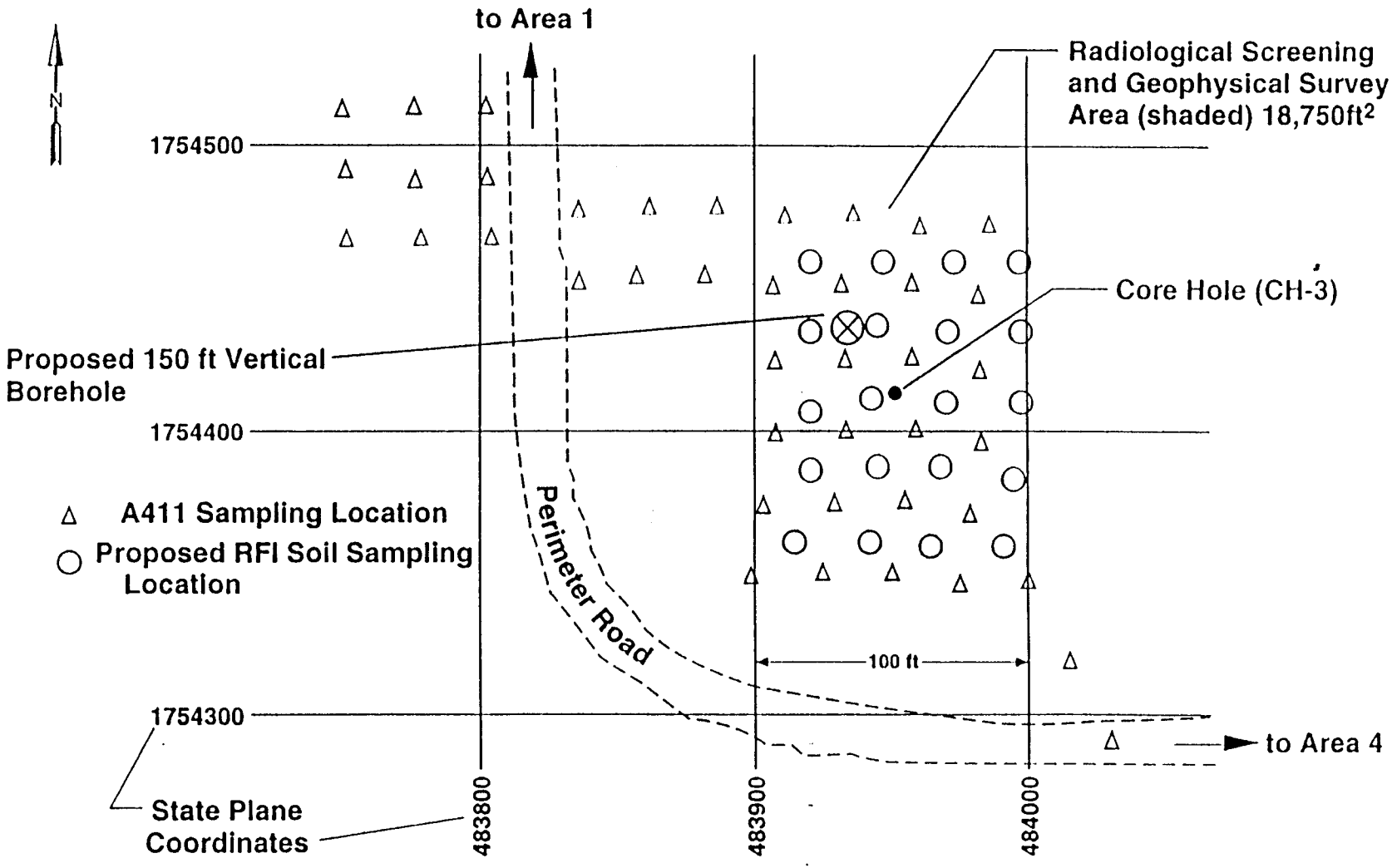
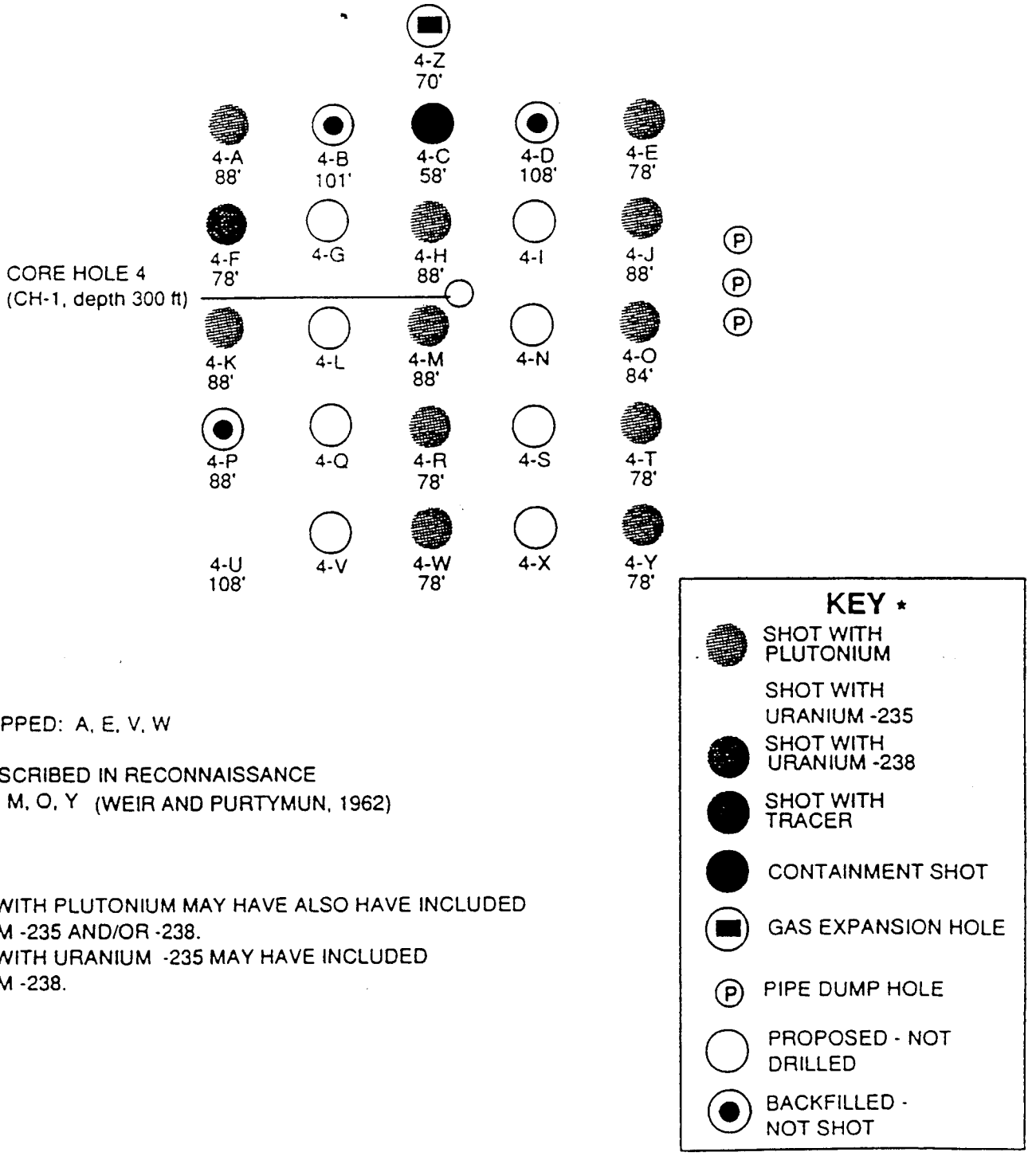


Figure 7.5-3 Phase I soil sampling and borehole locations for Area 3.

FIGURE 7.2-1 MDA AB SHOT HOLE PATTERNS &DEPTH

(e) AREA 4



HOLES MAPPED: A, E, V, W

HOLES DESCRIBED IN RECONNAISSANCE NOTES: K, M, O, Y (WEIR AND PURTYMUN, 1962)

* SHOTS WITH PLUTONIUM MAY HAVE ALSO HAVE INCLUDED URANIUM -235 AND/OR -238.
SHOTS WITH URANIUM -235 MAY HAVE INCLUDED URANIUM -238.

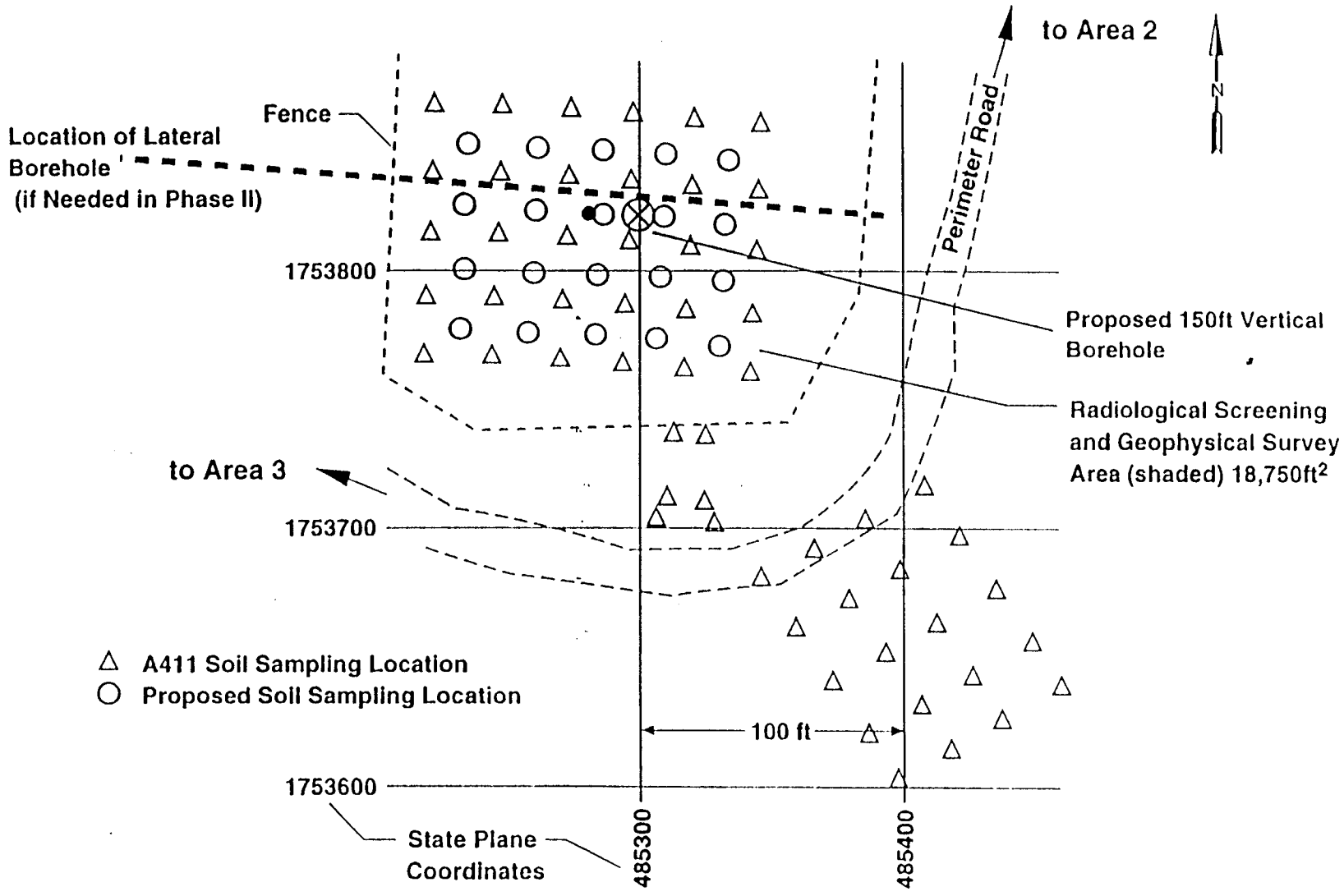


Figure 7.5-4 Phase I RFI soil sampling and borehole locations for Area 4.

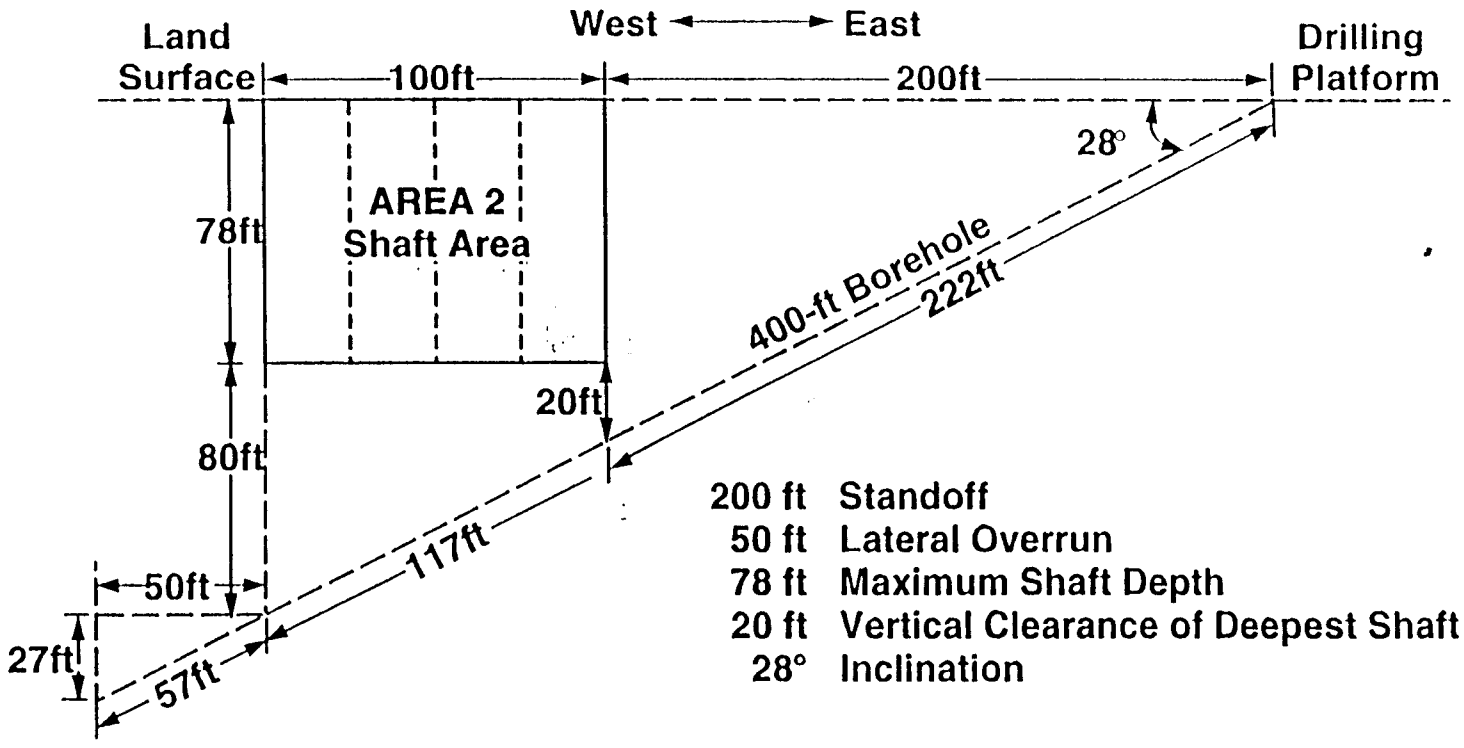


Figure 7.5-5 Placement of Area 2 lateral borehole.