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US Army Corps of Engineers

Toxic and Hazardous Materials Agency

FINAL

TECHNICAL AND SAMPLING/ANALYSIS PLAN FOR FORT MEADE BASE CLOSURE PARCEL SITE INSPECTION AND PHASE II REMEDIAL INVESTIGATION STUDIES

Prepared for:

U.S. Army Toxic and Hazardous
Materials Agency
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Distribution Unlimited,
approved for Public Release

September 1990

EA Project 10559.05

THAMA Form 45, 1 Jul 90

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Steven A. Brown — Date
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Kenneth W Kilmer — 6 Sept. 1990

Kenneth W. Kilmer — Date
Director of Engineering Development

September 1990

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1. PROJECT DESCRIPTION

1.1 INTRODUCTION

This Technical and Sampling/Analysis Plan (T & S/A) supports the environmental studies to be completed by EA Engineering, Science and Technology, Inc. (EA) at specific sites located within the area identified for Base Closure at Fort Meade, Maryland. EA is conducting this work for the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) under Contract No. DAAA15-88-D-0005, Modification 000102. This Plan in conjunction with separate Safety and Health, Resource and Data Management, and Quality Assurance Plans form the framework upon which this project will be conducted.

Fort Meade has been a permanent U.S. Army installation since 1917. It is located on approximately 13,000 acres in northwestern Anne Arundel County, Maryland. In December, 1988, the Secretary of Defense's Commission issued a Base Closure and Realignment and this report identified 9,000 acres for closure and realignment. Fort Meade is situated almost equidistant between Baltimore, Maryland and Washington, D.C. (Figure 1-1). Figure 1-2 is a map of the Fort Meade area and can be found in the back pocket of this plan. This figure shows the division between the Cantonment area and the land identified for closure plus the relative locations of the sites to be studied during this project. The Cantonment area, which occupies the northernmost one-third of the installation contains administrative, recreational and housing facilities. The Base Closure Parcel (BCP) encompasses the southernmost two-thirds of the installation. This area is largely wooded and contains the active sanitary landfill, an inactive clean fill dump, three inactive sanitary/rubble fill areas, Tipton Airfield, numerous underground storage tank sites, four water supply wells and associated distribution system. Vast land areas are used for training troops. Virtually all of the BCP has been used as range and impact areas over the years. An additional

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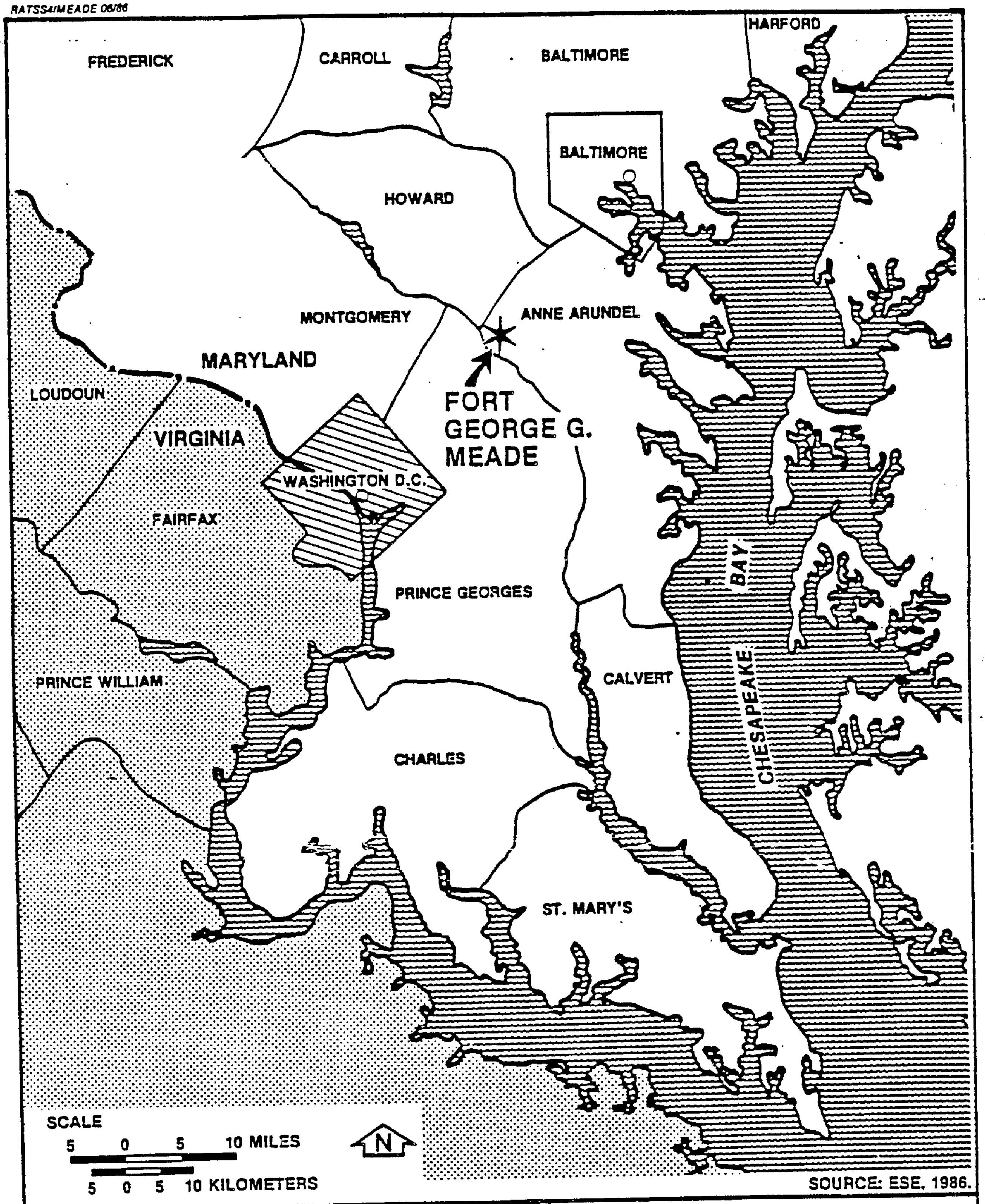

Figure 1-1. Ft. Meade regional location map.

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U.S. Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, Maryland

inactive landfill, a salvage yard, plus a number of UST sites are located within the Cantonment area but are close enough to the cantonment/closure boundary to be considered a potential contamination source that may affect the base closure area.

This T & S/A plan includes project sites that are being studied for the first time and sites that have an existing data base from previous studies. The sites with no available data will be evaluated as Site Inspection sites and the sites where existing data is available will be studied as Phase II Remedial Investigation sites. Table 1-1 is a list of sites and it is organized to show the discrete SI and Phase II RI sites. The reporting of the data obtained from the work outlined in this plan will involve submission of a Draft and Final Site Inspection report covering the sites that have no existing data base. The Phase II RI data will be used to complete a Final Draft RI report by incorporating the data from the Phase II RI into the existing Draft RI report. This Final Draft RI report will be followed by a Final RI report.

1.2 PREVIOUS INVESTIGATIONS

Argonne National Laboratory completed an Enhanced Preliminary Assessment Report: Fort Meade, Maryland (October 1989) for USATHAMA. This report involved identifying and characterizing all environmentally significant operations and concerns on the BCP relative to the potential for contamination problems associated with Army operations and the transfer of the property. The work consisted of a review of all available records with respect to air, soil, surface water and ground water conditions and quality. Conclusions from this study provided a list of areas of concern that needed further study. These areas included the following topical areas and issues:

- active and inactive landfills
- underground storage tanks

TABLE 1-1 LIST OF PROJECT SITES

Site Inspection Sites	
I	Inactive Landfills
	Landfill #1
	Landfill #2
	Landfill #3
	Landfill #4
II	Defense Property Disposal Office (DPDO) Salvage Yard
III	Ordnance Demolition Area
IV	Fire Training Area
V	Surface Water Survey
VI	Seventeen Underground Storage Tank Sites
VII	Asbestos Survey
VIII	Ecological Survey
Phase II Remedial Investigation Sites	
I	Active Sanitary Landfill
II	Clean Fill Dump

- asbestos
- unexploded ordnance
- surface water
- burning grounds

EA's combined SI and Phase II RI project will address all of these issues, however, the unexploded ordnance issue will involve a limited effort. The ordnance clearance work for this project will involve only surface clearance of the access roads and subsurface clearance of the boreholes.

1.3 GENERAL PROJECT OBJECTIVES AND SCOPE

The SI objectives involve characterizing site conditions and the nature of contamination, if any, at sites where there was no available field data. The Phase II RI objectives were established to further characterize site conditions, and provide additional data on the nature and extent of contamination.

Initial activities involved a review of the Enhanced PA report, and existing aerial photos. An aerial survey will be performed by Potomac Aerial Surveys under subcontract to EA to prepare topographic site maps of the study areas. EA initiated discussions with past and present Fort Meade personnel to gather information on the history and current status of the active and inactive landfills, and the underground storage tanks.

The specific scope of work for the respective SI and RI sites are addressed in the Technical Plan sections 3 and 4. In general, the scope of field activities includes the use of electromagnetic and soil gas surveys as preliminary tools. Additional work tasks include soil borings, monitoring well installation, aquifer tests, and soil, ground-water, surface-water and stream sediment sampling. Ecological surveys will also be performed to evaluate and characterize the aquatic, terrestrial and wetland habitats. The electromagnetic surveys will be utilized to delineate the inactive landfill boundaries and assist with placement of soil borings and monitoring wells. The soil gas surveys will be used to assess the potential for contamination at the UST sites and provide a basis for additional work at these sites. The purposes of the soil borings are to characterize the subsurface materials and obtain soil samples for laboratory analysis. Monitoring wells are to be installed to obtain ground-water samples for analysis and to gather information on ground-water flow direction and velocity. The exact number and tentative location of monitoring wells to be installed around the landfills have been addressed by this plan.

1.4 PLAN ORGANIZATION

Section 2 of this plan provides a general physical description, including land use information, physiography, and geology of the Fort Meade area. Section 3 is the Technical Plan section for the SI sites. This section includes site descriptions and the scope and sequence of field activities to be conducted. Site maps showing the number and location of proposed sampling stations for each site are also provided. Section 4 is the Technical Plan section for the Phase II RI sites. This section includes a summary of the combined Phase I RI study at the active sanitary landfill and clean fill dump. Site descriptions, project objectives and scope are also included. Site maps showing sampling locations are included. Section 5 provides a summary of the analytical program. This section includes a list of the Target Compound analyte groups and the analytical methods to be used. It also includes a table listing all of the sites and the matrix and number of samples to be collected. Section 6 details the field methods and sampling procedures to be used during this project.

2. PHYSICAL DESCRIPTION

2.1 LAND USE

The 9,000-acre Base Closure Parcel (BCP) to be excessed contains training and range areas, Tipton Army Airfield, inactive landfills, four potable water wells and associated pumping and distribution systems. The Range/Impact and Training Areas comprise approximately 7,000 of the 9,000 acres and have been used for the training of regular and reserve Army units and National Guard units since 1918. The training activities in the past occurred throughout the parcel proposed to be excessed. The Range and Impact Area is currently located on the eastern half of the parcel and historical records indicate that portions of the western half were also used as Range and Impact areas. Presently there are 26 ranges used mostly as rifle and pistol ranges. Range 16 is used for ordnance demolition by the Explosive Ordnance Detachment at Fort Meade. The active approximately 100 acre sanitary landfill and clean fill dump are located along the eastern boundary of the parcel. An extensive wetland community associated with the Little Patuxent River can be identified from the topographic maps. The Walter Reed Medical Center Farm, which has recently been torn down, was previously used as a research facility for specialized disease testing and toxicology. This facility was located along the western boundary of the study area. There are one inactive and one active ammunition supply points (ASP) on site. ASP 1 was recently deactivated and is located near the active sanitary landfill. ASP 2 has been constructed recently and is located just south of Tipton Army Airfield. The airfield, constructed in 1960, is located on the northern edge of the Fort Meade continuous forest region. It consists of four hangars and operations buildings. Throughout the BCP, the natural resources are managed to provide wildlife habitat for hunting. Wetland areas are also managed to enhance waterfowl habitat and sport fishing.

2.2 PHYSIOGRAPHY

Fort Meade is located in northwestern Anne Arundel County, within the Coastal Plain Physiographic province. The topography of the study area is shown on Figure 1-2 and is marked by rolling uplands dissected by low-gradient streams that generally flow in a southerly direction towards broad, flat river valleys. The land surface elevation within the 9,000-acre parcel ranges from a high point of approximately 280 ft above Mean Sea Level (MSL) (85 m) in the northwest portion of the study area to a low point of approximately 66 ft above MSL (20 m) in the southern portion. A northwest-southeast trending ridge reaching an elevation of 220 ft above MSL is located in the eastern portion of the study area.

2.3 SURFACE WATER HYDROLOGY

Surface runoff is ultimately directed towards either the Little Patuxent River, which traverses the central portion of the study area or the Patuxent River, located to the south of the study area. Both rivers flow to the southeast. Extensive wetland areas are located along both of these river channels within the Fort Meade area.

2.4 GEOLOGY

Fort Meade is located near the Fall Line, the boundary between the Coastal Plain and the Piedmont physiographic provinces (Figure 2-1). Landfill sites 1 and 2 are located in the outcrop area of the Quaternary deposits consisting of Patuxent River terrace deposits and alluvium. These deposits cover a large part of the west-central portion of the study area along the banks of the Little Patuxent River. The terrace deposits consist of interbedded sand and gravel with lesser amounts of silt and clay. These deposits vary considerably in thickness, averaging approximately 25 ft. The alluvium consists of interbedded sand, silt, clay, and commonly organic matter. Within the study area, the alluvium underlies the flood plains of the Little Patuxent and Patuxent rivers and their tributaries, as well as marsh land.

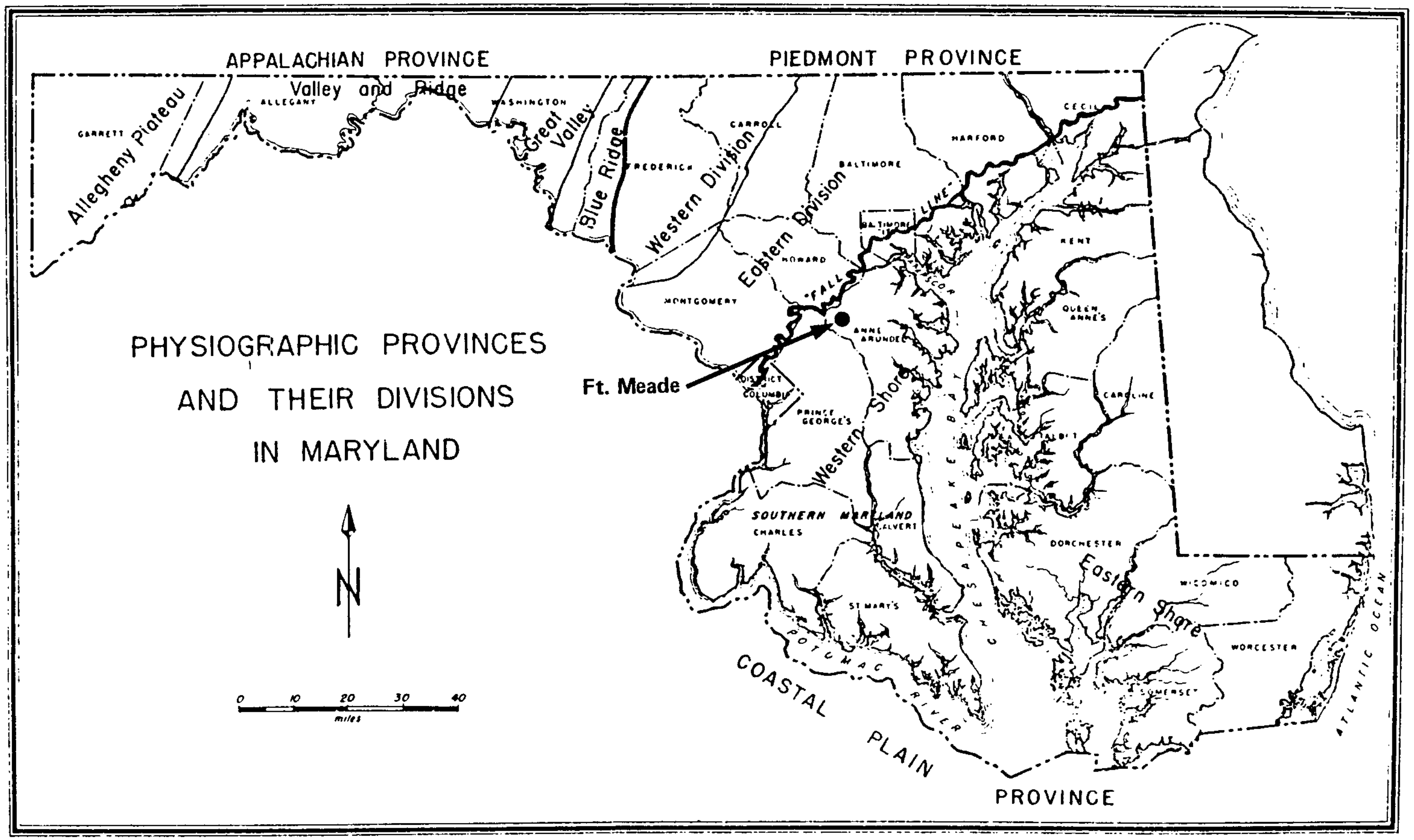
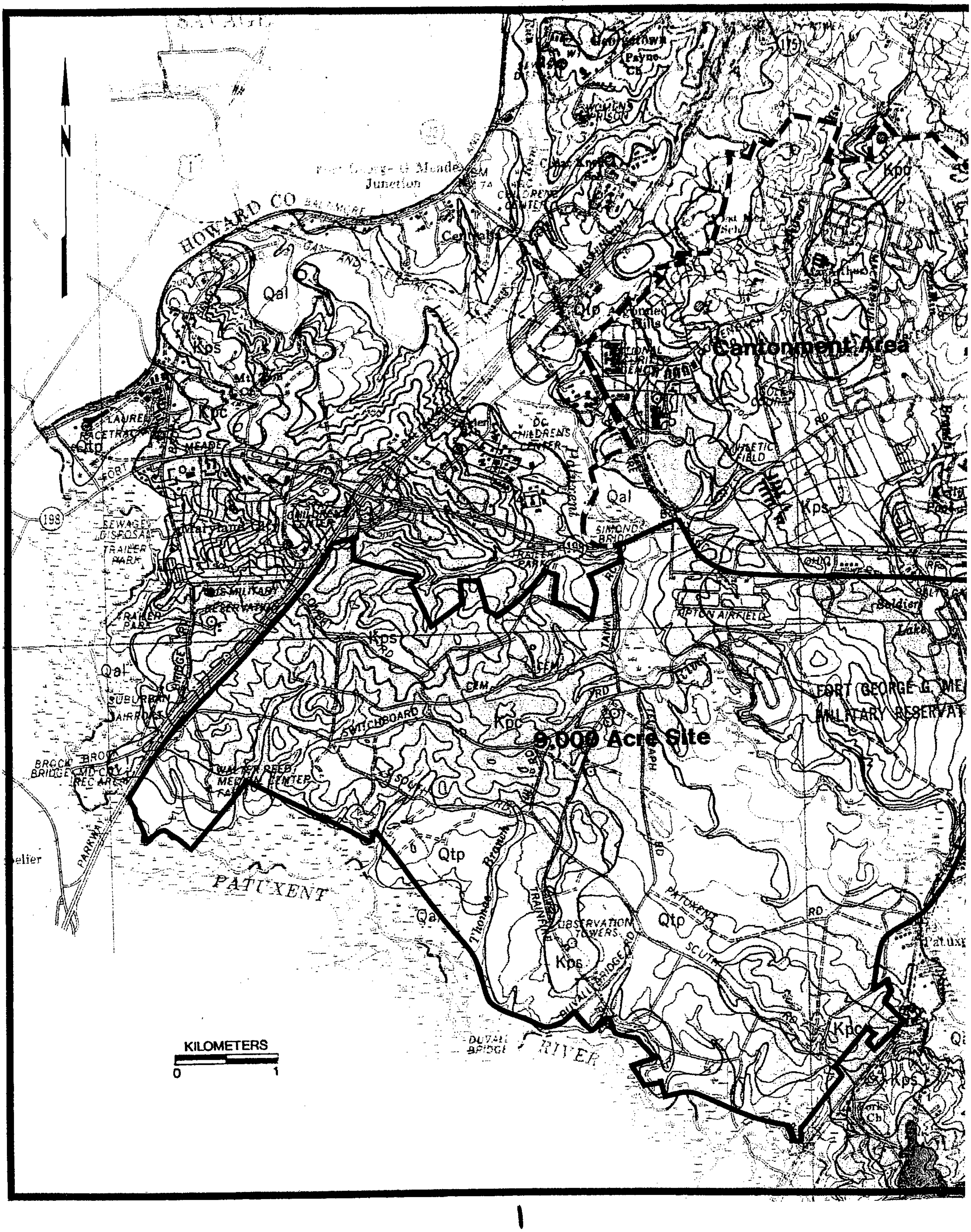


Figure 2-1. Physiographic provinces and their divisions in Maryland (Source: Vokes and Edwards, 1974).

This area is underlain by a wedge-shaped mass of unconsolidated sedimentary deposits, the Coastal Plain deposits, which overlie much older consolidated rocks. The outcrop belt of the Potomac Group of Lower Cretaceous age occupies nearly the entire northern third of Anne Arundel County where Fort Meade is located. The Potomac Group comprises the entire thickness of Coastal Plain sediment in the northern part of the County. The Potomac Group is approximately 600+ ft thick in the study area and its component formations from oldest to youngest are the Patuxent, Arundel, and Patapsco. Because formations of the group were deposited under fluvial and lacustrine conditions, sand, silt, and clay layers are commonly intercalated and limited in lateral extent (Mack and Achmad 1986). The type of depositional environment, including the occurrence of lenticular bedding and vertical repetition of essentially similar units, have made division of mappable units within the Potomac Group a subject of continued debate. The 9,000-acre parcel is located within the outcrop area of the upper Patapsco aquifer and the unnamed confining bed which separates the upper and lower Patapsco aquifers. Figure 2-2 is a geologic map of the FGGM area. Figure 2-3 shows a geologic cross section and the stratigraphic sequence in the FGGM area. Table 2-1 provides information on the stratigraphic and hydrologic characteristics of the geologic formations in Anne Arundel County. Glaser (1976) recognized two lithologic units in the Potomac Group, a sand-gravel facies and a silt-clay facies within the study area. The sand-gravel facies encompasses the Upper Patapsco aquifer, whereas the silt-clay facies includes the unnamed confining bed.

2.5 HYDROGEOLOGY

Recent studies (Mack and Achmad 1986) have shown that the Potomac Group is comprised of three separate and distinct aquifers in Anne Arundel County. These aquifers are known locally as the Patuxent, Lower Patapsco, and Upper Patapsco, and are in the Patuxent and Patapsco formations.


N
HOWARD CO
Cantonment Area
9,000 Acre Site
Qal
Kps
Kpc
Qtp
Kpg
LAUREL RACETRACK
SEWAGE DISPOSAL
TRAILER PARK
DC CHILDRENS CENTER
ATHLETIC FIELD
TIPTON AIRFIELD
FORT GEORGE G. ME
MILITARY RESERVAT
SWITCHBOARD
WALTER REED MEDICAL CENTER
OBSERVATION TOWERS
Thomas Branch
PATUXENT
DUVALL BRIDGE
RIVER
KILOMETERS
0
1

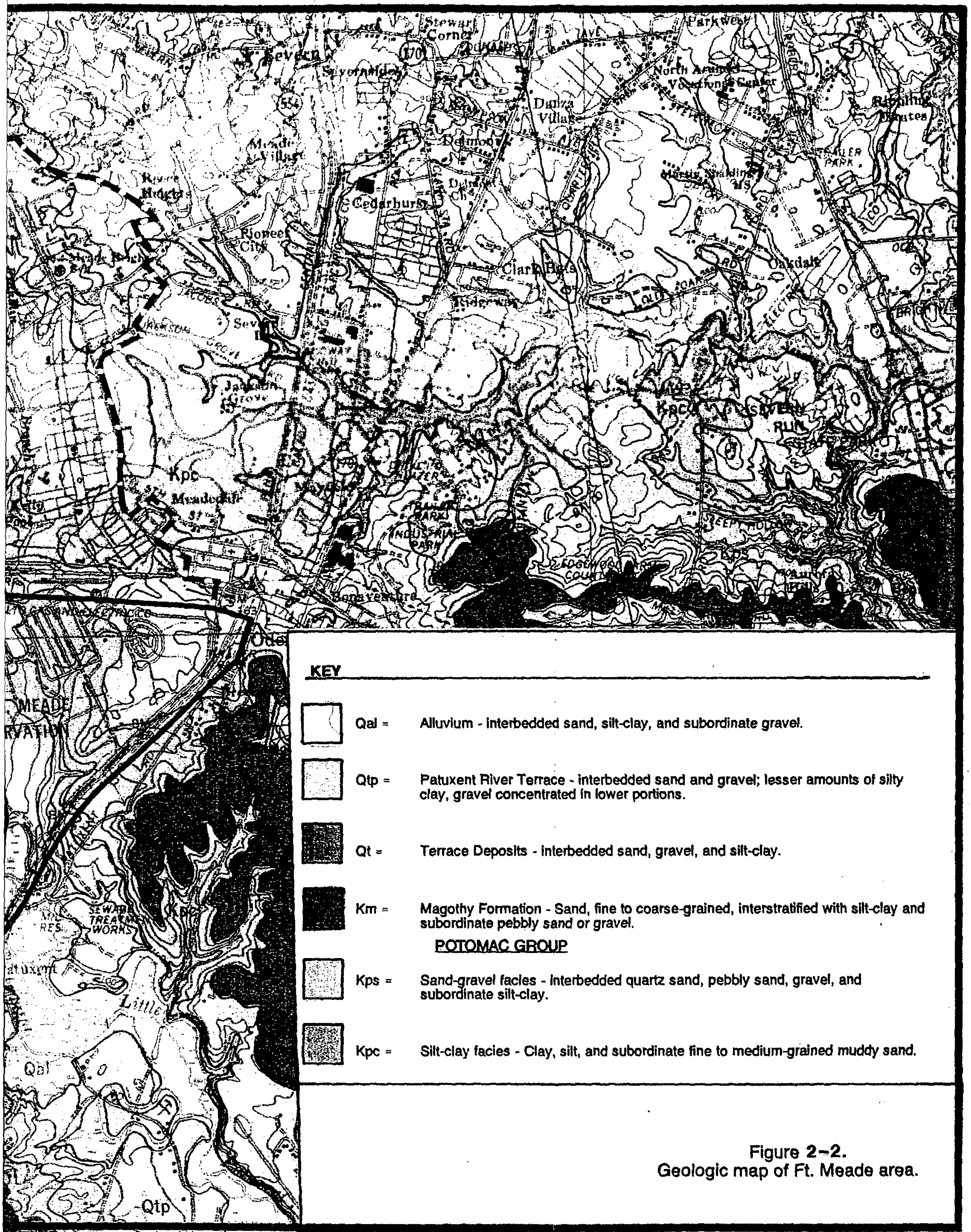


Figure 2-2.
Geologic map of Ft. Meade area.

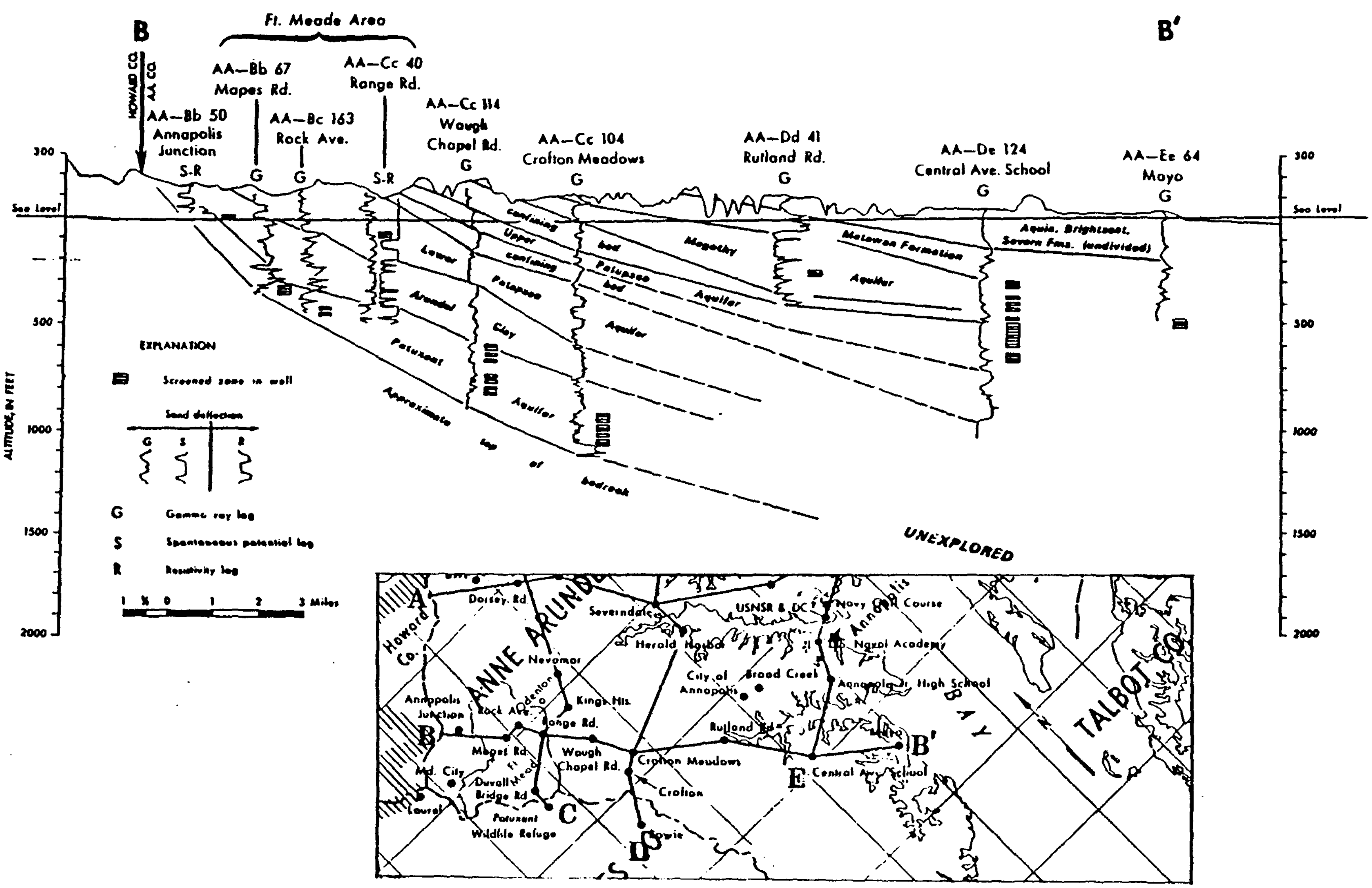


Figure 2-3. Hydrogeologic cross-section across Anne Arundel County (Source: Mack and Achmad 1986).

TABLE 2-1. STRATIGRAPHIC AND LITHOLOGIC CHARACTERISTICS OF GEOLOGIC FORMATIONS IN ANNE ARUNDEL COUNTY[1]

System	Series	Group	Formation	Average thickness (feet)	Lithologic symbol	Hydrologic character	General lithology
QUATERNARY	HOLOCENE and PLEISTOCENE		Alluvium and terrace deposits	30		Confining bed in most places. Poor aquifer in some places.	Sand, gravel, silt, and clay.
TERTIARY	EOCENE	PAMUNKEY	Nanjemoy Formation	80		Confining bed	Sand, with clayey layers, glauconitic.
			Marlboro Clay	30		Confining bed	Clay, plastic, pale-red to silvery gray.
	PALEOCENE		Aquia Formation	100		Aquifer	Glauconitic, greenish to brown sand with indurated or "rock" layers in middle and basal parts.
			Brightseat Formation	40		Confining bed in most places. Poor aquifer in some places.	Sand, silt, and clay, olive gray to black, glauconitic.
CRETACEOUS	UPPER CRETACEOUS		Severn Formation	90		Poor aquifer in places.	Sand, silty to fine, with some glauconite.
			Matawan Formation	30		Confining bed	Silt and fine sand, clayey, dark gray to black, glauconitic.
			Magothy Formation	100		Aquifer	Sand, light gray to white, with inter-bedded thin layers of organic black clay.
	LOWER CRETACEOUS	POTOMAC	Patapsco Formation, Upper part	250		Confining bed	Clay, tough, variegated color.
						Aquifer	Sand, fine to medium, brown color.
			Patapsco Formation, Lower part	250		Confining bed	Clay, tough, variegated color.
						Aquifer	Sand, fine to medium, brown color.
			Arundel Clay	250 (?)		Confining bed	Clay, red, brown, and gray, contains some ironstone nodules and plant remains.
			Patuxent Formation	250 (?)		Aquifer ? Confining bed Aquifer ?	Sand, gray and yellow, with interbedded clay; kaolinized feldspar and lignite common. Locally clay layers predominate.
LOWER PALEOZOIC (?) TO PRECAMBRIAN(?)			Basement Complex 1/	Unknown		Confining bed	Probably gneiss, granite, gabbro, meta-gabbro, quartz diorite and granitized schist.

These aquifers are confined, except in their outcrop areas where they exist under water-table conditions. Two distinct confining beds consisting of silt-clay facies separate these three aquifers.

The confining bed that separates the Lower Patapsco from the Patuxent aquifer is the Arundel Formation. The Arundel Formation is on the average 250 ft thick and consists of red, brown, and gray clay with some ironstone nodules. The confining bed separating the Lower and Upper Patapsco aquifers has not been named. This layer is approximately 125 ft thick and consists of massive beds of clay of low vertical hydraulic conductivity; however, there are layers within this confining bed that are relatively permeable.

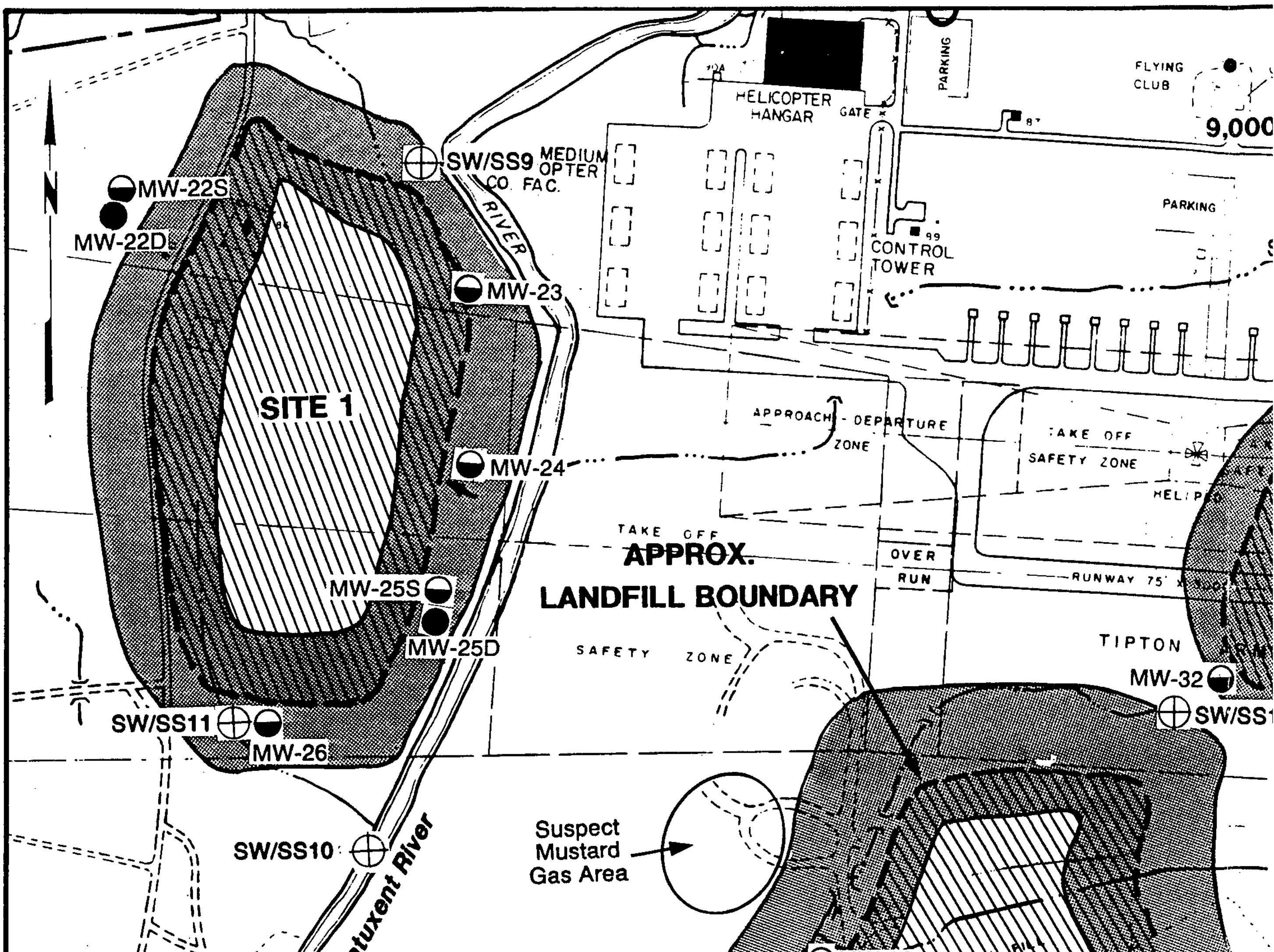
3. TECHNICAL PLAN FOR SITE INSPECTION SITES

3.1 LANDFILL No. 1

3.1.1 Site Description

Landfill No. 1 is located between Tank Road and the Little Patuxent River, west of Tipton Airfield (Figure 3-1), and was used as an unlined sanitary landfill from 1950 to 1964. There is no information available indicating the types of material disposed of at this area. The surface elevation of the site ranges from 100 to 110 ft above MSL. Surface water discharges to a wetland area to the south and a tributary of the Little Patuxent River to the north. The Little Patuxent River is located approximately 300 ft east of the site and flows to the south. The Fort Meade and Howard County Sewage Treatment Plant outfalls are located north of Site No. 1.

The site is covered with tall grass and some small trees. The site topography is relatively flat and does not reflect any significant mounding of waste. Waste was probably placed by utilizing the trench-fill method. Between the landfill boundary and the Little Patuxent River, areas of standing water were noted. A wetland area is located along the southern boundary of the site. The depth to water is expected to be within 10-15 ft of the surface because of the position of this site relative to the river. This site is situated in the outcrop area of alluvial deposits along the banks of the Little Patuxent River. This alluvium consists of very heterogeneous sediments with poorly sorted muddy sand and silt to an approximate depth of 30 ft. The underlying material is expected to consist of a thin lens of Patuxent River terrace deposits or the Lower Patapsco Formation. The Lower Patapsco Formation consists of fine to medium sand and is expected to be approximately 50-70 ft thick at the site. The Arundel Clay, a significant clay unit acts as a confining bed separating the Lower Patapsco and Patuxent aquifers.



N
SITE 1
SITE 2
MW-22S
MW-22D
MW-23
MW-24
MW-25S
MW-25D
MW-26
MW-27
MW-28
MW-29
MW-30D
MW-30S
MW-31
MW-32
SW/SS9
SW/SS10
SW/SS11
SW/SS12
SW/SS13
SW/SS14
MEDIUM OPTER CO. FAC.
RIVER
Little Patuxent River
HELICOPTER HANGAR
GATE
PARKING
FLYING CLUB
9,000
CONTROL TOWER
APPROACH - DEPARTURE ZONE
TAKE OFF SAFETY ZONE
HELIPAD
TAKE OFF
OVER RUN
SAFETY ZONE
APPROX. LANDFILL BOUNDARY
TIPTON
Suspect Mustard Gas Area
CLEAN FILL
TANK

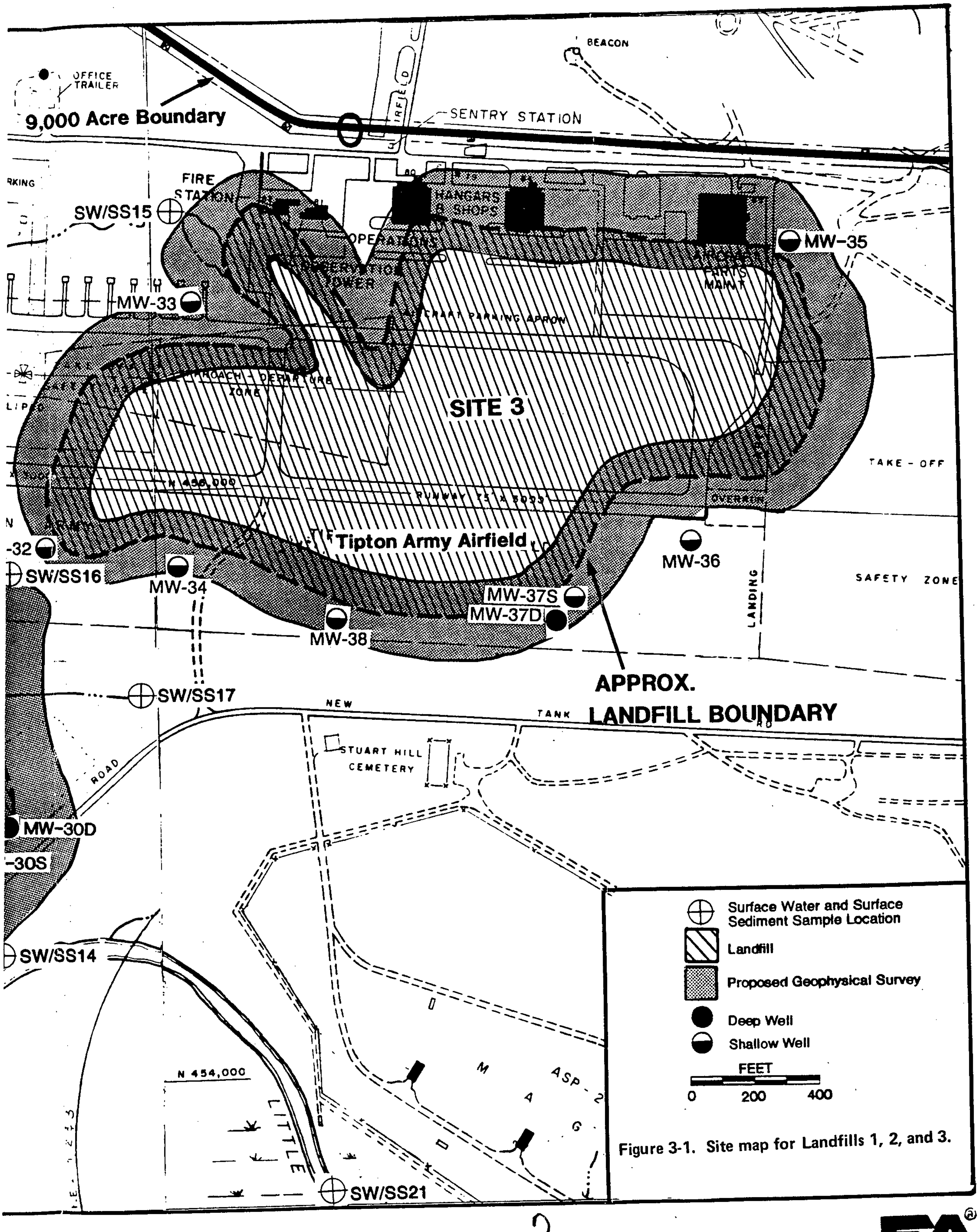


Figure 3-1. Site map for Landfills 1, 2, and 3.

3.1.2 Field Work Plan

3.1.2.1 Geophysical Survey

An electromagnetic (EM) survey will be conducted in the landfill area to delineate the waste boundaries and assist in selecting well locations outside of the fill area. A grid system will be set up and will consist of survey lines spaced 100 ft apart from one another and oriented perpendicular to the suspected landfill boundary. The proposed survey grid area is shown on Figure 3-1. EM readings will be obtained at stations located at 10-m intervals along each survey line. At each station, two readings will be taken, one in a horizontal dipole mode (+7.5 m effective depth) and the other in the vertical dipole mode (+15 m effective depth).

3.1.2.2 Monitoring Well Network Design

The shallow monitoring well network will consist of one upgradient well and four downgradient wells to be completed in the alluvial deposits of the upper portion of the Lower Patapsco, the water-table aquifer. Two deeper monitoring wells (one upgradient and one downgradient) are to be installed at this site to monitor the water quality below the first significant confining layer or a deeper portion of the water-table aquifer if no confining layers are identified. Because of the proximity of the inactive landfill sites 1, 2, 3, 4 and 5, a single deep monitoring well network has been designed to address these sites. This deep monitoring well network will include the installation of two deep wells at Site No. 1 and one deep monitoring well at Sites 2, 3, 4 and 5. All of these deep wells will be coupled with shallow wells at each site to form two-well clusters. Water quality and water level data from the deeper wells will be evaluated relative to the general area around Sites 1-5. The proposed locations of the monitoring wells were chosen to provide adequate site coverage and assess potential contamination that may be emanating from the landfill. These locations will also be selected after reviewing the available aerial photos and geophysical survey data. Preliminary locations are shown on Figure 3-1.

3.1.2.3 Sample Collection and Analysis

One round of ground-water samples will be collected from each monitoring well and analyzed as part of this study. Three surface water and surface sediment samples will be collected at Site 1. These three samples will be collected (1) in the tributary (SW/SS 9) to the Little Patuxent River located along the north boundary of Site 1 (2) in the Little Patuxent River downgradient of the discharge from the wetland area (SW/SS 10) and (3) in a drainage channel (SW/SS 11) for the wetlands area along the south boundary prior to discharging into the river. Initial attempts to locate leachate seeps at this site have been unsuccessful, however, field surveys will be conducted to review site conditions following a moderate to heavy rainfall event to increase the potential of locating any leachate seeps. If seeps are located samples will be collected. All of the samples to be collected will be analyzed for the Full Target Compound List (TCL) of parameters as shown on Table 5-2.

3.1.2.4 Aquifer Tests

One aquifer test will be conducted on a shallow and deep well, respectively, following sample collection. These tests will provide data on ground-water flow velocity in the shallow and deep portions of the water-table aquifer.

3.1.2.5 Landfill Gas Monitoring

Due to the age of the landfill (25+ years), EA does not believe that gas monitoring for methane and chlorinated organic emissions is warranted at Site No. 1. Most studies indicate that a vast majority of landfill gas generation occurs in the first 10-20 years after the site is inactive.

3.2 LANDFILL NO. 2

3.2.1 Site Description

Landfill No. 2 lies along New Tank Road, north of the Little Patuxent River and south of Tipton Airfield. This fill area was operated as an unlined facility and was reportedly used for rubble disposal between 1964 and 1972. However, signs of recent use for disposal of construction rubble are present. No information exists indicating hazardous material disposal at this site. Surface elevation ranges from 100 to 110 ft above MSL. The site topography slopes to the south and southwest towards a small tributary to the Little Patuxent River located to the west of the site and the Little Patuxent River located approximately 450 ft south of the site. Two storm water outfalls discharge to surface water channels to the north and northeast of Site #2. These outfalls carry water draining from the Tipton airfield area.

The Enhanced PA report referred to a potential encounter with mustard gas canisters in the mid-1950s near the south border of Tipton Army Airfield. The Excavation shop at Fort Meade was using heavy equipment in the area to remove borrow material and the operator reportedly was overcome by vapors. The excavation site was closed and backfilled shortly after the incident. An attempt was made by the Installation to locate the burial site using geophysical methods but it was unsuccessful. The warning signs are located west of Site 2, between the river and the site (Figure 3-1).

This site is located within the Patuxent River terrace deposit outcrop area along the north bank of the Little Patuxent River. The surface conditions are similar to those of Site 1 and consist of tall grass and sparse small trees. Piles of brush and concrete, and small areas of standing water, were noted during site visits.

3.2.2 Field Work Plan

3.2.2.1 Geophysical Survey

An EM survey will be conducted to delineate waste boundaries. A grid network will consist of survey lines spaced 100 ft apart from one another, and EM readings will be obtained at stations located at 10-m intervals along the lines. These grid lines will be oriented perpendicular to the suspected landfill boundary which has been approximated using the aerial photos. The approximate survey grid area is shown on Figure 3-1. This survey data will be used to also assist in selection of well locations outside of the fill area.

3.2.2.2 Monitoring Well Network Design

Six monitoring wells (five shallow and one deep) will be installed around the landfill perimeter as shown on Figure 3-1. The well locations were chosen in order to provide five downgradient shallow monitoring wells, and one deep downgradient monitoring well for the site. The proximity of Site 2 to 3 will allow for the use of water level data from the wells that will be installed at Site 3 to be used to evaluate the ground-water flow direction at Site 2. Thus, no upgradient well was installed at Site 2. As stated in Section 3.1.2.2, a deep well will be coupled with a shallow well at this site to form a two-well cluster to address water quality and vertical hydraulic gradient. This two-well cluster will be located off the southeast site boundary.

3.2.2.3 Sample Collection and Analysis

Ground-water samples will be collected from each monitoring well and analyzed for the full TCL list of parameters as shown in Table 4-2. Similar field efforts will be expended at Site 2 to collect a leachate seep sample as stated in the Section 3.1.2.3. Initial efforts to locate seeps were unsuccessful. Two surface water and surface sediment samples (SW/SS 12 and 13) will be collected from the tributary located to the west of Site 2. An additional surface water and surface sediment sample (SW/SS 14) will be collected in a small tributary south of Site 2 that flows into the Little Patuxent River. The tentative locations for these samples are shown on Figure 3-1 . The surface water and surface sediment samples will be analyzed for the full TCL list of parameters.

3.2.2.4 Aquifer Tests

One aquifer test will be conducted on a shallow and deep well, respectively, following sample collection. These tests will provide data on ground-water flow velocity in the shallow and deep portions of the water-table aquifer.

3.2.2.5 Landfill Gas Monitoring

Site No. 2 will not be sampled for gas emissions because: (1) the landfill is 18 years old; and (2) the fill was reportedly used for rubble disposal which has little or no potential for landfill gas generation.

3.3 LANDFILL NO.3

3.3.1 Site Description

This sanitary landfill was in use from the 1940s to the 1950s and initially consisted of a large unlined sand pit. There is no available information on the types of material deposited in the fill area at this site. Leachate seeps reportedly have been observed during periods of rainfall south of the airfield. The storm water network discharges to the west and southwest of the airfield into drainage channels that flow to the Little Patuxent River.

Tipton Army Airfield was constructed over the fill area in 1960. It consists of four hangars and an operations building, a fire station, taxiways and runway, and a helicopter training area. During construction of the airfield, much of the landfill was excavated and the materials were disposed of off the installation.

Surface elevations range from 125 to 150 ft above MSL. Surface runoff is directed to the south and west towards the Little Patuxent River. Based on topography, shallow ground water flows to the west and south. This site is located in the outcrop area of the Lower Patapsco Formation north of Site 2.

3.3.2 Field Work Plan

3.3.2.1 Geophysical Survey

An EM survey will be conducted at the site to provide data on the location of waste boundaries at the site. The construction of the runway, taxiways and associated buildings over the fill area will limit the survey to accessible area free of outside interference.

A grid network will be set up in the selected areas consisting of survey lines spaced 100 ft apart from one another. Figure 3-1 shows the survey grid area. Earth conductivity readings will be obtained at stations located at 10-m intervals along each survey line when possible.

3.3.2.2 Monitoring Well Network Design

Eight monitoring wells (seven shallow and one deep) will be installed around the perimeter of this landfill. Shallow well locations were selected to provide upgradient and downgradient locations and adequate site coverage. The deep well location was chosen to provide a downgradient monitoring location for this site. The tentative well locations are shown on Figure 3-1.

3.3.2.3 Sample Collection and Analysis

Ground-water samples will be collected from each monitoring well and analyzed for the full TCL list of parameters. Three surface water and surface sediment samples (SW/SS 15, 16, 17) will be collected in the vicinity of this site. These samples will be collected at the storm water outfalls draining the area. Two of the outfalls are located along the south site boundary and the other is located along the northwest site boundary. All of the monitoring well and surface water and surface sediment sampling locations are shown on Figure 3-1.

3.3.2.4 Aquifer Tests

One aquifer test will be conducted on a shallow and deep well, respectively, following sample collection. These tests will provide data on ground-water flow velocity in the shallow and deep portions of the water-table aquifer.

3.3.2.5 Landfill Gas Monitoring

Site No. 3 will not be sampled for gas emissions because of the age of the fill (~ 40 years) and the fact that the airfield has been constructed over the majority of the site.

3.4 LANDFILL NO. 4

3.4.1 Site Description

This landfill is not located on the BCP, however, it is close enough to the Cantonment area/BCP boundary that potential contaminant migration from this site onto the BCP is possible, and thus this site is being evaluated. Landfill No. 4 consists of approximately 11 acres and is located just north of the newly extended Route 32 in a wooded area. Aerial photographs show that this area was used from approximately the 1950s to the 1970s. Available information indicates that this area was used as a rubble disposal area. This site is located approximately 1000 ft west of Site No. 5. The U.S. Corps of Engineers have conducted a baseline ground-water study in the vicinity of Sites 4 and 5 for evaluation relative to potential construction of a hazardous waste storage facility. This study included installation of five piezometers and three monitoring wells.

3.4.2 Field Work Plan

3.4.2.1 Geophysical Survey

An EM survey will be conducted to delineate waste boundaries. A grid network will consist of survey lines spaced 100 ft apart from one another, and EM readings will be obtained at stations located at 10-m intervals along the lines. These grid lines will be oriented perpendicular to the suspected landfill boundary. The survey grid area is shown on Figure 3-2. This survey data will be used to also assist in selection of well locations outside of the fill area.

3.4.2.2 Monitoring Well Network Design

Three shallow monitoring wells are to be installed around the landfill perimeter. A deep monitoring well will be installed along the southeast site boundary and coupled with a shallow well to form a two-well cluster. Tentative locations are shown on Figure 3-2. An existing monitoring well (COE-3) that was installed by the U.S. COE is located along the north boundary of the landfill will be used to collect water level and ground-water quality data.

3.4.2.3 Sample Collection and Analysis

One round of ground-water samples will be collected from the four new wells and the existing well. The ground-water samples collected from these wells will be analyzed for the full TCL list of parameters. A surface water and surface sediment sample (SW/SS 18) will be collected

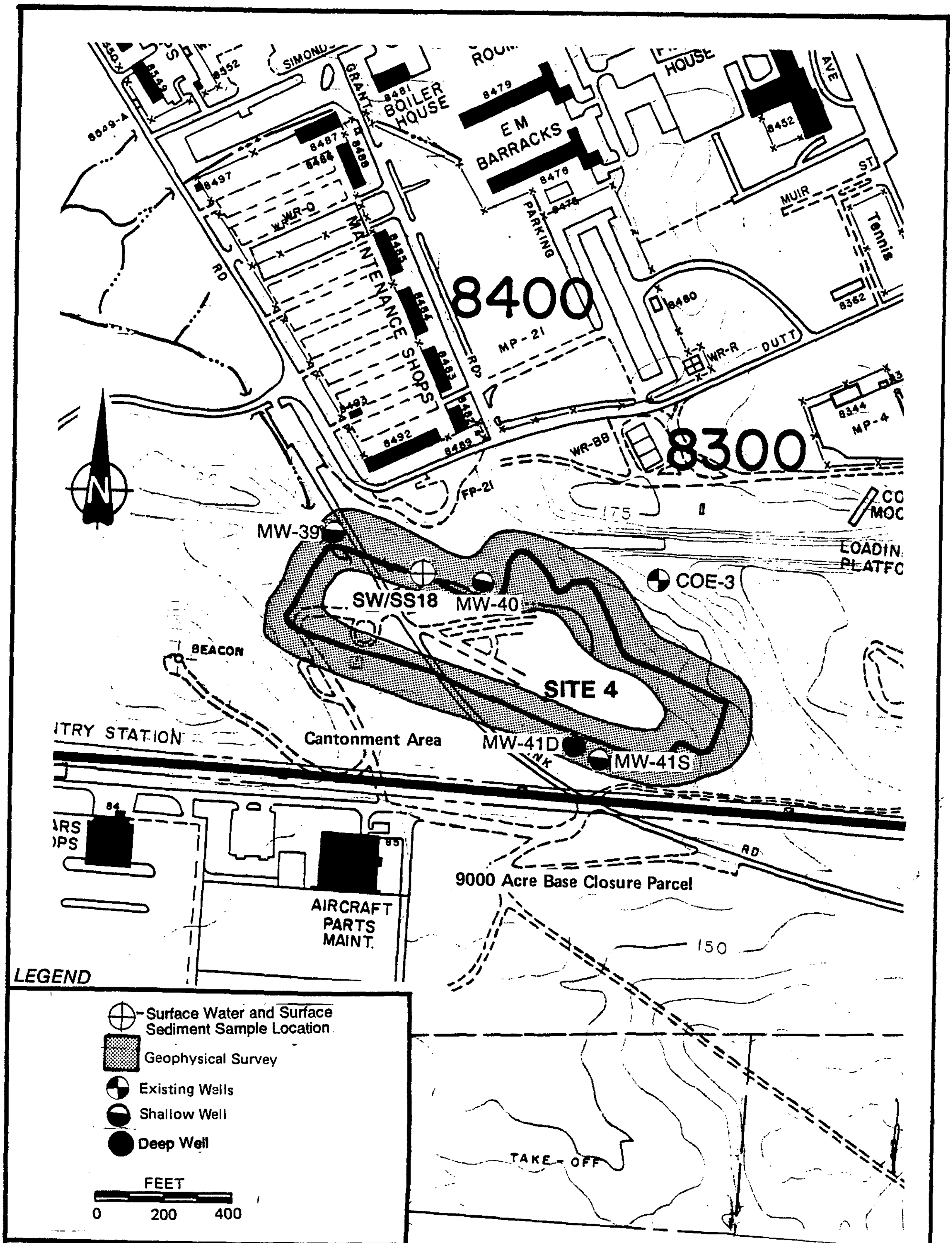


Figure 3-2. Inactive Landfill 4 site map.

from the intermittent stream that traverses the site and also analyzed for the full TCL list. The sampling of this intermittent stream channel will be performed following a storm event.

3.4.2.4 Aquifer Tests

One aquifer test will be conducted on a shallow and deep well, respectively, following sample collection. These tests will provide data on ground-water flow velocity in the shallow and deep portions of the water-table aquifer.

3.4.2.5 Landfill Gas Monitoring

Site 4 will not be sampled for gas emissions because of the age of the landfill (~20-30 years) and the fact that it was reportedly used as a rubble disposal area.

3.5 DPDO SALVAGE YARD

3.5.1 Site Description

The DPDO salvage yard is located just north of the BCP boundary. The relative location of this site to the other inactive landfills is shown on Figure 1-2. Figure 3-3 is a site map showing the surrounding site area. This area encompasses approximately 10 acres and is used as a surficial storage area for a wide range of materials, including abandoned cars, office equipment, crates, and scrap metals.

3.5.2 Field Work Plan

3.5.2.1 Geophysical Survey

No geophysical survey is planned for this area because of the significant amount of surface interference. There is no available information to indicate that waste material has been disposed of below the surface.

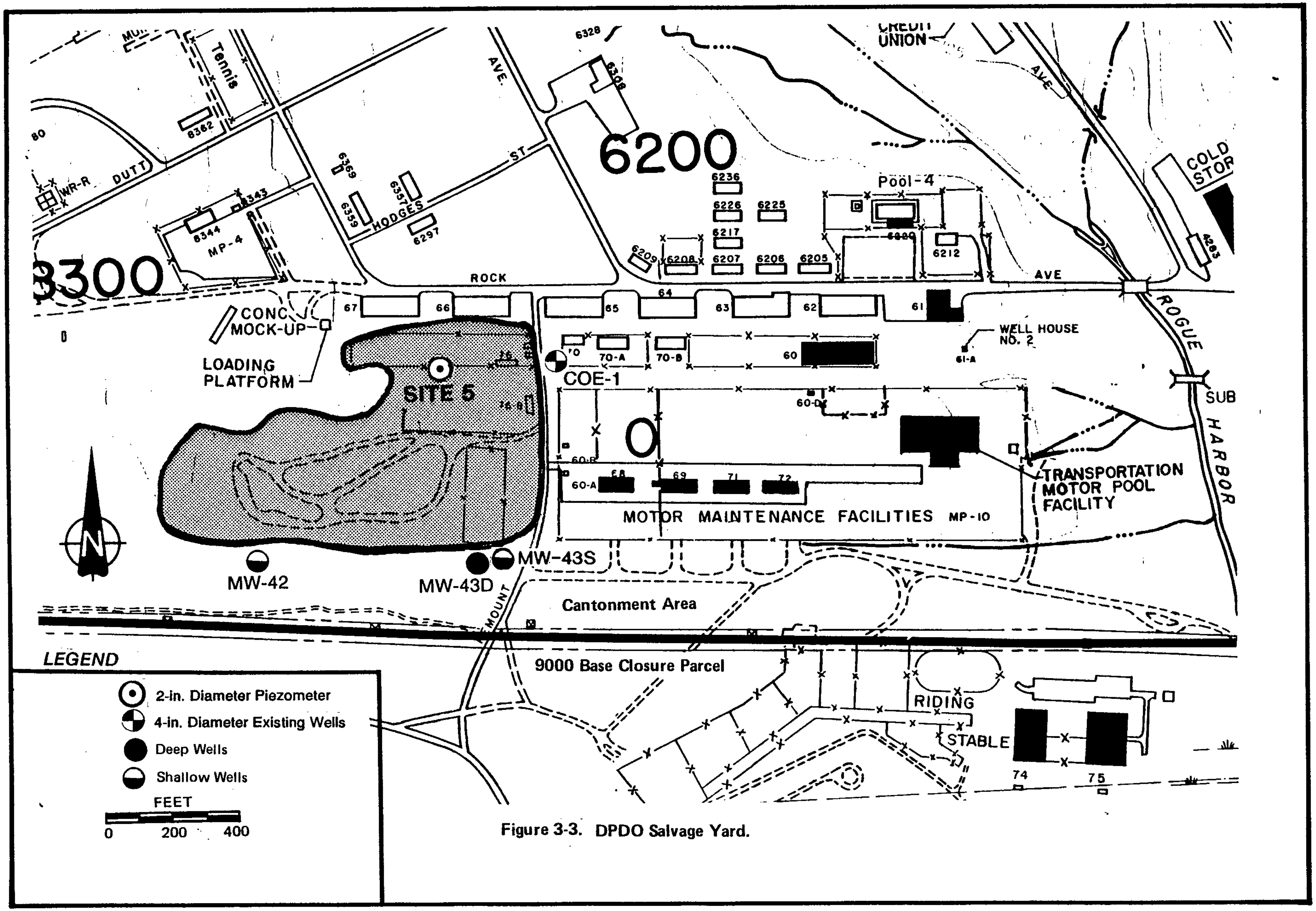


Figure 3-3. DPDO Salvage Yard.

3.5.2.2 Monitoring Well Network Design

Three monitoring wells (two shallow and one deep) are to be installed along the southern boundary of this disposal area. There are two existing monitoring wells located along the north site boundary. One of these wells, COE-1, is a 4-in monitoring well and DH-1-OW, is a piezometer. The monitoring well is located off the northeast site boundary and the piezometer is located in the northern portion of the site.

3.5.2.3 Sample Collection and Analysis

Ground-water samples will be collected for analysis from all the new wells plus, COE-1, the existing 4-in well. Water level data will be collected from the piezometer. Ground-water samples will be analyzed for the full TCL list of parameters. A survey will be conducted to evaluate surface soil contaminated areas. If areas of concern are located soil samples will be collected and the analytical parameters will be based on field observations relative to the waste material in the area of the staining.

3.5.2.4 Aquifer Tests

One aquifer test will be conducted on a shallow and deep well, respectively, following sample collection. These tests will provide data on ground-water flow velocity in the shallow and deep portions of the water-table aquifer.

3.6 ORDNANCE DEMOLITION AREA

3.6.1 Site Description

This area is located at Range 16, which is in the southeastern area of the BCP. This area is used by the 549th and 144th U.S. Army Explosive Ordnance Detachments stationed at Fort Meade to destroy obsolete ordnance. It is reportedly used approximately four times a year. The explosive limit on ordnance demolition is five pounds of C-4. The ordnance demolition takes place in an unlined crater between two earth berms.

3.6.2 Field Work Plan

The objective of the work to be completed at this site is to assess the potential for soil contamination in the active demolition area that could be a result of Army operations. The scope of work will include collecting two soil samples from the active demolition area. These samples will be analyzed for explosives and nitrate/nitrite. The analytical results from these soil samples will be evaluated relative to the potential for the soil to act as a contaminant source for ground-water contamination. Depending on the results, this study will address the need for further soil and/or ground-water sampling and analysis at this site.

3.7 FIRE TRAINING AREA

3.7.1 Site Description

This site is located west of Airfield Road, between Tipton Airfield and the B&O Railroad tracks. The Flying Club occupies an office trailer located adjacent to the site. This Fire Training area was constructed in 1979 and consists of a 20 ft diameter concrete pad surrounded by a 8-10 in high concrete berm. This area also consists of a large enclosed structure utilized to train firefighters for work in smoke-filled enclosed structures, and small burn pans. The Fort Meade Fire Department utilizes this area on a routine basis to practice fire fighting. Fires are set using excess aviation fuel or gasoline from the Tipton Airfield operations and then extinguished.

The enhanced PA report indicated that another fire training area was reportedly located in the vicinity and probably underneath the existing helicopter hangar building. Presently there is no active fire training area in this area. There are some USTs in this area which will be evaluated using soil gas surveys. The old fire training area will be considered when evaluating the soil gas data from these UST sites.

3.7.2 Field Work Plan

3.7.2.1 Soil Gas Survey

A soil gas survey will be conducted at this site. Sample locations will be established along a grid network over the selected area shown on Figure 3-4. Sample points will be located along survey lines at 30-ft intervals around the concrete pad burn area and the other smaller burn pans. If contamination is detected, the sampling grid will be expanded and additional samples will be taken to assess direction of migration. At each sampling station, soil vapor samples will be extracted from a nominal depth of 3 ft. Aliquots of soil vapor samples will be analyzed at the site. An HNU Model 4212 gas chromatograph equipped with dual column/duel detector capability will be used to analyze soil gas samples for volatile hydrocarbons and halocarbons. Volatile hydrocarbons will be analyzed using the flame ionization detector (FID) on the gas chromatograph. This detector will be calibrated for benzene, toluene, ethylbenzene, and o-xylene. If unidentified volatile organics are detected during the survey by gas chromatographic analysis, a soil gas sample will be collected on a Tenax trap and submitted to the laboratory for GC/MS analysis to identify the unknown compound.

3.7.2.2 Soil Sampling

Soil samples will be collected at or near possible sources of onsite contamination. The locations of these samples will be dependent on review of the soil gas data. Samples will be collected from a depth of 1 to 3 ft below grade and submitted for metals, volatile and semi-volatile organic compounds as shown in Table 5-2.

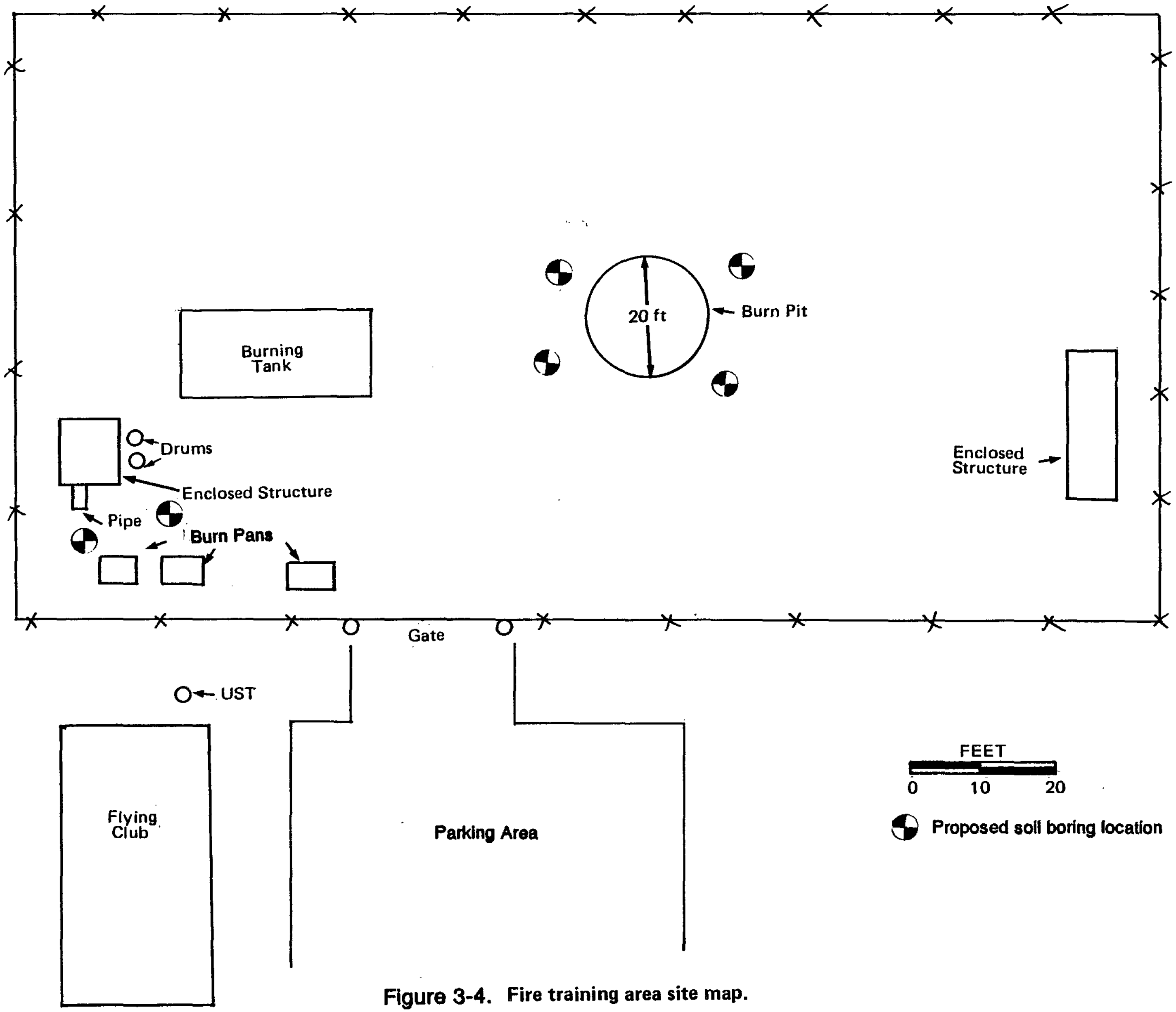


Figure 3-4. Fire training area site map.

3.7.2.3 Monitoring Well Network Design

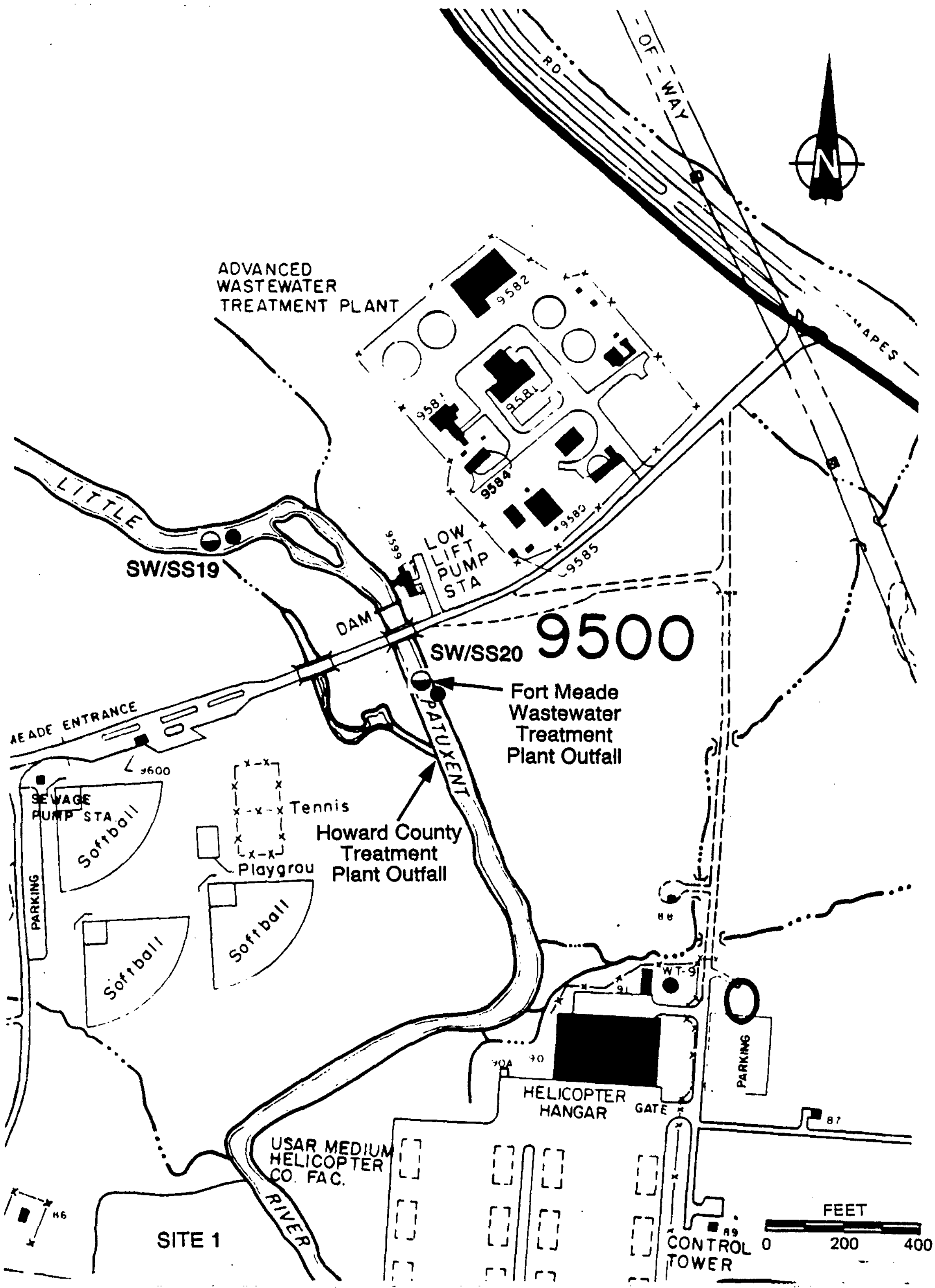
Following completion of soil gas survey and data review, a decision will be made with USATHAMA approval as to the need for installation of monitoring wells or soil sampling. If wells are to be installed, the analytical parameters will also be established based on the soil gas data.

3.8 SURFACE WATER QUALITY AND AQUATIC ECOLOGY SURVEYS

Two water and two sediment samples (SW/SS 19 and 20) will be collected from Soldiers Lake--one near the influent and one near the discharge. Exact sampling locations will depend on depth and bottom composition. Silt/clay substrate would be preferred because it would be more likely to trap particulate-bound pollutants than a sandy substrate. Figures 3-5 and 3-6 show the surface water and sediment sampling locations for Fort Meade STP No. 2 and Soldiers Lake, respectively.

Sediment and water will be sampled from four stations on the Little Patuxent River: one upstream of STP No. 2 (SW/SS 21); one at the outfall from STP No. 2 (SW/SS 22); one downstream of the dump sites (SW/SS 23) and one near the site boundary (SW/SS 24) as the Little Patuxent leaves the base. Samples will be collected from shallow pools where silt/clay sediment can be found. Three sets of sediment and water samples will be collected from each of the three abandoned landfills near the airfield, as shown in Figure 3-1. The locations of these samples are discussed in the field work plan for each site.

Water samples will be preserved onsite, and all samples will be stored on ice and delivered to the analytical laboratory within 24 hours of sampling. All samples will be analyzed for the TCL list of parameters. In addition, sediment samples will be analyzed for total solids content, total organic carbon, and surface water samples will be analyzed for total suspended solids.



NOTE: An additional surface water and surface sediment sample will be collected downstream of inactive Landfills 1, 2, and 3. Refer to Figure 3-1.

= Surface Water
= **Surface Sediment**

Figure 3-5. Ft. Meade Sewage Treatment Plant No. 2, site map.

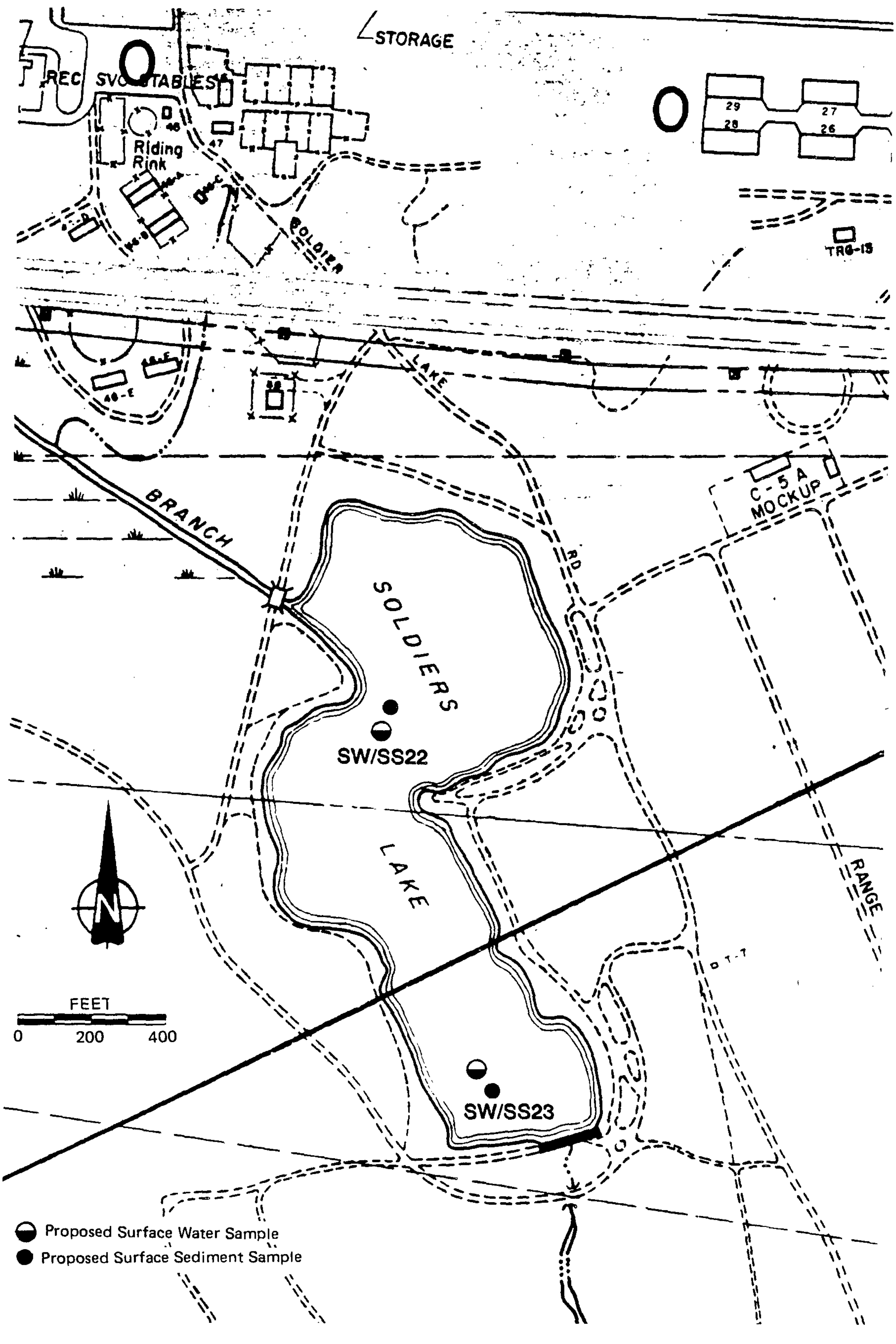


Figure 3-6. Soldiers Lake site map.

In addition, kinetic invertebrate and fish community composition will be sampled at a station location on the Little Patuxent River above the discharge of the Fort Meade Sewage Treatment Plant No. 2 but within the northern site boundary. Ecological samples will be collected using EPA protocol or a standard multihabitat approach. Other sampling locations will be downstream of the STP location at stations near areas of potential impact and of additional areas where no adverse effects are expected to assess "normal" benthos and fish community composition. The downstream extent of sampling will be on the Little Patuxent River at the southern edge of the reservation boundary. Stations will be established in areas of similar habitat including substrate type of the stream bed, canopy and vegetation types, flow, riffle/run ratio, and depth. Based on observations of the area, station locations will be chosen in areas of potential impact of the sewage treatment plant and the landfills, in addition to an upstream reference location not affected by Fort Meade activities. This data will be used to characterize water quality over a longer time scale than permitted with single water quality grab samples.

3.9 UNDERGROUND STORAGE TANK SITES

Table 3-1 provides a brief description of the sites in which the SVCA technique will be used. This section will provide a more detailed description of the sites. The scope of work to be conducted by EA at these sites will be coordinated with the Fort Meade Environmental Office UST program.

3.9.1 Site Descriptions and Soil Gas Surveys

3.9.1.1 Building 90A POL Storage Area (Site 1)

Building 90A is located west of building 90, which houses USAR Medium Helicopter Company. The building and immediately surrounding area store waste oils, solvents, lubricants and detergents. According to personnel interviewed, empty 55-gal drums are washed out and the rinse water is dumped into a "holding pit." This pit is periodically pumped out by the base engineering services. The capacity of this pit is not known and its tightness is suspect; therefore, leakage of rinsate residues from the holding pit over long periods of time into the subsurface is suspected. The approximate area under investigation is 100 ft by 200 ft. Ten to fifteen soil vapor sampling locations are scheduled for this site. Soil vapor samples will be analyzed for volatile organic hydrocarbons and halogenated organic compounds using gas chromatography/FID, ECD. The site area is shown in Figure 3-7.

3.9.1.2 Flying Club Fuel Storage Tanks (Site 4)

Several underground storage tanks were removed from the site in 1989. Due to the extent of contamination which was encountered during removal of the tanks, several monitoring wells were installed in the area. The tanks were replaced with above-ground tanks encased in a berm. The approximate area under investigation is 150 ft by 150 ft. Ten to fifteen soil vapor sampling locations are scheduled for this site. Soil gas samples will be analyzed for volatile organic hydrocarbons using gas chromatography/FID. The site area is shown in Figure 3-7.

3.9.1.3 No. 2 Fuel Oil Tank Sites (Sites 2, 5, 6, 7, 8, 9, 12, 13, 15, 16, 17) Buildings 91, 80, 84, 85, T30 T31, T57, T58, TR2, 81, 82, 04, 69, and 10-29 (excluding 21)

These ten sites contain underground storage tanks in which No. 2 fuel oil is stored. A large percentage of these tanks were observed to have product-stained soil around the fill cap and tank vent. At some sites, monitoring wells have been installed around the tanks. The potential exists for long-term migration of spillage into the vadose zone surrounding the tanks. The affected area surrounding each tank has been estimated to be 100 ft by 100 ft. Some sites may be slightly larger. Table 3-1 provides the number of sampling locations at each site. Soil gas samples will be analyzed for volatile organic hydrocarbons onsite using gas chromatography/FID. The site areas are shown in Figures 3-7, 3-8, and 3-9, 3-10.

TABLE 3-1 SOIL GAS SURVEY AND UNDERGROUND STORAGE TANK SITE INFORMATION

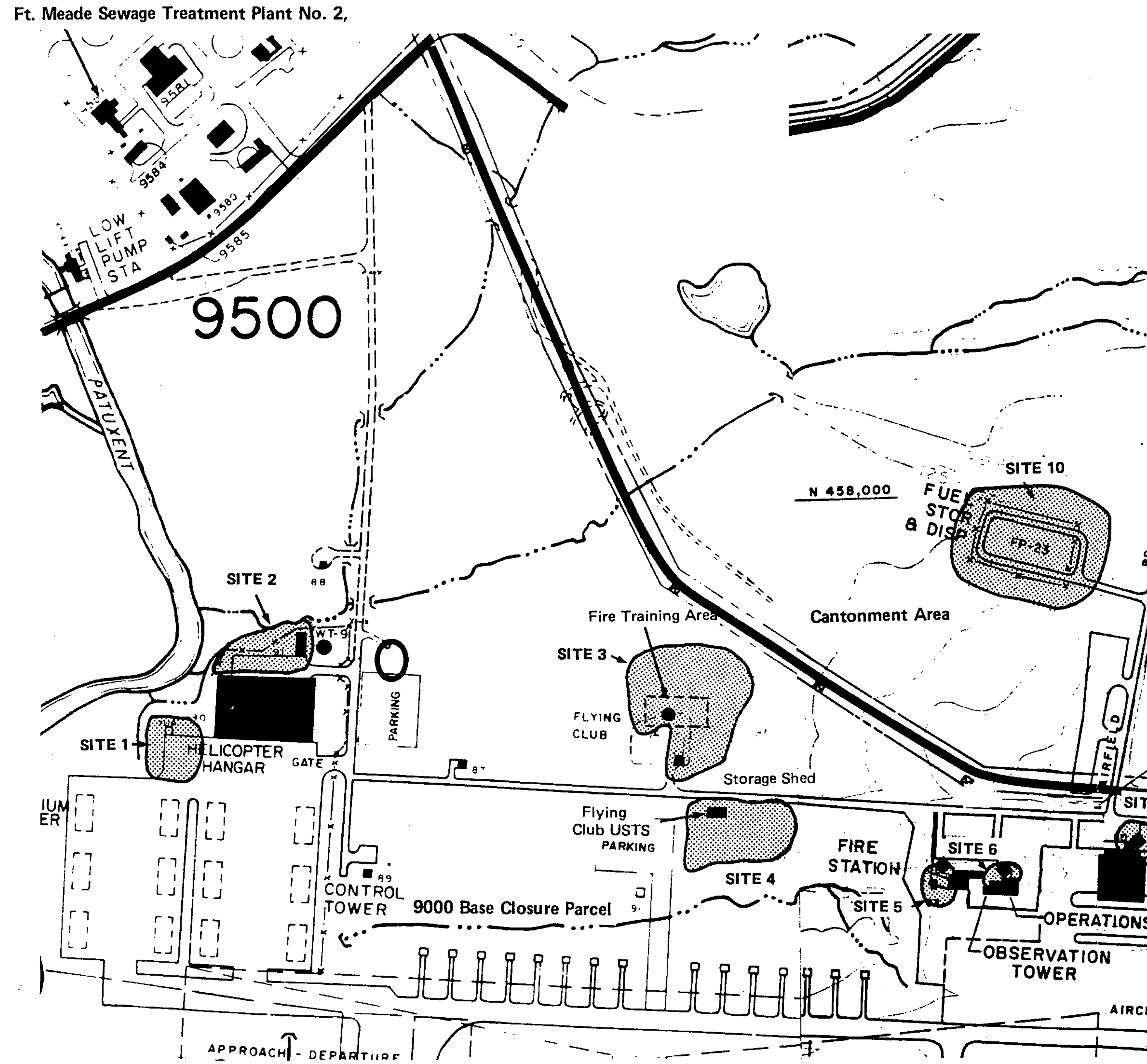
Site Designation	Name	Size	Number of Soil Vapor Sampling Locations	Suspected Contaminants	Calibration Standards	Instrument/Detector
1	Bldg 90A, POL Storage Area	100' x 200'	10-15	Waste Oils, Fuels Solvents, Detergents	BTEX TCA, TCE, PCE	Gas Chromatograph/ECD,FID
2	Bldg 91, Former Fuel Oil Tanks	100' x 100'	10-15	No. 2 Fuel Oil	BTEX	Gas Chromatograph/FID
3	Fire Training Area & Storage Shed	~200' x 200'	25-30	Waste Oils, Solvents, Fuel Oils	BTEX, TCA, TCE, PCE	Gas Chromatograph/ECD, FID
4	Flying Club Fuel Storage Tanks	150' x 150'	10-15	Aviation Gas	BTEX	Gas Chromatograph/FID
5	Bldg 82 Fire Station	100' x 100'	10-15	No. 2 Fuel Oil	BTEX	Gas Chromatograph/FID
6	Bldg 81 Flight Operations	100' x 100'	10-15	No. 2 Fuel Oil	BTEX	Gas Chromatograph/FID
7	Bldg 80 2 Fuel Oil Tanks	100' x 100'	10-15	No. 2 Fuel Oil	BTEX	Gas Chromatograph/FID
8	Bldg 84 Fuel Oil Tank	100' x 100'	10-15	No. 2 Fuel Oil	BTEX	Gas Chromatograph/FID
9	Bldg 85 Fuel Oil Tank	100' x 100'	10-15	No. 2 Fuel Oil	BTEX	Gas Chromatograph/FID
10	FP-23, Fuel Storage & Dispensing	~200' x 300'	40	JP-5, Aviation Gas	BTEX	Gas Chromatograph/FID
11	Motor Pool Fuel Distributing 3 20K Tanks	200' x 200'	25-30	Unleaded (MOGAS) Diesel	BTEX	Gas Chromatograph/FID
12	Bldg 69 10K Fuel Oil Tank	100' x 200'	10-15	No. 2 Fuel Oil	BTEX	Gas Chromatograph/FID

B - Benzene
T - Toluene
E - Ethylbenzene
X - O-xylene
TCA - 1,1,1-Trichloroethane
TCE - Trichloroethene
PCE - Tetrachloroethene

ECD - Electron Capture Detector
FID - Flame Ionization Detector

TABLE 3-1 (Cont.)

Site Designation	Name	Size	Number of Soil Vapor Sampling Locations	Suspected Contaminants	Calibration Standards	Instrument/Detector
13	Warehouse Area Bldgs 10-29 (Excluding Bldg 21)	2400' x 100'	70-90	No. 2 Fuel Oil	BTEX	Gas Chromatograph/FID
14	Warehouse Area Bldg 21	100' x 100'	10-15	Gasoline, Solvents No. 2 Fuel Oil	BTEX TCA, TCE, PCE	Gas Chromatograph/ECD, FID
15	Bldg 04 Hunting Control Office	100' x 100'	10-15	No. 2 Fuel Oil	BTEX	Gas Chromatograph/FID
16	Bldg T57, T58, & TR2	3 Areas 100' x 100'	20-25	No. 2 Fuel Oil	BTEX	Gas Chromatograph/FID
17	Bldg T30 & T31	100' x 200'	10-15	No. 2 Fuel Oil	BTEX	Gas Chromatograph/FID



Ft. Meade Sewage Treatment Plant No. 2,
9581
9584
9580
9585
LOW LIFT PUMP STA
9500
PATUXENT
SITE 2
88
WT-9
SITE 1
HELICOPTER HANGAR
GATE
PARKING
Fire Training Area
SITE 3
FLYING CLUB
Storage Shed
Cantonment Area
N 458,000
SITE 10
FP-25
Flying Club USTS
PARKING
SITE 4
FIRE STATION
SITE 6
SITE 5
CONTROL TOWER
9000 Base Closure Parcel
OPERATIONS
OBSERVATION TOWER
APPROACH - DEPARTURE

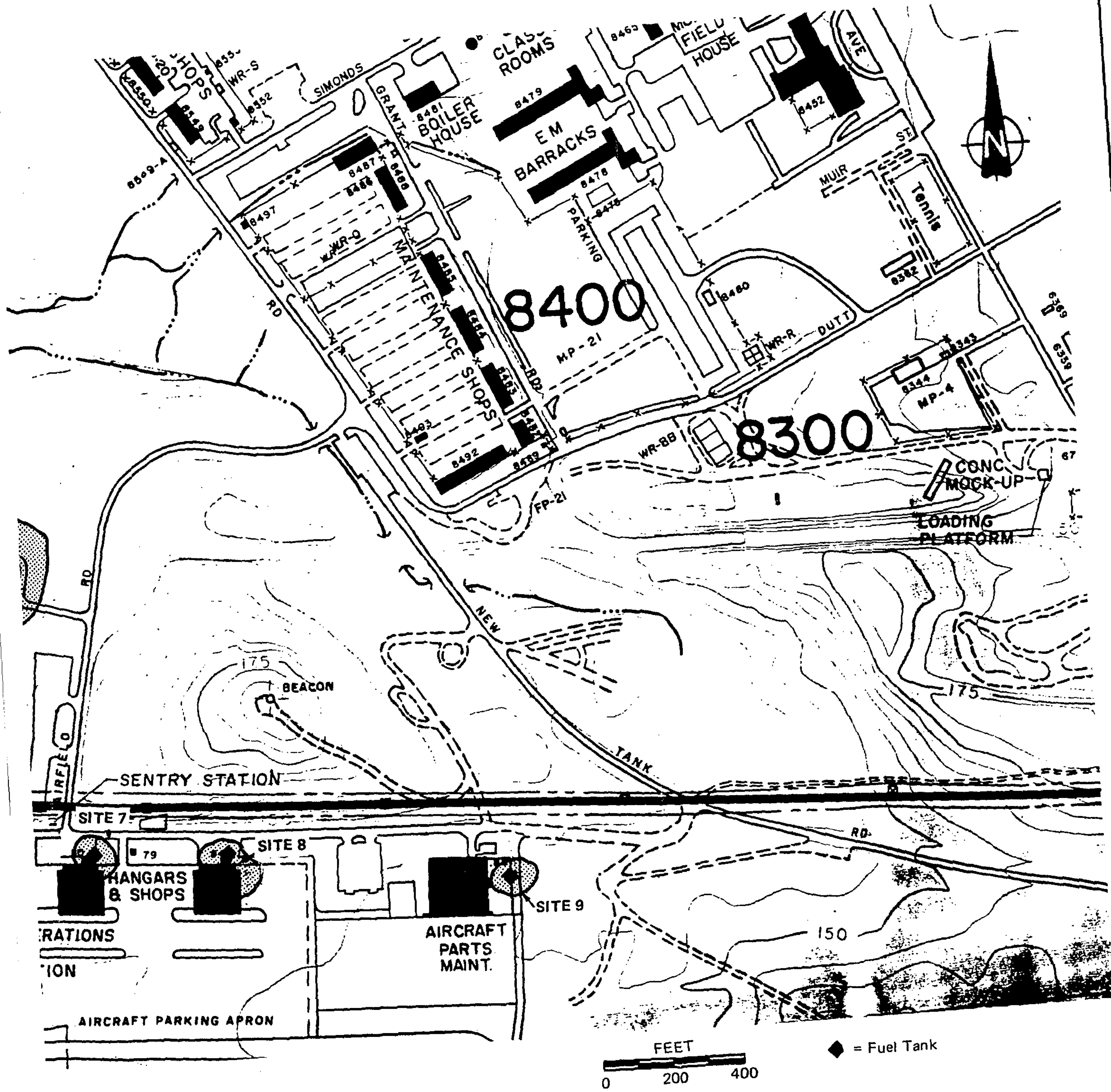


Figure 3-7. UST Sites 1 through 10.

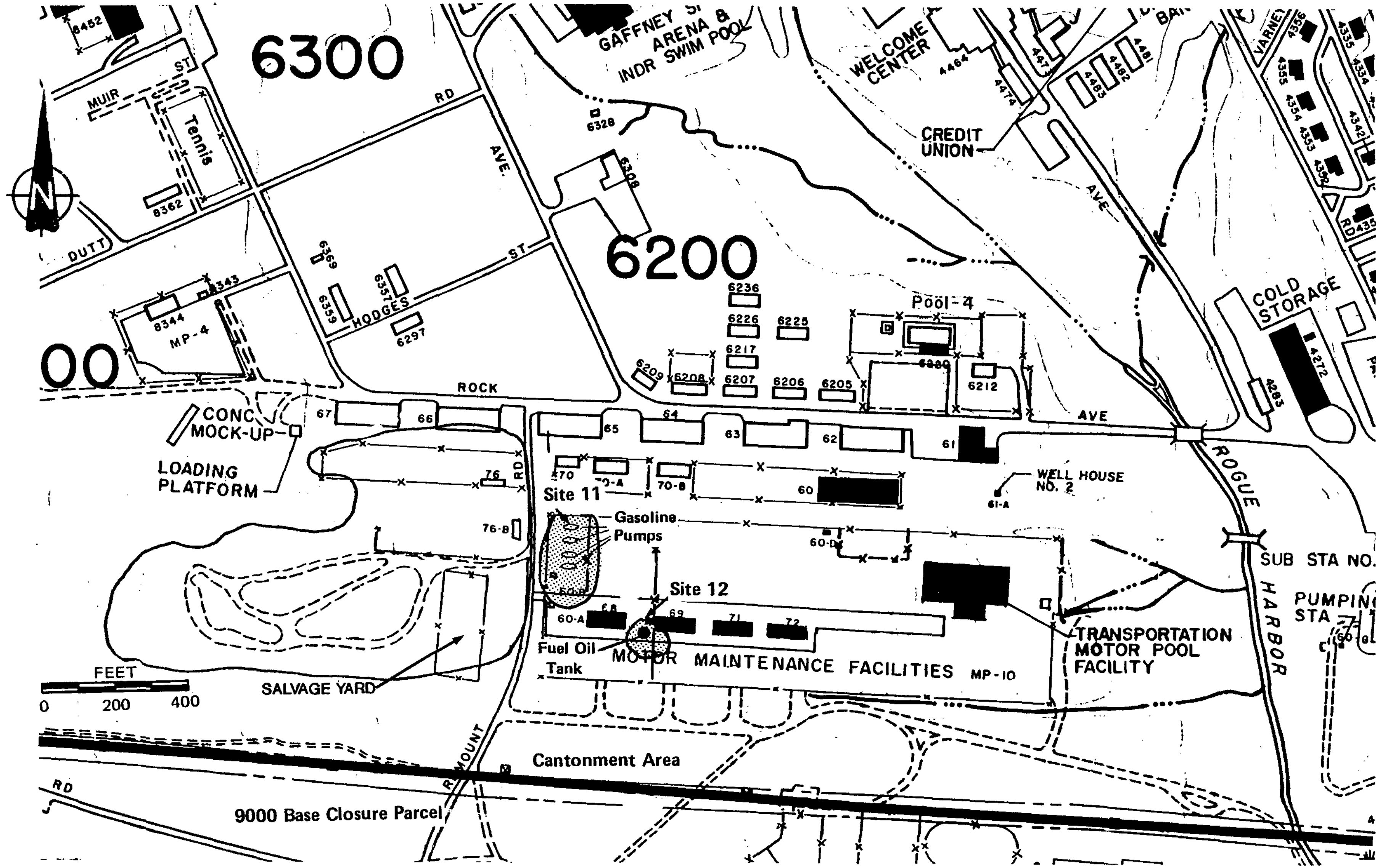


Figure 3-8. UST Sites 11 and 12.

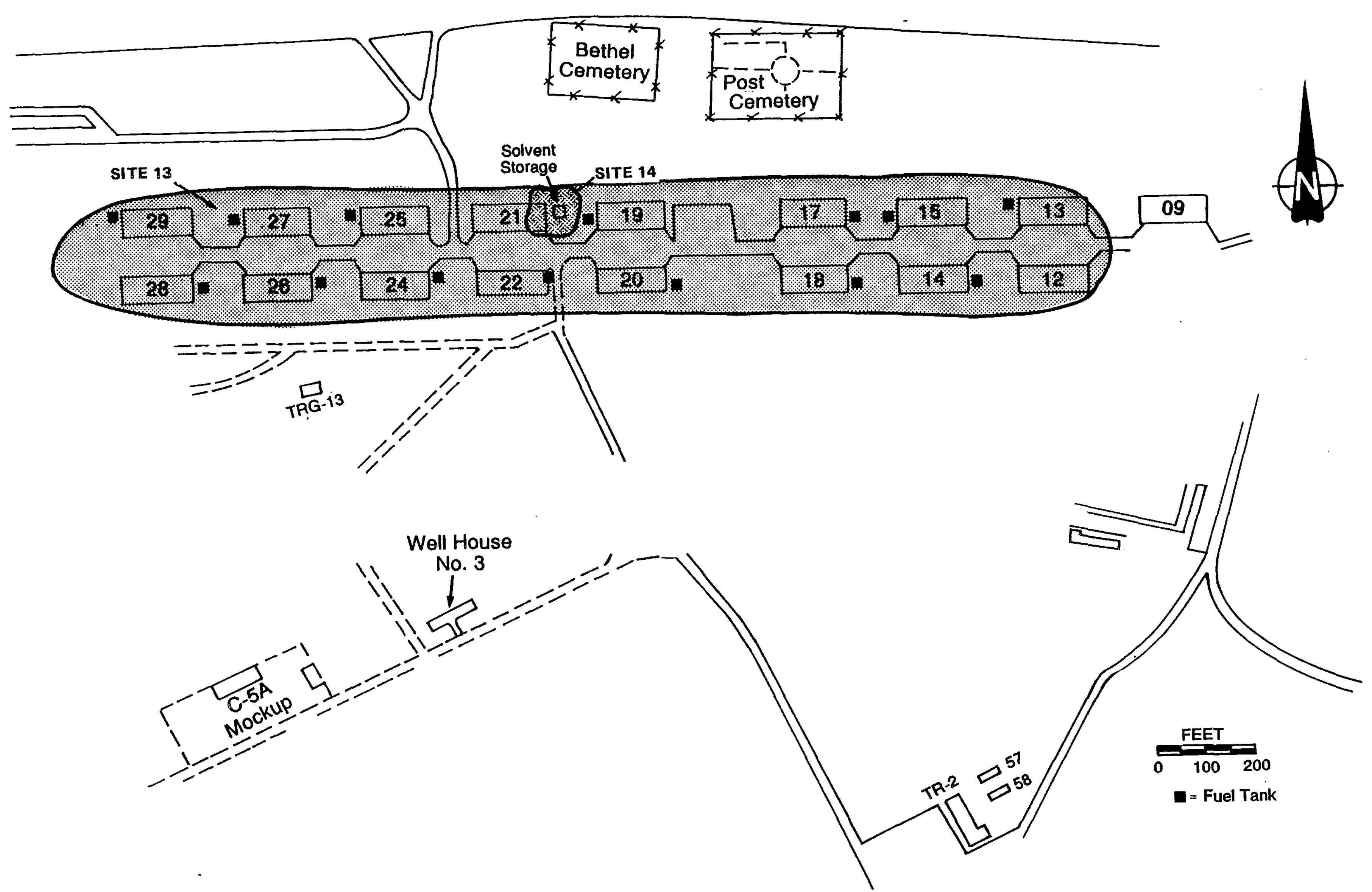


Figure 3-9. UST Site 13 and 14.

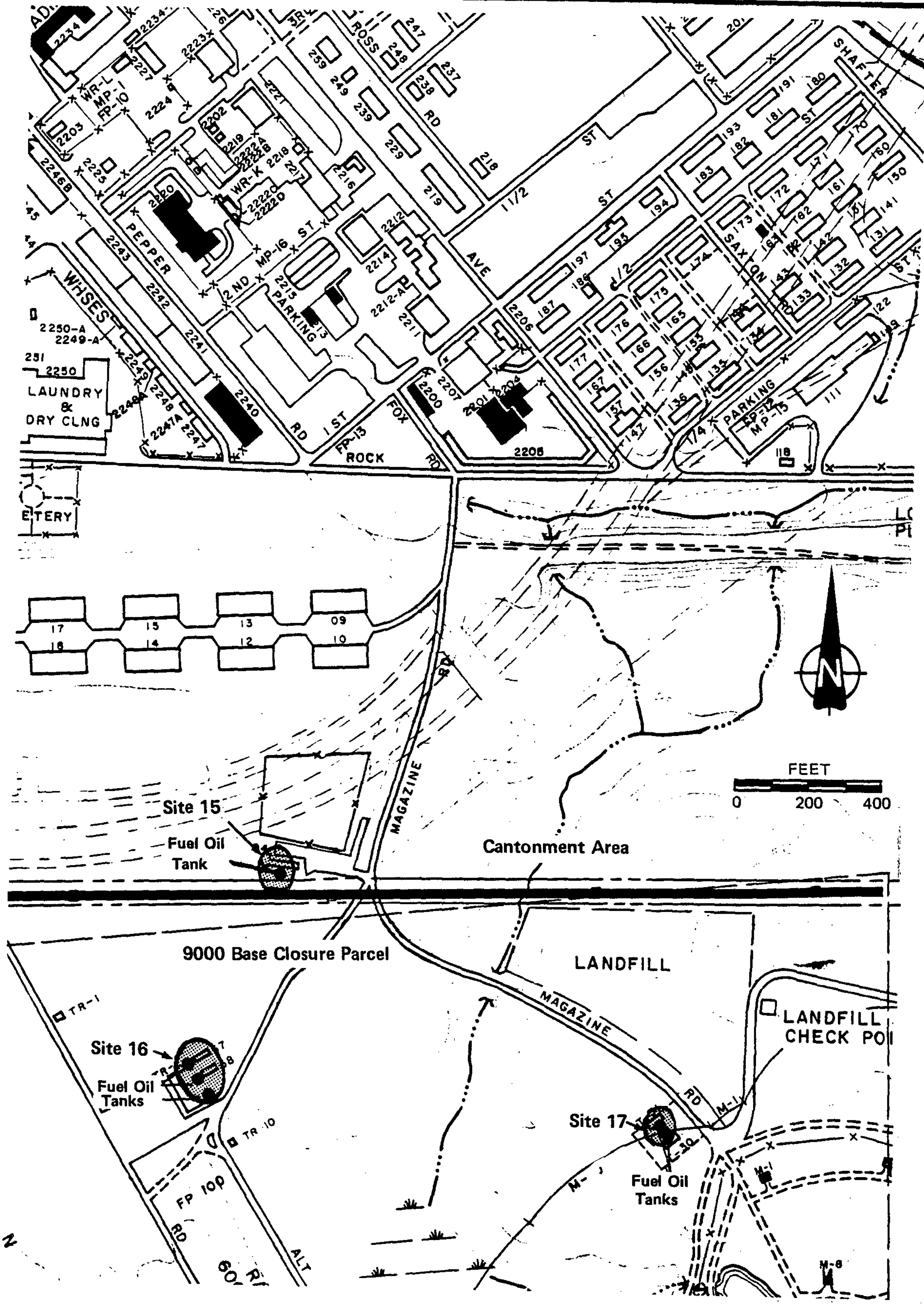


Figure 3-10. UST Site 15, 16, and 17.

3.9.1.4 FP-23, Fuel Storage and Dispensing (Site 10)

Four steel tanks were removed in late January 1990. These included a 10,000-gal aviation gas tank, a 10,000-gal JP-4 tank, and two 20,000-gal JP-4 tanks. The approximate size of the area is 300 ft by 400 ft. Contaminated soil excavated from the site was disposed of at the sanitary landfill on Fort Meade. The actual storage area is surrounded by a fence. Forty soil vapor sampling locations are scheduled inside the fenced area surrounding the site. Soil gas samples will be analyzed for volatile organic hydrocarbons using gas chromatography/FID. The site area is shown in Figure 3-7.

3.9.1.5 Motor Pool Fuel Distributing Area (Site 11)

The motor pool fuel distributing area is located on New Tank Road across from the Post salvage yard. Three 20,000-gal tanks exist at the site, two unleaded and 1 diesel. The tanks currently onsite have been in the ground for approximately 3 years. According to Lee Davis, Branch Chief in charge of the site, these tanks have always had mechanical problems and are believed to be leaking. The area under investigation is approximately 200 ft by 200 ft. A total of 25-30 soil vapor sampling locations are scheduled for this site. Soil vapor samples will be analyzed for volatile organic hydrocarbons using gas chromatography/FID. The site area is shown in Figure 3-8.

3.9.1.6 Building 21 (Site 14)

Building 21 has an underground No. 2 fuel oil tank. There is also a storage shed in which gasoline and various solvents are stored. The potential exists for leakage from the fuel oil tank as well as surface infiltration from spilled solvents and gasoline. The area under investigation is approximately 100 ft by 100 ft. Ten to fifteen soil vapor sampling locations are scheduled for this site. Soil vapor samples will be analyzed for volatile organic hydrocarbons and halogenated organic compounds by gas chromatography/FID, ECD. The site area is shown in Figure 3-9.

3.9.2 Monitoring Well Installation

Additional soil sampling and monitoring wells may be necessary following a review of the soil gas data obtained at these UST sites and the Fire Training Area (see Section 3.7.2.1). As the soil gas surveys are completed, the data will be reduced in the office and preliminary data will be provided to USATHAMA for review. Based on a review of the data and discussions between EA, USATHAMA, and Fort Meade Environmental Office, decisions will be made relative to the need for additional soil sampling, installation of monitoring wells and analytical parameters for ground-water samples.

3.10 ASBESTOS SURVEY

3.10.1 Site Description

There are several structures of various sizes ranging from aircraft storage and maintenance to munitions storage located within the BCP. Included among these are the support facilities at Tipton Army Airfield and the bunker facilities associated with the range facilities. EA will inspect all structures included within the boundary of the investigation area for the presence and condition of asbestos containing materials (ACM) according to the work plan detailed below.

3.10.2 Field Work Plan

3.10.2.1 Building Inspection

EA will carefully review the details of building construction as described in any available plans and specifications. References to any potential asbestos-containing building material (ACBM) will be noted. EA will also review the findings of any previous or current asbestos-related activities and utilize the results as appropriate.

Copies of building floor plans and typical construction cross sections will be obtained, where available, and used during the survey to record the location of sampling areas and sample numbers.

A walk-through inspection of all accessible spaces in the building will be conducted by experienced inspectors. Suspect ACBM will be touched to aid in the identification of the material as friable materials, those materials which may be crushed or pulverized by hand pressure, and non-friable materials. If the material is inaccessible due to height (over 7 ft), access will be obtained via the use of ladders or manlifts.

Each distinct homogeneous area (an area of ACBM that seems by texture and color to be uniform and is assumed to have been applied during the same time period) of suspect ACBM will be identified and assigned a sequential "area number" which will be logged on the building drawing, if available. The location, type of material, general condition, and estimated dimensions of the area will be descriptively detailed on the Building/Structure Survey Form.

3.10.2.2 Sample Analysis

The samples will be analyzed using the technique of polarized light microscopy and dispersion oils, as recommended in the "EPA Interim Method for the Determination of Asbestos in Bulk Insulation Samples" (EPA 600/M4-80-020). AMA Analytical Services, Inc. will perform the primary analysis. Clayton Environmental Consultants will perform the quality control analysis. Both laboratories participate in the NIOSH Proficiency Analytical Testing (PAT) Program and the EPA Quality Assurance Program asbestos Analysis and are accredited by the American Industrial Hygiene Association (AIHA).

3.11 ECOLOGICAL SURVEY

An ecological survey will be conducted in the vicinity of Landfills 1, 2, 3, and 4, the DPDO Salvage Yard, Ordnance Demolition Area, and the Fire Training Area. The purpose of the ecological survey is to document the existing condition of resources in the general vicinity of the referenced facilities.

The ecological survey will include an evaluation of land cover and land use characteristics, vegetation types, wetland areas, potential for wildlife habitat, and an assessment of the presence or absence of state and federally protected Rare, Threatened or Endangered species or habitats. This information, together with the information obtained during the surface water quality survey described in Section 3.8, will provide a sufficient characterization of existing conditions at Fort Meade in the vicinity of the SI sites. The approach used to obtain this information is outlined in Section 6.9, and briefly, is based on aerial photo interpretation coupled with field reconnaissance efforts. Wetland locations will be identified in accordance with the three parameter approach outlined in the Federal Manual (1989). The Rare, Threatened and Endangered Species/Habitat evaluation will be conducted in accordance with standard consultation practices outlined in the Section 7 of the Endangered Species Act.

4. TECHNICAL PLAN - PHASE II REMEDIAL INVESTIGATION SITES

12 s }
5 d } Phase I
5 s }
1 d } Phase II

23 wells installed by Thoma

4.1 ACTIVE SANITARY LANDFILL

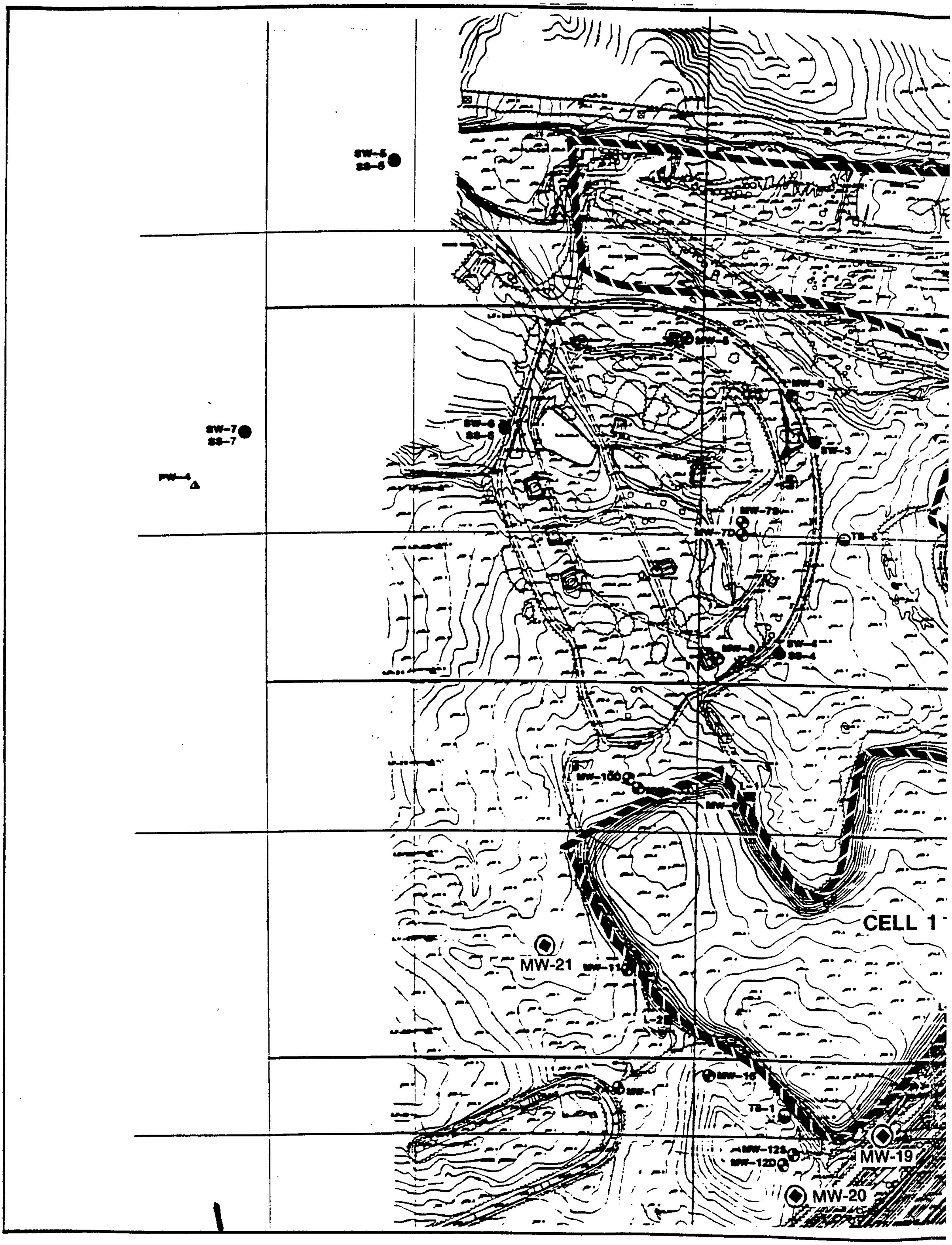
4.1.1 Site Description

The Active Sanitary Landfill (ASL) is located along the eastern boundary of the military reservation and consists of approximately 130 acres (see Figure 1-2). This landfill was opened in 1958 and operated utilizing the trench-fill method until 1976. At that time, the trench-fill method had consumed all of the landfill area, and the area-fill method was initiated. The surrounding land use consists of an inactive ammunition bunker area to the west, firing ranges to the south, the town of Odenton and an offpost trailer park to the east, and Meadedale, a small post community, to the north. Amtrak and Baltimore and Ohio (B&O) rail lines are located along the east boundary of the Sanitary Landfill area. Refuse disposed of in the landfill generally consists of mixed residential, commercial, administrative, and nonhazardous industrial wastes. The landfill topography and existing and proposed sampling locations are shown on Figure 4-1.

Recent topographic maps and interviews with landfill operating personnel have indicated that two 10-ft lifts have been placed on the trench-fill area in Cell 1. Cell 2 is the active fill area, and two 10-ft lifts have been placed on a portion of Cell 2. The waste is being placed in Cell 2 from east to west. In Cell 3, no additional lifts have been placed above the trench-fill material.

4.1.2 Previous Investigations

Prior to EA's Remedial Investigation study at this site, four 4-in. monitoring wells and two 2-in. wells were in place around the landfill perimeter. Analytical results from ground-water samples collected from these wells showed elevated volatile organics in one of these wells (MW-2). An increasing trend of physical parameters was also noted in


SW-5
SS-5
SW-7
SS-7
PW-4
SW-6
SS-6
MW-5
SW-3
MW-7D
SW-4
SS-4
CELL 1
MW-21
MW-1
TB-1
MW-12D
MW-19
MW-20

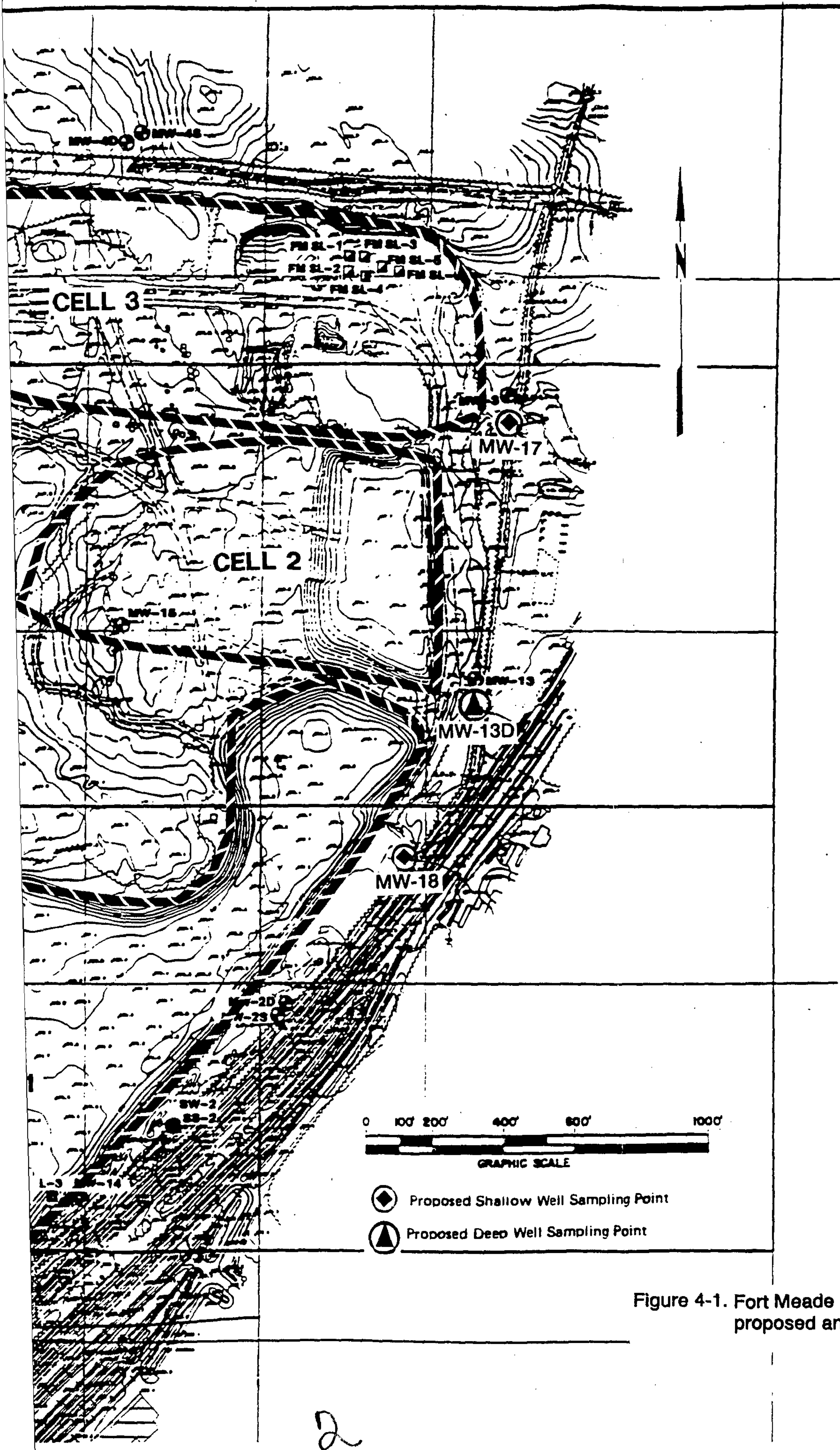


Figure 4-1. Fort Meade active sanitary landfill proposed and exisitng well locations.

a number of wells. This trend plus the elevated volatile organics indicating the potential for degradation of the ground-water quality in the water-table aquifer due to the landfill operations and a need for additional work. The scope of EA's Phase I RI study included installation of 12 shallow and 5 deep monitoring wells around the landfill perimeter. The sampling and analysis plan for this study included (1) collecting ground-water samples from all existing and newly installed wells, (2) surface water and stream sediment sampling, and (3) collection of three leachate seep samples. A review of the data confirmed that the landfill is a source of low level volatile organic contamination in the water-table aquifer. In comparing the data to regulatory criteria (MCL or MCLG) benzene was the only volatile organic compound that exceeded these criteria. The MCL for benzene is 5 µg/L and the MCLG is 0 µg/L. These values were exceeded in four wells: MW-9 (6 µg/L), MW-11 (10.7 µg/L), MW-12s (11.8 µg/L), and MW-15 (25.6 µg/L). The analytical results obtained from the analysis of leachate sample, L-1, showed elevated levels of six volatile organic compounds, including acetone (37.0 µg/L), 1,2 dichlorobenzene (9.8 µg/L), benzene (7.69 µg/L), ethylbenzene (27.1 µg/L), toluene (5.8 µg/L) and total xylenes (74.0 µg/L).

4.1.3 Field Work Plan

The objective of EA's Phase II RI study is to provide further site characterization and further address the degree and extent of contamination that was documented in the Phase I RI study and previous investigations. The Phase I RI study specifically indicated that more information was needed to assess the extent of contamination along the southeast-east boundary. In addition monitoring of the existing and new wells should continue to provide a more complete data base for a feasibility study at the ASL.

The scope of EA's Phase II RI study will consist of the installation of six monitoring wells (five shallow and one deep) downgradient of Cell 1 and along the southeast-east fill boundary. Of these new wells MW-17, MW-18, MW-19, MW-20 and MW-21 are to be completed in the water-table aquifer. MW-17 is being installed as a replacement well for MW-3. MW-3 is a previously installed well that is usually dry and is no longer functioning properly as a monitoring point. The other shallow wells are located along the southeast-east boundary to provide additional geologic and ground-water quality data along this boundary. MW-13D is being installed as a deep well next to MW-13S to provide additional site coverage for monitoring the deeper confined aquifer in this area. Following installation, ground-water samples will be collected from all the wells and analyzed for the full TCL list of parameters. The list of sample designations for this site is provided in Table 5-3.

Ground-water samples will also be collected from two potable wells, PW-4 and PW-5 for analysis. These wells are completed at depths in excess of 600 ft. in the Patuxent formation and the analytical results will provide information on the ground-water quality in this aquifer. The locations of these wells are shown on Figure 1-2. In addition to these wells a ground-water sample will be collected from Cc40, an observation well installed by the U.S. Geological Survey. This well is located south of the landfill and is completed in the lower Patapsco formation at a depth of 238 ft. The analytical results obtained from this sample will provide additional information on the ground-water quality in the lower Patapsco formation in a down gradient direction.

The three leachate seep sample locations that were sampled in the Phase I RI study will be resampled during this study. These locations are shown on Figure 4-1. They are positioned around the perimeter of Cell 1. These samples will be analyzed for the full TCL list of parameters.

Three background soil samples will be collected from areas on Fort Meade to use as a comparison to conduct the risk assessment evaluation. The areas chosen will be at a distance from any potential contaminant source areas. These samples will be analyzed for the full TCL list of parameters.

4.1.4 Landfill Gas Monitoring

EA will conduct SVCA sampling and analysis (methane and chlorinated organics) in three areas at this site, Cell 1, Cell 3, and the perimeter of the site. Cell 2 is not included because this is still an active cell. Cell 1 is closed and because of its proximity to the installation boundary poses the greatest potential for landfill gas emission and horizontal migration offsite in the soil. The perimeter wells will be sampled to determine the potential for offsite migration of landfill gas in the soil. A 200 ft grid will be used for sampling.

In order to asses the effect of the landfill gas contamination on the atmosphere, a passive soil gas sampling procedure will be employed. This procedure is discussed in detail in Section 6.8. In general, this procedure utilizes an absorbent activated-charcoal sampler that is buried at a shallow depth (1 to 3 ft) and is capable of collecting volatile organic compounds from the soil gas emanating from the landfill. These samplers will be solvent desorbed and analyzed for purgeable halocarbons and aromatics by EPA methods 601 and 602. From these results emission rates will be calculated. Table 6-1 is a list of the compounds that will be included in the analysis of these samplers. Five to fifteen passive soil gas samples are scheduled for burial and subsequent laboratory analysis. The locations of the passive samplers will be selected based on the soil gas survey for methane.

4.2 CLEAN FILL DUMP

4.2.1 Site Description

The Clean Fill Dump (CFD) shown on Figure 4-2 was designed to be used by the U.S. Army to accept waste that primarily consisted of construction and demolition rubble. This site was used by the Army from 1972 to 1985. An Army Environmental Hygiene Agency (AEHA) study on the CFD noted that many of the excluded types of waste had been observed at the CFD. This site encompasses approximately 15 acres and is located in a remote area of the installation near the eastern Fort boundary. The CFD is surrounded by upland wooded areas on the north, south, and east, and by a low-lying marshy area to the west.

Over the years some uncontrolled dumping has occurred very near the CFD site along Boundary Road due somewhat to the remote location. Recent efforts have been taken to control this unauthorized dumping through installation of a gate on Boundary Road. The waste dumped in this area has recently been covered with soil and a gate has been installed along Boundary Road to control access to this area from off-post.

Surface topography slopes to the southwest and south towards the marshy area to the west and the Little Patuxent River located near the southern boundary of the site.

4.2.2 Previous Investigation

The scope of the previous study involved installation of one upgradient (CFD-1) and three immediately downgradient wells (CFD-2, 3, 4) with one additional downgradient well (CFD-5) located further from the site. A surface water sample (CFD-SW-1) was collected from a small stream located downgradient of the CFD.

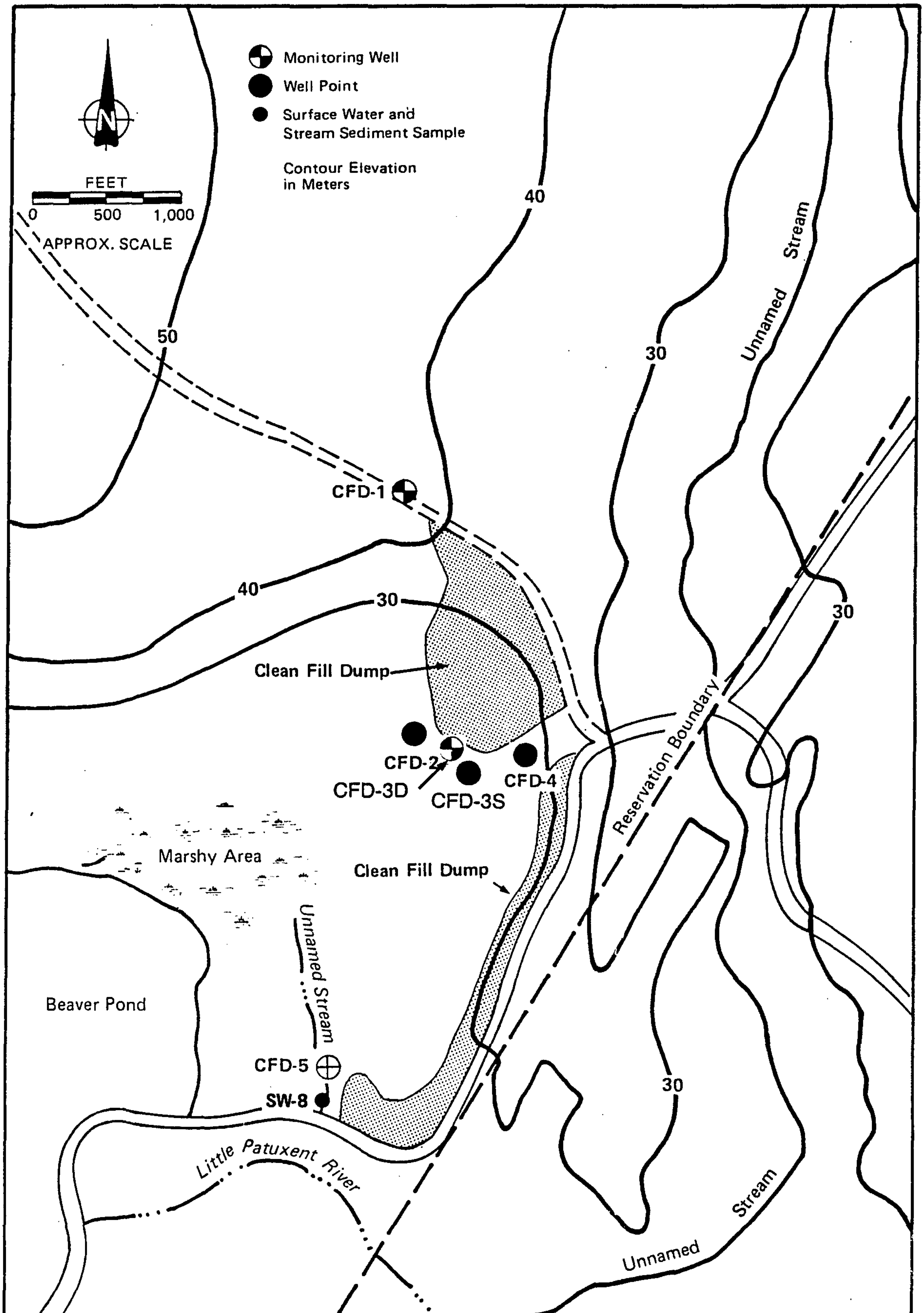


Figure 4-2. Clean Fill Dump site map.

The analytical results from ground-water samples collected from the monitoring wells indicated that one well, CFD-3, had elevated levels (7.0 ug/L) of trichloroethylene (TCE) and (54.0 ug/L) tetrachloroethylene (PCE). The surface water sample analytical results did not show any elevated levels of contaminants.

4.2.3 Field Work Plan

The objective of the work to be conducted at this site as part of this project involves installation of a deep well (CFD-3D) as a cluster companion to CFD-3S to collect additional data to assess the potential for the vertical migration of the contaminants detected. Ground-water samples will be collected for analysis from all existing wells and the newly installed well. A surface sediment sample will be collected from the small tributary where the surface water sample CFD-SW-1 was collected during the Phase I RI study. All samples will be analyzed for the full TCL list of parameters.

4.3 ECOLOGICAL ASSESSMENT OF REMEDIAL INVESTIGATION SITES

As part of the remedial investigation, an ecological assessment of the Clean Fill Dump and the Active Sanitary Landfill areas will be conducted. EA proposes to use existing information from the Base Environmental Office and various reports to describe the existing conditions for land cover/land use, vegetation types, and wildlife habitat. A series of maps will be developed based on existing aerial photographs to document the distribution of terrestrial habitat types in the vicinity of the areas of concern. Field reconnaissance will conducted to ground truth the aerial photo interpretation and develop accurate descriptions of the existing resources in these vicinities. A description of potential beneficial and adverse environmental effects relating to base closure and remediation activities will be included.

EA proposes to use all existing information coupled with aerial photo-interpretation and field reconnaissance to more accurately represent the spatial distribution of wetlands in the vicinity of the areas of concern on the base. Specifically, the distribution of non-tidal wetlands in the immediate vicinity of the Clean Fill Dump and Active Sanitary Landfill will be ascertained using the three-parameter approach described in the Federal delineation manual (1989).

EA proposes to conduct a Phase I evaluation of the presence of State or Federally listed Rare, Threatened, and Endangered species on the 9,000-acre site.

While EA is aware of several plant and animal species present on site which are considered rare or threatened by the Maryland Natural Heritage Program, we propose to concentrate only on the distribution of those species which involve Federal or State listed species subject to protection from existing regulatory structure (e.g., Section 7, Endangered Species Act).

This effort will require three tasks. First, the gathering of existing information regarding the distribution of Rare, Threatened, and Endangered species onsite. Consultation with Federal and State rare, threatened, and endangered species programs is included in this task. Second, the site's unique habitat characteristics present (and their distribution) and the particular characteristics of the Rare, Threatened, and Endangered species thought to occur on the site or considered likely to occur on the site will be evaluated. This evaluation will permit EA to develop the most efficient subsampling approach to conducting detailed field surveys during the times when identified species are likely to occur/be observed in their particular habitat types. If any Rare, Threatened, and Endangered species are located, they will be described in detail and located on a quadrangle sheet using appropriate methods. At such a time as rare, threatened, and endangered species are found, the Section 7 consultation process required by the Act will need to be discussed in regard to the need for escalation to the Biological Assessment and Biological Opinion level at the Fish and Wildlife Service.

The final task would include the tasks necessary to prepare a written description of EA's methodologies, findings, agency position, and beneficial and adverse effects to the resource from the operations of the site and proposed remediation sites.

5. SUMMARY OF ANALYTICAL PROGRAM

5.1 ANALYTICAL METHODS AND PARAMETERS

Hittman-Ebasco Laboratories will provide analytical services for this project under subcontract to EA. Hittman-Ebasco is a USATHAMA certified laboratory and will use USATHAMA approved analytical methods to conduct the analyses. The Quality Assurance Plan for this project provides additional specific information on the analytical laboratory certification and methods for this project. The analytical parameters were selected from the Target Compound List (TCL) of parameters relative to the contaminants of interest at the respective sites. Table 5-1 is a list of the TCL analyte groups and the certified reporting limits for each parameter. Table 5-2 summarizes the field sampling plan described in Sections 3 and 4. Table 5-3 is a list of the sample designation numbers and associated analytical parameters for each site.

5.2 QUALITY CONTROL SAMPLES

For each ground-water sampling event that involves sampling on consecutive days in the same week using the same vehicle and sampling gear, a field blank and trip blank will be collected. The field blank will be analyzed for the full TCL and the trip blank will be analyzed for volatile organics only. Rinsate blanks will be collected when soil samples are collected for analysis. These blanks will be collected by pouring distilled water over the sampling gear and into the sample container, and transferring the water into the rinsate blank sample. The rinsate blank sample will be analyzed for the full TCL list. A water matrix trip blank will also be used during soil sampling events and analyzed for volatile organics.

TABLE 5-1 CERTIFIED REPORTING LIMITS (CRL) FOR CERTIFIED COMPOUNDS AND DETECTION LIMITS FOR NON-CERTIFIED COMPOUNDS ON TARGET COMPOUND LIST

Inorganic
Group A - Metals

	Water (µg/L)			Soil (µg/L)		
PARAMETER	METHOD NUMBER	IDL OR CRL	URL	METHOD NUMBER	IDL OR CRL	URL
Aluminum	SS08	504	4500	JS09	1140	4500
Antimony	SD15	5.64	120	204.2	0.68	*
Arsenic	SD14	6.92	100	JD12	0.68	10
Barium	SS08	23.3	200	JS09	7.9	20
Beryllium	SS08	27	500	JS09	0.684	5.0
Cadmium*	213.2	2.8	*	213.2	0.56	*
Calcium	SS08	286	1000	JS09	83	1000
Chromium*	218.2	2.2	*	218.2	0.44	*
Cobalt	SS08	31.6	500	JS09	4.47	500
Copper	SS08	51.8	200	JS09	4.56	20
Iron	SS08	90.8	500	200.7	2.62	*
Lead	SD14	4.5	50	JD12	1.38	10
Magnesium	SS08	207	5000	JS09	135	5000
Manganese	SS08	47.6	200	JS09	46.7	200
Mercury	SB12	1.83	20	JB10	0.1	1.0
Nickel	SS08	28.2	1500	JS09	2.66	150
Potassium	SS08	898	2500	JS09	252	2500
Selenium	SD14	3.15	100	JD12	1.34	10
Silver	SD14	0.99	10	JD12	0.125	2.0
Sodium	SS08	576	6000	JS09	73.1	580
Thallium*	279.2	3.5	*	279.2	0.7	*
Vanadium	SS08	53.6	1000	JS09	2.89	80
Zinc	SS08	54.8	200	JS09	5.64	20
GROUP A - Non-Metals						
Cyanide	TY09	10.7	100	KY06	9.38	100

* - NON-CERTIFIED, NO URL PROVIDED

TABLE 5-1 (Cont.) - VOLATILE ORGANICS

	Water (µg/l)		Soil (µg/g)	
	METHOD#	UM23	METHOD#	LM22
	CRL	URL	CRL	URL
Group B-Purgeable Organics				
Benzene	1.5	100	.38	40
Carbon tetrachloride	2.4	100	.45	40
Chlorobenzene	1.7	100	.46	40
1,2-Dichloroethane	6.8	100	1.6	40
1,1,1-Trichloroethane	2.0	100	.45	40
1,1-Dichloroethane	2.2	100	1.1	40
1,1,2-Trichloroethane	1.5	100	.41	40
1,1,2,2-tetrachloroethane	3.0	100	.69	40
Chloroethane	2.0	100	1.6	40
2-Choroethylvinyl ether	28	100	.39	40
Chloroform	1.5	100	1.8	40
1,1-Dichloroethylene	1.7	100	10	40
trans-1,2-Dichloroethylene	2.5	100	2.2	40
1,2-Dichloropropane	1.6	100	.37	40
1,3-Dichloropropene (cis and trans)	17	100	.46	40
Ethylbenzene	2.4	100	.50	40
Methylene chloride	26	100	8.5	40
Chloromethane	1.8	100	2.5	40
Bromomethane	10	100	.01	40
Bromoform	24	100	.48	40
Bromodichloromethane	1.5	100	.45	40
Fluorotrichloromethane	3.2	100	2.1	40
Chlorodibromomethane	2.1	100	.45	40
Tetrachloroethene	2.3	100	.37	40
Toluene	1.7	100	.43	40
Trichloroethene	2.9	100	1.7	40
Acetone	10	*	10	*
Carbon disulfide	5	*	5	*
2-Hexanone	10	*	10	*
2-Butanone	10	*	10	*
4-Methyl-2-Pentanone	10	*	10	*
Styrene	5	*	5	*
Vinyl Acetate	10	*	10	*
Total Xylenes	15	*	15	*
Vinyl Chloride	29	100	2.3	100

* - NON-CERTIFIED, NO URL PROVIDED

NON-CERTIFIED ANALYSES SHOULD BE REFERENCED BY
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TABLE 5-1 (Cont.) - SEMI-VOLATILE ORGANICS

	Water (µg/l)		Soil (µg/g)	
	METHOD# CRL	UM22 URL	METHOD# CRL	LM21 URL
Group C - Base/Neutral Extractables				
Bis (2-chloroethyl) ether	2.8	30	0.28	5
1,3-Dichlorobenzene	4.1	30	0.18	5
1,4-Dichlorobenzene	3.9	30	0.22	5
1,2-Dichlorobenzene	3.6	30	0.51	5
Bis(2-chloroisopropyl)ether	2.7	30	0.20	5
Hexachloroethane	7.4	30	0.87	5
N-Nitroso-di-n-propylamine	3.4	30	0.43	5
Nitrobenzene	2.6	30	0.32	5
Isophorone	4.1	30	1.00	5
Bis(2-chloroethoxy)methane	2.5	30	0.45	5
1,2,4-Trichlorobenzene	7.3	30	0.29	5
Naphthalene	2.7	30	0.28	5
Hexachlorobutadiene	9.7	30	0.22	5
Hexachlorocyclopentadiene	10	30	1.80	5
2-Chloronaphthalene	3.6	30	0.35	5
Acenaphthylene	2.1	30	0.40	5
Dimethyl phthalate	7.9	30	0.40	5
Acenaphthene	2.4	30	0.41	5
Fluorene	2.7	30	0.38	5
Diethyl phthalate	18	150	0.45	5
2,4-Dinitrotoluene	4.9	30	0.33	5
2,6-Dinitrotoluene	4.0	30	0.65	5
4-Chlorophenyl phenyl ether	62	150	0.55	5
N-Nitrosodiphenylamine	4.0	30	0.55	5
4-Bromophenyl phenyl ether	33	150	0.40	5
Hexachlorobenzene	2.6	30	0.57	5
Phenanthrene	3.1	30	0.42	5
Anthracene	2.8	30	0.44	5
Di-n-butyl phthalate	4.1	30	0.85	5
Fluoranthene	1.5	150	1.30	5
Pyrene	3.1	1	0.41	1
Butyl benzyl phthalate	4.5	30	1.30	5
Benzo(a)Anthracene	1.6	30	1.70	5
3,3'-Dichlorobenzidine	44	150	0.70	5
Chrysene	2.8	30	0.38	5
Bis(2-ethylhexyl)phthalate	16	30	1.30	5
Di-n-octyl phthalate	10	30	1.00	5
Benzo(a)pyrene	10	30	1.10	5
Indeno(1,2,3-cd)pyrene	16	150	1.80	5
Dibenzo(a,h)anthracene	14	30	1.40	5
Benzo(g,h,i)perylene	8.9	30	1.50	5
Benzo(b)fluoranthene	13	150	1.20	5
Benzo(k)fluoranthene	12	30	1.50	5

TABLE 5-1 (Cont.) - SEMI-VOLATILE ORGANICS

	Water (µg/l)		Soil (µg/g)	
	METHOD#	UM22	METHOD#	LM21
	CRL	URL	CRL	URL
Group C - Base/Neutral Extractables (cont.)				
Dibenofuran	10	*	330	*
2-Methyl naphthalene	10	*	330	*
3-Nitroaniline	50	*	1600	*
2-Nitroaniline	50	*	1600	*
4-Nitroaniline	50	*	1600	*
Group D - Acid Extractables				
Phenol	3.5	150	0.29	5
2-Chlorophenol	3.2	30	0.24	5
2-Nitrophenol	4.2	150	0.38	5
2,4-Dimethylphenol	47	150	0.56	5
2,4-Dichlorophenol	4.5	150	0.35	5
p-Chloro-m-cresol	37	30	0.46	5
2,4,6-Trichlorophenol	5.6	150	0.42	5
2,4-Dinitrophenol	35	150	2.00	5
4-Nitrophenol	23	150	0.42	5
4,6-Dinitro-o-cresol	36	150	1.40	5
Pentachlorophenol	5.8	30	0.49	5
Benzoic Acid	50	*	1600	*
2-Methylphenol	10	*	330	*
4-Methylphenol	10	*	330	*

* - NON-CERTIFIED, NO URL PROVIDED

NON-CERTIFIED ANAYSES SHOULD BE REFERENCED BY
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TABLE 5-1 (Cont.) - PESTICIDES

GROUP E - Pesticides/PCB's

Parameter	Water (µg/l) METHOD# UH15		Soils (µg/g) METHOD# LH12	
	CRL	URL	CRL	URL
Aldrin	0.045	0.100	0.008	0.200
Alpha-BHC	0.050	*	0.008	*
Beta-BHC	0.050	*	0.008	*
Gamma-BHC	0.062	0.400	0.033	0.800
Delta-BHC	0.050	*	0.008	*
Chlordane	0.085	0.400	0.129	0.100
4,4'-DDD	0.003	0.028	0.008	0.100
4,4'-DDE	0.007	0.066	0.008	0.200
4,4'-DDT	0.016	0.025	0.006	0.500
Dieldrin	0.015	0.100	0.006	0.100
Endosulfan I	0.050	*	0.008	*
Endosulfan II	0.100	*	0.016	*
Endosulfan Sulfate	0.100	*	0.016	*
Endrin	0.100	*	0.016	*
Endrin ketone	0.100	*	0.016	*
Heptachlor	0.019	0.100	0.005	0.100
Heptachlor epoxide	0.015	0.250	0.009	0.100
Toxaphene	1.000	*	0.160	*
Methoxychlor	0.500	*	0.080	*
PCB-1016	0.097	1.000	0.039	1.000
PCB-1221	0.500	*	0.080	*
PCB-1232	0.500	*	0.080	*
PCB-1242	0.500	*	0.080	*
PCB-1248	0.500	*	0.080	*
PCB-1254	1.000	*	0.160	*
PCB-1260	0.231	1.000	0.108	1.000

* - NON-CERTIFIED, NO URL PROVIDED

NON-CERTIFIED ANALYSES SHOULD BE REFERENCED BY
THE EPA CLP IFB SOW 7/88

TABLE 5-1 (Cont.) - EXPLOSIVES

GROUP F - EXPLOSIVES BY HPLC

Parameter	Water (µg/l)		Soils (µg/g)	
	METHOD# UW21		METHOD# LW17	
	CRL	URL	CRL	URL
1,3,5-Trinitrobenzene	0.25	50	0.253	25
1,3-Dinitrobenzene	2.62	50	0.188	25
2,4,6-Trinitrotoluene	0.94	100	0.625	50
2,4,-Dinitrotoluene	0.50	10	0.502	50
2,6-Dinitrotoluene	0.50	10	0.334	50
HMX	4.16	100	0.437	50
Nitrobenzene	1.52	20	0.535	100
RDX	1.59	100	0.173	50
Tetryl	3.74	500	3.72	50

TABLE 5-2 FORT MEADE SAMPLING AND ANALYSIS PLAN

	No. of Samples and Matrix					Full TCL				
	G.W.	S.W.	S. Sed.	Leachate	Soil	List	VOA	Metals	Explos.	BN
I. Site Inspection Sites										
Inactive Landfill #1	7	3	3	1		X				
#2	6	3	3	1		X				
#3	8	3	3	1		X				
#4	5	1	1	1		X				
DPDO Salvage Yd	4				2	X				
Ordnance Demolition Area					2				X*	
Fire Training Area					6		X	X		X
Soldiers Lake		2	2			X				
Sewage Treatment Plant #2		3	3			X				
TOTAL	30	15	15	4	10					

* = Plus nitrate/nitrite

TABLE 5-2 (Cont.)

	No. of Samples and Matrix					Soil	Full TCL				
	G.W.	S.W.	S. Sed.	Leachate	Soil	Gas	List	VOA	Metals	Explos.	BN
II. Phase II Remedial Investigation Sites											
Active Sanitary Landfill	29			3	3		X				
Clean Fill Dump	6		1			5-15	X	X			
Quality Assurance											
Field Blank	6						X				
Trip Blank	8							X			
	—	—	—	—	—						
Total	49	0	1	3	3						

36 water 5 soil

7 TCLP

TABLE 5-3 SAMPLE DESIGNATIONS FOR EACH SITE

I. Site Inspection Sites	Sample Designation and Matrix				
	Ground-water	Surface Water	Surface Sediment	Leachate	Soil
Inactive Landfill #1	MW-22S	SW-9	SS-9	L-4	
	MW-22D	SW-10	SS-10		
	MW-23	SW-11	SS-11		
	MW-24				
	MW-25S				
	MW-25D				
	MW-26				
Inactive Landfill #2	MW-27	SW-12	SS-12	L-5	
	MW-28	SW-13	SS-13		
	MW-29	SW-14	SS-14		
	MW-30S				
	MW-30D				
	MW-31				
Inactive Landfill #3	MW-32	SW-15	SS-15	L-6	
	MW-33	SW-16	SS-16		
	MW-34	SW-17	SS-17		
	MW-35				
	MW-36				
	MW-37S				
	MW-37D				
	MW-38				
Inactive Landfill #4	MW-39	SW-18	SS-18	L-7	
	MW-40				
	MW-41S				
	MW-41D				
	COE-3				

TABLE 5-3 (Cont.)

I. Site Inspection Sites	Sample Designation and Matrix				
	Ground-water	Surface Water	Surface Sediment	Leachate	Soil
DPDO Salvage Yard	MW-42				SO-19
	MW-43S				SO-20
	MW-43D				
	COE-1				
Fire Training Area					SO-21
					SO-22
					SO-23
					SO-24
					SO-25
					SO-26
Soldier Lake		SW-19	SS-19		
		SW-20	SS-20		
Sewage Treatment Plant		SW-21	SS-21		
		SW-22	SS-22		
		SW-23	SS-23		
Ordnance Demo.					SO-27
					SO-28
Fort Meade Southeast Boundary		SW-24	SS-24		

TABLE 5-3 (Cont.)

Table 5-3, cont.

II. Phase II Remedial Investigation Sites	Sample Designation and Matrix					
	Ground-water	Surface Water	Surface Sediment	Leachate	Soil	Soil Gas
Active Sanitary Landfill	MW-1			L-1	SO-27	SG-1-15
	MW-2S			L-2	SO-28	
	MW-2D			L-3	SO-29	
	MW-4S					
	MW-4D					
	MW-5					
	MW-6					
	MW-7S					
	MW-7D					
	MW-8					
	MW-9					
	MW-10S					
	MW-10D					
	MW-11					
	MW-12S					
	MW-12D					
	MW-13S					
	MW-13D					
	MW-14					
	MW-15					
	MW-16					
	MW-17					
	MW-18					
	MW-19					
	MW-20					
	MW-21					
	PW-4					
	PW-5					
	USGS-Cc-40					
Clean Fill Dump	CFD-1		SS-8			
	CFD-2					
	CFD-3S					
	CFD-3D					
	CFD-4					

6. FIELD METHODS AND SAMPLING PROCEDURES

6.1 DRILLING PROCEDURES, MONITORING WELL INSTALLATION, AND DEVELOPMENT

The geotechnical procedures to be utilized at FGGM will be in accordance with the Geotechnical Requirements for Drilling, Monitoring Wells, Data Acquisition, and Reports, U.S. Army Toxic and Hazardous Materials Agency (revised March 1987). These requirements are provided in Appendix A. Any discrepancies between these requirements and this Technical Sampling and Analysis (TS&A) plan shall be resolved in favor of this TS&A with USATHAMA approval.

Because of the potential for unexploded ordnance (UXO) to be located all across the Base closure parcel, this plan, in conjunction with the Project Health and Safety Plan, indicates that prior to drilling at all sites on the Base closure parcel, a surface explosive ordnance sweep will be completed by UXB International, Inc., to detect for UXOs. This surface sweep is effective to a depth of 5 ft. Subsurface ordnance clearance will be conducted to a depth of 20 ft as the borehole is advanced.

Materials used during drilling activity, including bentonite (pellets, powder) and filter pack material (No. 2 sand), and appropriate manufacturer's specifications will be submitted to the Contracting Officer for approval prior to any drilling activity. Two samples of the drilling water source will be collected and analyzed, and another sample will be collected at a later date. The drilling water will consist of untreated water obtained from the PW-6 pump house. This well is a part of the Fort Meade potable water distribution system. It is completed in the Patuxent aquifer and draws water from a depth of 600 to 750 feet below land surface.

The proposed drilling program involves the installation of shallow and deep monitoring wells around the perimeter of the four inactive landfill sites, the active landfill, the clean fill dump, and the DPDO salvage area. Shallow monitoring well borings will be drilled utilizing hollow-stem augers to expected maximum completion depths of 30 ft. The deep wells will be installed using mud rotary drilling methods to an anticipated depth range of 70 to 100 ft. A nominal 8-in. diameter borehole will be maintained during drilling for well installation. Soil samples will be collected at 5-ft intervals for the entire boring depth. The sampler will be driven 18 in. with a 140-lb hammer, free falling 30 in., in accordance with ASTM-D 1586-84 specifications. Samples will be collected utilizing a 24-in. long, 2-in. O.D., 1-3/8 in. I.D. split spoon sampler. All split spoon samples will be screened in the field for volatile organic vapors using a photoionization detector (PID), classified in accordance with the Unified Soil Classification System (USCS) and Munsell Color Chart, and logged. The samples will be placed in glass jars, appropriately labeled and retained by EA until final report acceptance. The drill rig, drill tools, and associated equipment will be steam cleaned prior to commencement of drilling at each monitoring well location. All water used to assist drilling operations will be obtained from the approved tested source located on the base.

Upon completion of a boring, monitoring wells as shown on Figure 6-1 will be installed as per the following specifications:

1. All monitoring well casings and screens will be constructed of 4-in. inner-diameter Schedule 40 polyvinyl-chloride (PVC) plastic pipe. Flush joint, threaded casing and screen will be used. No glue or solvents will be used.

2. The screened interval for monitoring wells will consist of 10 ft factory-slotted (0.01-in.) well screen of the same material and diameter as the casing. The screened interval of the shallow wells ($\simeq$ 30 ft depth) will be such that the top of the screen is located approximately 2 ft above the water table. The screen interval for the

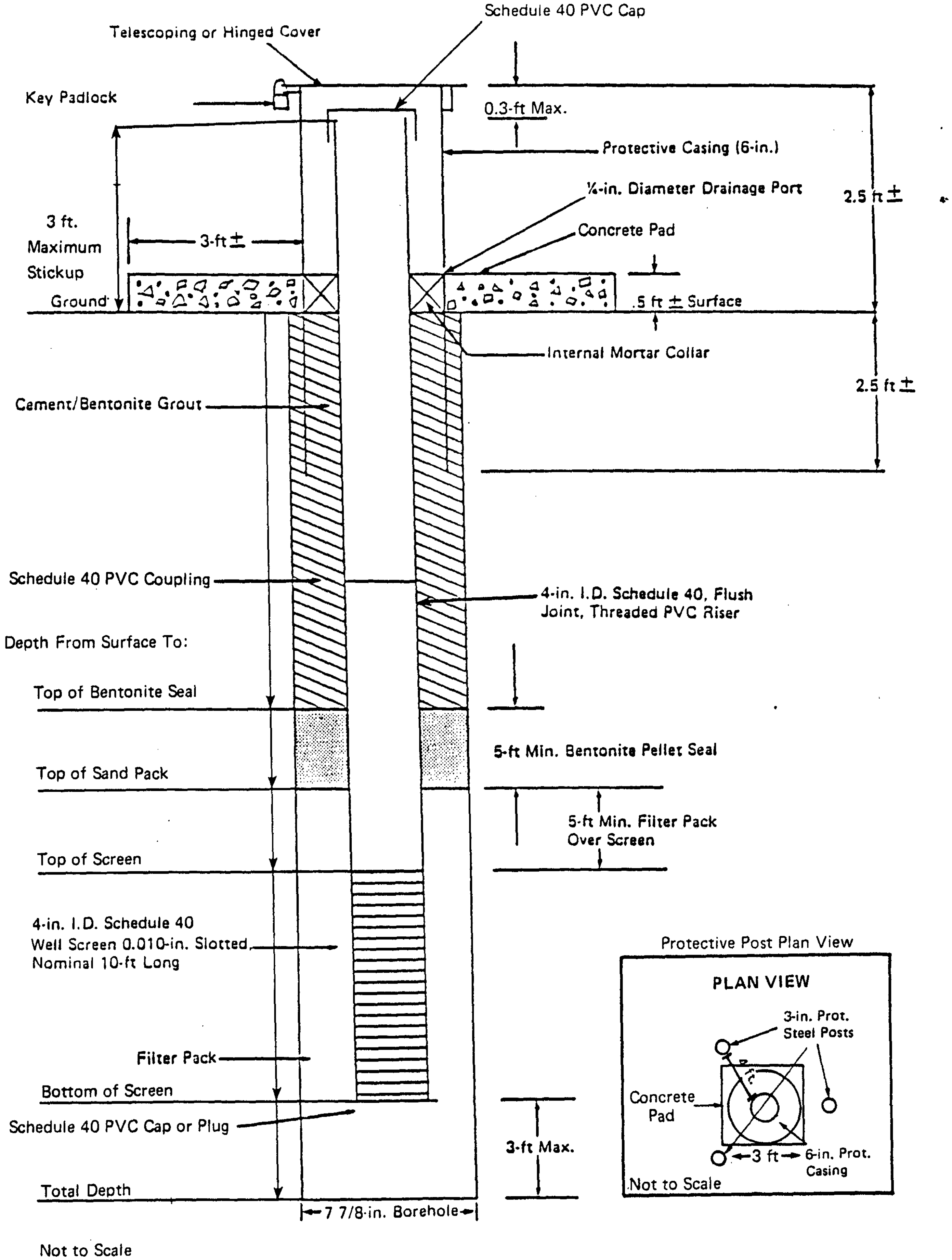

Figure 6-1. Typical overburden monitoring well construction diagram.

deep wells will be set at approximately 60 to 100 ft below grade, depending on stratigraphic conditions. The bottom of the screen will be capped with a PVC cap.

3. All wells shall be filter-packed using a No. 2 quartz sand which has been approved by USATHAMA from the base of the well to a minimum of 5 ft above the top of the screen. An impervious 5-ft seal of bentonite pellets will be installed on top of the sand filter pack material.

4. All wells will be continuously pressure-grouted via tremie pipe from the top of the impervious seal to the ground surface with a 20:1 cement-bentonite grout with a maximum 7 gal of approved water per 94-lb bag of cement.

5. The drilling subcontractor shall be responsible for clearing the boreholes and wells of any fluids or substances which interfere with the free flow of ground water through the well screen. The monitoring wells shall be developed by air lift/surge (pumping and/or bailing may be used in low yield wells). During development, pH, temperature, and specific conductance will be measured for each well volume (nominal) removed and recorded on the boring log (Figure 6-2). Development will continue until a minimum of five well volumes are removed, the water is clear to the unaided eye, and three consecutive pH and conductivity readings do not vary by more than 10 percent. If the well yield is very low and development does not clear up the water in 4 hours, development will be considered complete when the pH and conductivity parameters do no vary by more than 10 percent.

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

LOG OF SOIL BORING

Co-ordinates: ______________________________

____

Surface Elevation: ______________________________

Casing Above Surface: ______________________________

Reference Elevation: ______________________________

Reference Description: ______________________________

JOB NO.	CLIENT	LOCATION

DRILLING METHOD:

BORING NO.

SHEET ___ OF ___

SAMPLING METHOD:

DRILLING

START	FINISH
TIME	TIME
DATE	DATE

WATER LEVEL				
TIME				
DATE				
REFERENCE				

DRILLING CONTR. ______

BY ______ DATE ______ CHK'D BY ______

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/6 in. SAMPLER		DEPTH IN FEET	GRAPHIC LOG	SURFACE CONDITIONS:
	/		/			0		
	/		/			1		
	/		/			2		
	/		/			3		
	/		/			4		
	/		/			5		
	/		/			6		
	/		/			7		
	/		/			8		
	/		/			9		
	/		/			0		
	/		/			1		
	/		/			2		
	/		/			3		
	/		/			4		
	/		/			5		
	/		/			6		
	/		/			7		
	/		/			8		
	/		/			9		
	/		/			0		

Figure 6-2. EA Soil Boring Log

6. All wells will be protected by placement of three 3-in. diameter steel posts filled with grout and radially located 4 ft from an outer 6-in. diameter protective steel casing stick up, properly tagged and flagged or otherwise made visible so that they can be readily located in the field and avoided by onsite equipment. The steel posts will be 5 ft in length and 2.5 ft will be placed in the ground with 2.5 ft above ground. A 3 ft^2, 6-in. thick concrete pad will be constructed around the well casing at ground-level elevation. If the well is installed in a paved area, it will be flush-mounted in a water tight enclosure.

7. All wells will be provided with lockable caps, and will be located by surveying as described in Section 6.6.

8. Hardin-Huber, Inc., a registered Maryland drilling subcontractor will be responsible for performing all drilling and well installation work. This includes the steam cleaning of all tools and well completion materials, other than filter sand and grouting materials, that enter boreholes during the course of work.

9. All water used to assist in drilling operations will be obtained from the Fort Meade potable water supply.

6.2 SURFACE WATER AND STREAM SEDIMENT SAMPLING

Water samples will be collected in pre-cleaned glass or Teflon-lined sample bottles. Immediately after collection, each sample will be apportioned among several bottles or vials, each containing appropriate preservatives (40 CFR 136). Sediment samples will be collected with a small ponar dredge or plastic coring tube and transferred to a clean plastic bag for storage. All water and sediment samples will be stored on ice and delivered to the analytical laboratory within 24 hours of sampling. At each station, water temperature, pH, conductivity, and dissolved oxygen will be measured with a Hydrolab water quality monitor.

6.3 SOIL SAMPLING

Soil samples will be collected for chemical analysis at selected UST sites and at fire training pits. The sampling agent will collect a sample (0-6 ft below surface) at each sampling station. A 4-in. diameter hand auger will be advanced to the top of the subsurface sample interval. The sample will then be collected with a stainless steel trowel or sampling trier and placed in a laboratory-cleaned container. Between each sample taken, all sampling equipment will be cleaned by the following procedure:

1. Wash with detergent.
2. Rinse with deionized water.
3. Air dry.

6.4 ELECTROMAGNETIC SURVEYING

An electromagnetic (EM) survey will be conducted at the four landfill sites. The EM survey data will be used to delineate waste boundaries and selection of monitoring well locations.

EM surveying makes use of time-varying, long-wave, radio-frequency electromagnetic fields induced into the earth. Basically, transmitter and receiver coils are coupled to the subsurface conductor (earth) by electromagnetic induction. The characteristics of electromagnetic wave propagation and attenuation define the electrical conductivities of the subsurface materials within certain limitations. Electromagnetic profiling is especially useful in determining lateral changes in conductivity.

In the past, EM surveys were primarily used in mineral exploration to locate faults, dikes, and other linear structures. More recently, EM surveys have been utilized in engineering and ground-water investigations to locate buried pipes, cables, and buried metallic waste (e.g., 55-gal drums and other metallic containers). EM surveys have also been used to map contaminant plumes at hazardous waste sites. EM surveys are particularly well suited to hazardous waste and engineering studies, since none of the equipment needs to be in contact with the ground surface and data can be gathered rapidly.

EM surveying requires sophisticated equipment which consists of a transmitting coil, a receiving coil, and the system electronics. The transmitter coil is used to induce a current in the subsurface materials, and to transmit a primary field to the receiver. The receiving coil is used to sense the induced field in the subsurface and compare it with the primary field generated by the transmitter. Under certain constraints, the ratio of the induced field to the primary field is linearly proportional to the conductivity of the subsurface materials.

There are two types of EM systems which are commonly used for engineering and ground-water investigations: fixed coil spacing and variable coil spacing. The fixed coil spacing (EM-31) is designed to be operated by a single person consisting of two coils built into a rodlike antenna, roughly 10 ft long, with the system electronics packaged in a single box. This system is limited to a depth penetration of approximately 18 ft, because of the relatively small coil separation, and can only be used for shallow profiling. Variable coil spacing equipment is planned for this project. The EM34-3XL system will be used with the 10-m coil spacing at FGGM. Data will be recorded at a 10-m interval when using the 10-m coil spacing to provide detailed information with respect to the extent of fill materials and the quality of shallow ground water.

In EM profiling, the two coils are held at a selected separation and kept coplanar while a reading is taken. The coils can be maintained in either a horizontal or vertical orientation. In general, for vertical coils, the effective depth of the measurement is equal to about 0.75 of the coil separation (7.5 meters) (approximately 75 percent of the measurement is contributed by the materials at that depth). With the coils held horizontally and coplanar, the effective depth of the measurement is equal to about 1.5 times the coil separation or 15 meters.

To measure terrain conductivity with variable coil systems, the transmitter operator occupies the measurement station and the receiver operator moves the receiving coil until the electronics register a null reading, indicating that the proper coil separation has been achieved. This feature eliminates the necessity of surveying measurement points along the survey line, which also adds to the overall speed of the survey. The terrain conductivity is then read from the receiver. Measuring stations are usually extended well beyond the expected width of a target at intervals that are smaller than the target width by a significant amount. Conductivity is usually reported in units of millimhos per meter (mmhos/m). Mhos/m is the reciprocal of ohm-m (resistivity).

The raw data will be reduced in the office and will be used to delineate the landfill perimeter and assist in selecting drilling locations outside of the fill area.

6.5 GROUND-WATER SAMPLING

Upon arrival at each monitoring well, the sampling agent will thoroughly inspect the well and the immediate area. Well site conditions and any unusual observations will be noted. Particular attention will be paid to evidence of tampering or damage. The agent will then unlock the well and determine the water and well depth using an electronic water level sounder to an accuracy of ±0.01 ft. The water level elevation will be referenced to the surveyed marking on the top of casing. These data will be used to prepare water level contour maps and to calculate the static volume of water in the casing. Next, a clean stainless steel submersible pump will be installed in the well, and a volume of water equal to, at a minimum, five well volumes (casing volume plus saturated filter pack assuming 30 percent porosity) will be evacuated in preparation for sampling. In order to ensure exchange of the entire static water column, the pumping level will be varied throughout the pumping interval. As water is purged, its physical character (i.e., odor, turbidity, and color) will be observed and noted. Evacuated water will be discharged from the well in a downgradient direction to minimize the potential for surface infiltration. Between wells, the pump and associated plumbing will be pressure jetted with clean water. Then, water will be pumped through the system to preclude the potential for cross contamination.

If the well goes dry during pumping or bailing, one is assured of removing all water which had prolonged contact with the well casing or air. If the recovery rate is rapid, allow the well to recover to its original level and evacuate a second time before sampling. If recovery is very slow, samples may be obtained as soon as sufficient water is available.

After the wells have been purged and have recovered, samples will be collected using dedicated (i.e., a separate bailer for each well) laboratory-cleaned, bottom-filling Teflon bailers and new lines. The first aliquot will be used to fill the volatile organic parameter containers (40-ml glass). The second aliquot of water removed will be used to determine pH, temperature, and specific conductance. These determinations will be made with calibrated and standardized instrumentation. Subsequent aliquots will be used to fill containers of appropriate composition containing appropriate preservatives for the parameters of interest (as specified in the QA/QC Plan). Special care will be taken in collecting these samples to ensure that volatile organic constituents are not lost through off-gasing and turbulence. One of the two aliquots for trace metal determinations will be filtered in the field using a 0.45-μ membrane filter prior to preservation. After collection, all sample aliquots will be labeled, security sealed, and placed in secure shipping containers for transport to the laboratory. To ensure sample integrity, all ground-water sampling will be accomplished under the protocol for chain-of-custody and sample handling established in the QA/QC Plan.

6.6 TOPOGRAPHIC SURVEY

Each soil boring and/or well installed under this contract will be topographically surveyed under the overall direction of a Maryland licensed surveyor, to determine its map coordinates using coordinates to within ±3 ft (±1 m).

Elevations for the natural ground surface (not the top of the coarse gravel blanket) and the highest point on the rim of the uncapped well casing (not protective casing) for each bore/well site shall be surveyed to within ±0.01 ft (±0.30 cm) using the National Geodetic Vertical Datum of 1929.

The topographic survey shall be completed as near to the time of last well completion as possible, but no longer than 5 weeks after well installation. Survey field data (as corrected), to include loop closure for survey accuracy, will be included with the final report. Closure shall be within the horizontal and vertical limits given above. These data shall clearly list the coordinates (and system) and elevation (ground surface, top of well, and protective casings) as appropriate, for all borings, wells, and reference marks. All permanent and semi-permanent reference marks used for horizontal and vertical control (e.g., bench marks, caps, plates, chiseled cuts, rail spikes) shall be described in terms of their name, character, and physical location.

6.7 AQUIFER TESTS

In situ hydraulic conductivities will be estimated utilizing a slug test method developed by Bouwer and Rice (1978). This procedure is applicable to fully or partially penetrating wells within a water-table (unconfined) aquifer. In applying this approach, water level data are electronically field recorded by a Hermit Environmental Data Logger, Model SE1000B, which can detect water level change to hundredths of a foot. The data are transferred to an IBM-AT computer and analyzed using a program developed from Bouwer's slug test methodology. This test is proposed to be conducted.

The slug test procedure is as follows. An initial static water level is recorded. A solid slug of known volume is quickly submerged in the well or a filled bailer with known volume is quickly withdrawn from the well at which time an elapsed time count begins. (All materials to enter the well will be thoroughly cleaned with the approved water.) Water levels are then automatically monitored until the well has recovered to not less than 90 percent of the original static level. Elapsed time versus residual water level is then computer graphed and used to calculate hydraulic conductivity (K) according to several empirically derived equations.

Slug tests will be performed after ground-water sampling.

6.8 GAS MONITORING

Soil gas analysis is most commonly used to investigate the spread of volatile organic contaminants from underground sources and is based on the behavior of gases or vapors evaporated from liquids in the subsurface. Vapors from a source migrate from the source through the atmosphere in the soil interstices following a concentration gradient. Once in the gaseous state, the vapor is transported according to Fick's Second Law. Vapor phase transport can be expressed according to the following mathematical expression:

$$\frac{\partial C}{\partial t} = D \frac{\partial^2 C}{\partial y^2} - V \frac{\partial C}{\partial y}$$

where:

- C = gaseous constituent concentration
- t = time
- D = diffusion coefficient
- y = distance
- V = interstitial gas velocity

Transport of vapor in the soil interstices is a diffusion-dominated process. While this expression is an oversimplification in that it addresses only one dimension, it is nevertheless valid to illustrate the process. The soil vapor survey is carried out by driving a sampling probe into the subsurface in a pattern that will generate data to meet the investigation objectives. After the probe has been driven and sealed (generally to a depth of 2 to 5 feet), a vacuum is applied to the distal probe end and gas is withdrawn and discharged to waste until a near-steady state condition is established. After near-steady state conditions have been established, an aliquot of gas is collected and introduced into an appropriate detection device. The detection device is selected based on the compounds of interest at the subject site. The options include gross contaminant indicators, selective detector gas chromatographs, and gas chromatograph/mass spectrometers. In soil vapor surveys it is generally desirable to generate data as near real time as possible so that more definitive sampling and follow-up can be implemented in a timely fashion. One of the primary advantages of the technique is that it yields results quickly so that assessments or plans for additional data gathering can be developed quickly.

The SVCA technique will be used in areas suspected of contributing volatile organic contamination to the ground water or vadose zone. The two major groups of volatile organic contaminants identified are hydrocarbons and chlorinated organics. Those areas which have been previously identified or which are suspected of containing these contaminants are given in Table 3-1.

Apart from the sites listed in Table 3-1, the SVCA technique will also be applied to areas suspected of having landfill gas contamination. The Active Sanitary Landfill detailed in Section 3, will be assessed for methane, hydrocarbons, and chlorinated organics. Together, these contaminants comprise the soil gas compound list, Table 6-1.

Whether a site will be investigated for methane, hydrocarbon, chlorinated organic contamination, or a combination thereof (Table 6-1) does not essentially alter the SVCA procedure.

In order to assess the effect of the landfill gas contamination on the immediate atmosphere, a passive soil gas sampling technique will be employed in addition to the (active) SVCA.

In passive sampling, an absorbent activated-charcoal sampler is buried at a shallow depth (1-3 ft) and allowed to collect VOCs from the soil atmosphere. SVCA data will be used to assess the optimal positions for passive sampler burial. After a set time (8 hours to two weeks) the sampler is retrieved and transported to a laboratory for analysis. Passive soil-gas samplers will be solvent desorbed and analyzed for purgeable halocarbons and aromatics by EPA methods 601 and 602 respectively. The data obtained will be used to assess a VOC emission rate from the landfill areas.

The passive soil-gas sampling technique will be employed (as determined by the SVCA data) at the active sanitary landfill. Five to fifteen passive soil gas samples are tentatively scheduled for burial and subsequent analysis. A minimum of one duplicate passive soil-gas sample will be obtained per 6 samples. Since the object of the passive soil-gas sampling technique is to assess the landfill gas emission rate. No soil-gas depth profile will be obtained by the passive sampling technique.

TABLE 6-1 SOIL GAS COMPOUND LIST

Target Compound	Abbreviation	Site Type
1. Hydrocarbon		
benzene	B	UST/Landfill
toluene	T	UST/Landfill
ethylbenzene	E	UST/Landfill
meta and para - xylene	m+p-X	Landfill
ortho-xylene	o-x	UST/Landfill
2. Methane	M	Landfill
3. Chlorinated Organics		
1,1,1 - trichloroethane	TCA	UST/Landfill
trichloroethene	TCE	UST/Landfill
tetrachloroethene	PCE	UST/Landfill
methylene chloride	MC	Landfill
carbon tetrachloride	CT	Landfill
trans -1,2 - dichloroethene	t-DCE	Landfill
cis - 1,2 - dichloroethene	c-DCE	Landfill

The SVCA sampling is conducted by a two-person EA team. Upon arrival at the site, a grid is established using a tape and visual sitings. Underground utilities (other than private site-owned) are marked by a utility locating service. After the grid has been established, the sampler is driven to a depth of 2-12 ft. In areas covered with asphalt or concrete, 1-in. holes are first drilled through the pavement to allow access to the subsurface. In all instances, special care is taken to ensure that the sampler is seated such that aspiration of ambient air is precluded. Figure 6-3 shows the configuration of the soil gas sampling apparatus.

After the sampler is firmly seated, a vacuum source is applied to the exposed end of the probe, and the system is pumped until a near-steady state is attained. This generally requires 2-4 minutes. During purging, soil resistance to vapor flow is measured, via an in-line vacuum gauge, and recorded. Steady-state conditions are not easy to determine in a practical sense. The object is to have soil vapor enter the sampling probe in the soil.

The vacuum gauge is useful in determining if vapors are entering the probe from the subsurface. If the vacuum gauge shows essentially no reduction in pressure after the vacuum pump is activated, vapors are being readily obtained and the system need only be purged for about 1 minute. This will purge a surplus of probe and sampler volumes. If a significant reduction of pressure is observed (e.g., 15 in. Hg vacuum) but the pressure returns to atmospheric fairly quickly after closing the sampling valve, a longer pumping time of 3-5 minutes would be adequate. If when the valve is closed the pressure does not noticeably increase in 30 seconds, soil vapor is not adequately entering the probe and sampling apparatus. In this case, a soil vapor sample cannot be obtained by active pumping. If soil vapor cannot be obtained from the driven probe at different depths, one additional probe will be driven in the immediate vicinity to try to obtain a soil vapor sample. If, after two attempts have been made, and a soil vapor sample cannot be obtained, the probes will be abandoned and the sampling location will be marked accordingly.

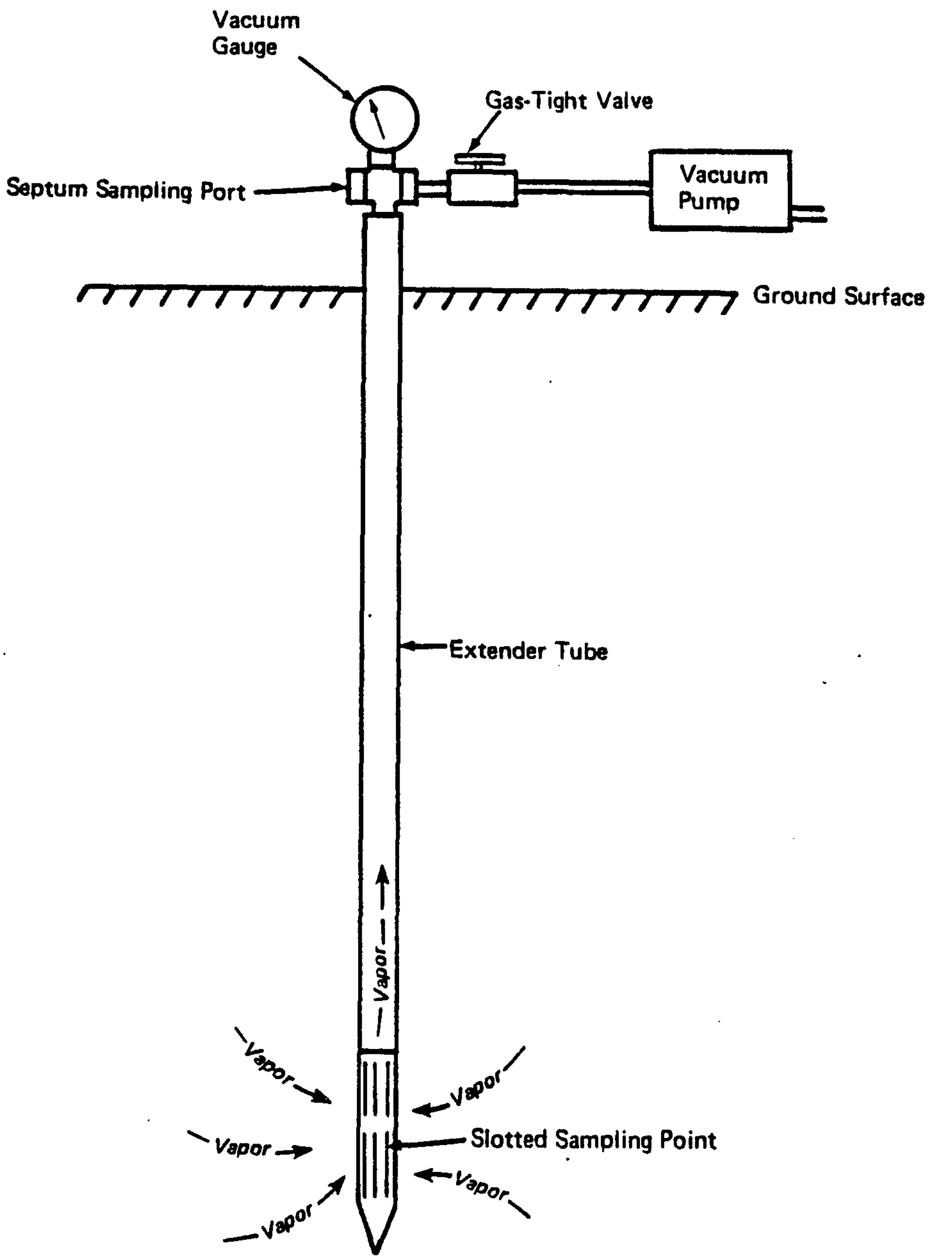

Figure 6-3. Soil gas sampling apparatus.

A minimum of one vertical profile will be conducted at each site under investigation. Vertical profiling will aid in delineating a three-dimensional scenario of the contamination. Final depth can be dependent upon probe refusal or water. Ground water in the area is estimated to be between 6 and 11 ft. In any event, vertical profiling will not exceed 15 ft.

After near-steady state conditions are reached in the ground probe apparatus, samples are collected for analysis. Clean, gas-tight syringes will be used to collect samples for compound-specific identification and quantification using gas chromatography (GC). The GC operating parameters for each contaminant group identified are detailed in Table 6-2.

Vapor samples will be analyzed onsite for the target compounds by means of a gas chromatograph interfaced with a data station. The programmable gas chromatograph will be equipped with both a flame ionization detector (FID) and an electron capture detector (ECD) and will have dual column capability. The FID, which is utilized for the detection of hydrocarbons (including methane), responds specifically to compounds that will yield a carbon skeleton which can be oxidized when introduced into an air/hydrogen flame. Therefore, it is sensitive to all organic compounds except formaldehyde and formic acid.

Soil vapor samples tend to contain many compounds. When a sample is injected into the gas chromatograph, compounds are first separated by an appropriate analytical column. As the separated compounds elute from the GC column, they enter the air/hydrogen flame where they become ionized. The resulting ions attach to an electrode which increases the signal current. The signal is then amplified, integrated, and reported as a chromatographic peak.

The ECD is utilized for the detection of halogenated organic compounds. The ECD is sensitive and selective for halogenated compounds. High-energy electrons from an electron emitter (Nickel 63 or tritiated

TABLE 6-2 GAS CHROMATOGRAPH OPERATING CONDITIONS

I. Operating Conditions for Halogenated Organic Analysis

Gas Chromatograph:	HNU 421 or Varian 3300
Column:	6 ft ss, 10% SP-2100
Carrier Gas:	High-purity nitrogen, 30 cc/min
Make-up Gas:	High-purity nitrogen, 60 cc/min
GC Operating Temperatures:	Oven programmed at 60 C for 3 minutes, then 60 to 160 C at a rate of increase of 10 c/minute. Hold at 160 C for 10 minutes.
Injection Port Temperature:	175 C
Detector:	Electron Capture Detector (ECD)
Detector Temperature:	250 C
Calibration Compounds:	TCA -(10.2 ppm-landfill) (11.0 ppm-UST)
	TCE - (5.6 ppm-landfill),(6.57 ppm-UST)
	PCE - (1.6 ppm-landfill), (1.53 ppm-UST)
	MC -(172 ppm-landfill)
	CT - (4.0 ppm-landfill)
	E-DCE - (351 ppm-landfill)
	C-DCE-(162 ppm-landfill)

II. Operating Conditions for Hydrocarbon Analysis

Gas Chromatograph:	HNU 421 or Varian 3300
Column:	10 ft ss
Carrier Gas:	High-purity nitrogen, 30 cc/minute
Operating Temperatures:	Column, programmed at 60 C for 3 minutes, then 60 C to 160 C at a rate of increase of 10 c/minute. Hold at 160 C for 10 minutes.
Injection Port Temperature:	180 C
Detector:	Flame Ionization Detector (FID)

TABLE 6-2 (Cont.)

Calibration Compound(s):	B - (21 ppm-landfill), (16.7 ppm-UST) T - (24 pp-landfill), (20.0 ppm-UST) E - (15 ppm-landfill), (15.3 ppm-UST) M+P-X - (42 ppm-landfill) O-X -(21 ppm-landfill),(11 ppm-UST)

III. Operating Conditions for Methane Analysis

Gas Chromatograph:	HNU 421 or Varian 3300
Column:	10 ft ss, Carboseive II
Carrier gas:	High-purity nitrogen, 30 cc/min
Operating Temperature:	Column, programmed at 60 C for 3 minutes, then 60 C to 160 C at a rate of increase of 10 c/minute. Hold at 160 C for 10 minutes
Injection Port Temperature:	180 C
Detector:	Flame Ionization Detector
Detector Temperature:	250 C
Calibration Compounds:	1018 ppm Methane

Note: Full calibration compound designation and abbreviations are shown on Table 6-2.

scandium) create many positive ions and low-energy electrons in the nitrogen carrier gas. These low-energy electrons are collected by an anode polarized with a low voltage (<20 v) to provide a sensing current. As electron-reacting substances (i.e., halocarbons) enter the detector, the signal current is reduced by the formation of slow-moving negative ions. When a sample is injected onto the gas chromatograph, compounds are separated on an appropriate analytical column, detected by the ECD, integrated, and reported as peaks on the chromatograms.

Dependent upon the site under investigation and suspected and/or known contaminants, one or both of the detectors on the gas chromatograph will be utilized. A more detailed description of the sites and suspected contamination is provided in Table 3-1.

The GC system will be calibrated by injecting a known amount of vapor standard onto each column in the gas chromatograph. Compound retention time and response data are stored in the data station and subsequently used to identify and quantify the selected compounds in the samples. Essentially, a calibrated analyte (e.g., benzene) has a known retention time and known GC response to calibrating concentration; therefore, the corresponding chromatogram peak for a sample run can be identified by retention time and quantified by comparison to the calibration response.

Concurrent with compounds eluting from the GC column, the integrator prints out a chromatogram, which is a continuous graph of GC detector response to the eluting compounds. Subsequently, a numerical summary of peak areas with corresponding compound identifications and concentrations is printed. Unknown peaks are quantified only by peak area.

Blanks are run to ensure that the system is free of contamination. Multiple standard runs, duplicates, and blanks ensure that the analytical system is producing reliable values.

Instrumentation

One or more of the following gas chromatographs will be used to analyze soil vapor samples in the field at Fort Meade. The gas chromatographs are permanently mounted in mobile laboratories which will be driven to the various sites under investigation.

HNU Model 421 Gas Chromatograph
Varian Model 3300 Gas Chromatograph
Shimadzu Model 14A Gas Chromatograph

All of the above systems are equipped with both a FID and a ECD. The systems have dual column capability and are equipped with a programmable temperature column oven.

Quality Control

Calibration standards will be analyzed on the gas chromatograph each day prior to analysis of any soil vapor samples. Standards will be analyzed thereafter after every sixth soil vapor sample. Air blanks will be analyzed prior to any soil vapor sampling each day to demonstrate that the sampling apparatus and GC system are free of contamination. Air blanks will also be analyzed in the middle and at the end of each day. One sample in ten will be duplicated for analysis.

6.9 ECOLOGICAL SURVEY PROCEDURE AND SAMPLING

Terrestrial survey efforts, including wetland and upland habitat characterizations, will be conducted using aerial photo interpretation coupled with a field reconnaissance effort for verification and further characterization. Field reconnaissance efforts will be performed using standard practices which have the goal of characterizing in-field patterns, colors and textural signal differences perceived on aerial photographs. Briefly, EA personnel will examine existing aerial photographs, separating areas with obvious differences in pattern, color, and textural signals, to group similar areas. Based on the number of different signals and the area of each signal type, EA will visit a subsample of each signal type and conduct an ecological characterization of each signal type. A signal type with large acreage and broad distribution will be subsampled for characterization. Subsampling will be conducted using standard scientific practices. Specific subsampling approaches cannot be selected until EA has a better understanding of the relative distribution of signal types. In addition the quality of the terrestrial and wetland habitat in the vicinity of the active and inactive landfills and other areas of concern will be characterized by plant community composition, land cover/use, aquatic resources and condition, etc. Benthos samples will be collected from riffle areas with cobble and gravel substrates at each location. Kicknet samples of approximately 1 m^2 will be taken in two areas of differing velocity at each station. The two samples will be composited, preserved with 10 percent formalin, labeled, and returned to the laboratory for analysis. The organisms will then be identified to the low practical taxonomic level, enumerated, and the data used for the metrics calculations.

Fish will be collected from a predetermined length of stream using a backpack-mounted pulse DC electrofishing unit. Sampling will be conducted at each location in an upstream direction in stream sections with multiple habitat types (riffle, run, pool). After the station is sampled, all fish will be counted and identified to species. All readily identifiable specimens will be returned to the stream after processing. Unidentified fish will be preserved in 10 percent formalin and identified in the laboratory. All fish collected will be examined for the presence of deformities, fin erosion, lesions, and other anomalies.

Once completed, this information will be used in the evaluation of concerns relating to the presence of rare, threatened, and endangered species. EA's Phase I survey for rare, threatened, and endangered species includes the following four components:

- Consultation with Federal and State and local regulatory agencies with responsibilities in the area of protection of rare, threatened, or endangered species.

- Evaluation of the life history habitat requirements for each species.

- Determination of potential areas times distribution on the site (if not provided or available from agencies).

- Subsampling will be conducted of specific habitat areas during appropriate time.

If no species are observed, this Phase I survey will be completed. This task includes work elements leading to the conclusion that species of concern were or were not observed onsite. If species are observed, additional field work will be required to estimate population size, distribution, etc.

6.10 ASBESTOS SAMPLING

Suspected asbestos containing building material ACBM will be sampled with a cork borer or other cutting tool. For sprayed-on or troweled-on surfacing materials on walls or ceilings, the number of samples collected will be based on the overall size of the sampling area as follows:

Sampling Area (sq. ft.)	Number of Samples
<1,000	3
1,000-5,000	5
>5,000	7

For thermal system insulation (pipe wrap, boiler and other insulation), at least three samples will be collected from each homogeneous area.

The number of samples which will be collected from each area of miscellaneous materials will vary, depending on the material in question. Due to the homogeneity of ceiling tile, only one sample of each type of ceiling tile will be collected. Fire doors and similar structures will be assumed to contain asbestos and will therefore not be sampled as the sampling of these materials may damage the integrity of the structure and reduce the protective factor of the item in question. All other friable and potentially friable suspect ACBM will sampled.

A number of statistically random sampling approaches will be used to select the sampling locations. For surfacing materials, the area will, where feasible, be divided into nine sections of approximately equal size. A table of random digits will be used to select the sections that will be sampled. Where feasible, statistically random sampling methods will be used when sampling pipe wrap and other insulation materials. Samples will be collected from a clearly visible location.

The sample containers will be sequentially numbered and the exact sample location will be recorded on the Building/Structure Survey Form and, when possible, on the building drawing. At least one quality control sample (side-by-side) will be collected for every 20 samples collected and sent to the secondary laboratory to confirm the results of the primary laboratory. The samples will be double-bagged and sealed prior to transport outside of the sampling area.

Precautions will be taken during sample collection to minimize the risk of exposure to survey personnel and/or building occupants. Survey personnel will wear appropriate protective equipment. A surfactant mist will be applied to the sample site before sampling to control dust generation. The sampling tool will be wet-wiped between samples, to reduce the likelihood of cross contamination. Any debris which may occur due to sampling will be cleaned up in accordance with EPA guidance and/or state and federal regulations.

APPENDIX A

GEOTECHNICAL REQUIREMENTS FOR DRILLING, MONITOR WELLS, DATA ACQUISITION, AND REPORTS

MARCH 1987

DEPARTMENT OF THE ARMY

U.S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY

ABERDEEN PROVING GROUND, MD 21010-5401

D I S C L A I M E R

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I. OBJECTIVE.

The objective of these requirements is to set forth the geotechnical criteria and procedures of the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA). These requirements are used in technical support of the Contracting Officer for geotechnical exploration and reporting. The application of geotechnology to environmental programs should begin with project conception. The Geotechnical Requirements join this application during the design of the field program, after the initial magnitude of the study has been determined and tentative well sites selected. The application of these requirements is intended to provide acceptable technical data and tracking procedures to accurately obtain, describe, and evaluate representative samples of the subsurface environment in terms of geology, hydrology, and groundwater chemistry. This sample-specific data can be merged with site-operational knowledge to characterize and appraise the contaminant potential of the site.

II. GENERAL POLICY.

A. The Geotechnical Requirements shall be a part of and attached to each Request for Proposal or Quotation (RFP/RFQ) involving subsurface exploration and resulting contracts and/or task orders. A verbatim copy of these Requirements, modified by only the initial contract or task order and subsequent amendments, shall be made part of and attached to the contractor's Technical Plan (or equivalent document).

B. The Geotechnical Requirements were written as a generalized document. Application to a specific contract or task is likely to generate obvious or subtle conflicts. When conflicts exist between the Geotechnical Requirements and specific contractual documents; i.e., the RFP/RFQ, contract, task order, or contractual amendments, the latest contractual documents shall take precedence.

C. Technically, the Contracting Officer is the only Governmental agent who has the authority to change a given contract. Some administrative aspects of this authority are usually delegated in writing to certain USATHAMA personnel serving as Contracting Officer's Representatives (COR). These aspects include the approval for use of specified items; e.g., the drilling water, granular filter pack, bentonite, etc., as discussed in the Geotechnical Requirements. USATHAMA's approval of these items is performed through and under the authority of the Contracting Officer. Therefore, the contractor's requests for approval of, variance from, or notification of problems with the technical items within these Geotechnical Requirements shall be directly sent from the contractor to the USATHAMA COR responsible for that contract or task.

D. Any deviation from the contract shall be requested of and approved by the Contracting Officer. Deviations approved for a given contract or task shall not be applicable to any other contract or task unless specified in the approval.

E. These requirements will be updated as required incorporating new technology, experience, and policy.

III. SPECIFIC ELEMENTS.

A. Drilling Operations.

1. Drilling Methods.

a. The object of drilling method selection is to use that technique which:

(1) Minimizes subsurface contamination or cross contamination.

(2) Provides representative data.

(3) Minimizes drilling costs.

b. To this end, the following drilling methods are typically used:

(1) Hollow-stem augers.

(2) Water/mud rotary.

(3) Cable tool/churn drill.

(4) Air rotary.

c. Of these, air rotary is the least desirable and is further discussed in section III.A.2. Other methods, like reverse circulation, may have applicability in certain cases. Unless specified in the RFP/RFQ, the drilling method shall be suggested and described by the contractor in his RFP/RFQ response and/or technical plan, for the Contracting Officer's consideration and approval.

2. Air Rotary.

a. Air systems, including bottled gas, shall not be used for drilling, well installation, well development, presample purging, or sampling unless specified in the statement of work. However, when alternative bids or proposals are allowed, the contractor may present as part of the bid/proposal package an alternative using an air system(s) for a given operation(s). The contractor's alternative shall include:

(1) Situation.

(2) Recommendation.

(3) The effect of usage upon groundwater and soil chemical analyses.

(4) Alternatives with cost savings or increases, as appropriate.

b. The above item shall be quantified, costed (in the appropriate section of the bid/proposal package), and shall incorporate the appropriate criteria discussed in paragraph III.A.2.c. below. Consideration and a recommendation by USATHAMA will be made during the course of bid/proposal evaluation, prior to contract award.

c. In general, air system plans shall:

(1) Specify the type of air compressor and lubricating oil and require a pint sample of each oil be retained by the contractor, along with a record of oil loss (on the boring log), for evaluation in the event of future problems. The oil sample(s) may be disposed of upon contract/task completion.

(2) Require an air line oil filter and that the filter be changed per manufacturer's recommendation during operation with a record kept (on the boring log) of this maintenance. More frequent changes shall be made if oil is visibly detected in the filtered air.

(3) Prohibit the use of any additive except approved water (III.A.10.b.) for dust control and cuttings removal.

(4) Detail the use of any downhole hammer/bit with emphasis upon those procedures to be taken to preclude residual groundwater sample contamination caused by the lubrication of the downhole equipment.

d. Air usage shall be fully described in the log or associated geotechnical report to include equipment description(s), manufacturer(s), model(s), air pressures used, frequency of oil filter change, and evaluations of the system performance, both design and actual.

3. Recirculation Tanks and Sumps. Portable recirculation tanks are suggested for mud/water rotary operations and similar requirements. The use of dug sumps/pits (lined or unlined) is expressly prohibited.

4. Site Geologist. A geologist shall be present and responsible at each operating drill rig for the logging of samples, monitoring of drilling operations, recording of water losses/gains and groundwater data, preparing the boring logs and well diagrams, and recording the well installation procedures of that rig. Each geologist shall be responsible for only one operating rig. Each geologist shall have onsite sufficient tools and professional equipment in operable condition to efficiently perform his/her duties as outlined in these Geotechnical Requirements and other contractual documents. Items in the possession of each geologist shall include, as a minimum: a copy of the geotechnical portion of the statement of work, the USATHAMA-approved Technical Plan (or equivalent) which incorporates these Geotechnical Requirements, the approved Safety Plan (approved after contract award), a 10X (minimum) hand lens, and a weighted (with steel or iron) tape(s), long enough to measure the deepest well within the contract, heavy enough to reach that depth, and small enough to readily fit within the annulus between the well and drill casing. Each geologist shall also have onsite a water level measuring device, preferably electrical.

5. Permits, Rights-of-Entry, and Licenses. The contractor shall be responsible for securing and complying with any and all boring or well drilling permits and/or procedures required by state or local authorities and

for determining and complying with any and all state or local regulations with regard to the submission of well logs, samples, etc. Submission of these items to state or local authorities shall be coordinated through USATHAMA. The contractor shall telephonically notify USATHAMA immediately in the event of any apparent discrepancy between contractual and state or local requirements. Notification shall include the nature of the discrepancy; the name, agency, and telephone number of the person noting the discrepancy; and the current status. Any rights-of-entry (for off-post drilling) will be obtained for and supplied to the contractor by the Contracting Officer. The contractor shall ensure that all drilling of boreholes, well installation, and topographic surveying is accomplished by companies appropriately licensed in the project State. A copy of each current license (denoting expiration date) shall be provided in the contractor's Technical Plan. If the project State does not require a licensed driller for this project, then a statement to that effect shall be included in the technical plan.

6. Drilling Safety and Underground Utility Detection. The contractor shall be responsible for determining and complying with any and all (to include host installation) regulations, requirements, and permits with regard to drilling safety and underground utility detection. The contractor shall include a discussion of his actions with regard to these items in his proposal and Safety Plan (also see III.A.12.b., III.A.12.d., and III.G.).

7. Lubricants. Only petroleum jelly, teflon tape, lithium grease, or vegetable-based lubricants shall be used on the threads of downhole drilling equipment. Additives containing lead or copper shall not be used. Any hydraulic or other fluids in the drilling rig, pumps, or other field equipment/vehicles shall NOT contain any polychlorinated biphenyls (PCBs).

8. Surface Runoff. Surface runoff; e.g., precipitation, wasted or spilled drilling fluid, and miscellaneous spills and leaks, shall not enter any boring or well either during or after drilling/well construction. To help preclude this, the use of starter casing, recirculation tanks, berms about the borehole, and surficial bentonite packs, as appropriate, are suggested.

9. Antifreeze. If antifreeze is added to any pump, hose, etc., in an area in contact with drilling fluid, this antifreeze shall be completely purged prior to the equipment's use in drilling, mud mixing, or any other part of the overall drilling operation. Only antifreeze without rust inhibitors and/or sealants shall be used. The contractor shall note on the boring log the dates, reasons, quantities, and brand names of antifreeze per above.

10. Materials.

a. Bentonite is the only drilling fluid additive allowed. No organic additives shall be used. Exception is usually made for some high yield bentonites to which the manufacturer has added a small quantity of polymer. The use of any bentonite must be approved by the Contracting Officer prior to the arrival onsite of the drilling equipment (rigs). This includes bentonites (powders, pellets, etc.) intended for drilling mud, grout, seals, etc. The following data, III.A.10.a.(1)-(5), shall be submitted in writing (see Figure 1) through USATHAMA to the Contracting Officer as part of the approval request. Allow six working days from the time of receipt by USATHAMA for request evaluation and recommendation.

III.A.10.a.

(1) Brand names(s).

(2) Manufacturer(s).

(3) Manufacturer's address(es) and telephone number(s).

(4) Product description(s) from package label(s)/manufacturer's brochure(s).

(5) Intended use(s) for this product.

b. Water.

(1) The source of any water to be used in drilling, grouting, sealing, filter placement, well installation, or equipment washing must be approved by the Contracting Officer prior to arrival of the drilling equipment onsite. Parameters for approval include:

(a) A deep aquifer origin (ideally, greater than 200 feet below ground surface).

(b) Well head upgradient of potential contaminant sources.

(c) Free of survey-related contaminants by virtue of pretesting (sampling and analysis) by the contractor using a laboratory certified by or in the process of being certified by USATHAMA for those contaminants. Pretesting shall be conducted on duplicate samples, each analyzed at a different time, using separate lots.

(d) The water to be non-treated and non-filtered.

(e) The tap to have 24-hour per day, 7-day per week access with plumbing sufficient to allow the filling of a 500 gallon tank in less than 20 minutes.

(f) The use of only one designated tap for access.

(2) Periodic testing of the approved water source may be required when the water is used to clean the sampling equipment after well installation. A detailed discussion of these requirements is provided in the USATHAMA Quality Assurance Program.

(3) Surface water bodies shall not be used, if at all possible.

(4) If a suitable source exists onsite, the contractor shall be directed to that source. If no onsite water is available, the contractor shall locate a potential source and submit the following data, III.A.10.b.(4)(a)-(h), in writing to USATHAMA (see Figure 2) for the Contracting Officer's approval prior to the arrival of any drilling equipment onsite. Allow three calendar weeks from the time of receipt by USATHAMA for request evaluation and recommendation.

III.A.10.b.(4)

(a) Owner/address/telephone number.

(b) Location of tap/address.

(c) Type of source (well, pond, river, etc.). If a well, specify static water level (depth), date measured, well depth, and aquifer description.

(d) Type of treatment and filtration prior to tap (chlorination, fluoridation, softening, etc.).

(e) Time of access (24-hours per day, 5-days per week, etc.).

(f) Cost per gallon charged by Owner/Operator.

(g) Results and dates of all available chemical analyses over past two years. Include the name(s) and address(s) of the analytical laboratory(s)

(h) Results and date(s) of duplicate chemical analysis (see III.A.10.b.(1)(c)) for project contaminants by a laboratory certified by or in the process of being certified by USATHAMA for those contaminants.

(5) The contractor has the responsibility to procure, transport, and store the water required for project needs in a manner to avoid the chemical contamination or degradation of the water once obtained. The contractor is also responsible for any heating, thermal insulation, or agitation of the water to maintain the water as a fluid for its intended uses.

(6) The contractor shall enter the chemical and geotechnical data for the approved water source into the Data Management System.

c. Grout.

(1) Materials. Grout, when used in monitor well construction or well abandonment, shall be composed by weight of 20 parts cement (Portland cement, type II or V) up to 1 part bentonite with a maximum of 8 gallons of approved water per 94 pound bag of cement. Neither additives nor borehole cuttings shall be mixed with the grout. Bentonite shall be added after the required amount of cement is mixed with water.

(2) Equipment. All grout materials shall be combined in an above-ground rigid container or mixer and mechanically (not manually) blended onsite to produce a thick, lump-free mixture throughout the mixing vessel. The mixed grout shall be recirculated through the grout pump prior to placement. Grout shall be placed using a grout pump and tremie. The grout pump for recirculation and placement shall be a commercially available product specifically manufactured to pump cement grouts. The tremie pipe shall be of rigid, not flexible, construction. Drill rods, rigid polyvinyl chloride (PVC) or metal pipes are acceptable tremies. Hoses and flexible PVC are unacceptable. Grout placement, via gravity and the grout head, using an elevated grout tank is expressly prohibited.

(3) Grout shall be placed in the monitor wells as follows:

(a) When a bentonite seal is used as shown in Figures 5 or 6:

(i) Prior to exposing any portion of the borehole above the seal by the removal of any drill casing (to include hollow-stem augers), the annulus between the well casing and drill casing shall be filled with grout.

(ii) The grout shall be placed from within a rigid tremie pipe, located just over the top of the seal.

(iii) The grout shall be pumped through this pipe to the bottom of the open annulus until undiluted grout flows from the annulus at ground surface, forming a continuous grout column from the seal to ground surface. The grout shall not penetrate the well screen or granular filter pack. Disturbance of the bentonite seal should be minimal.

(iv) The drill casing shall then be removed and more grout immediately added to compensate for settlement.

(v) If drill casing (to include hollow-stem auger) was not used, proceed with grouting to ground surface in one, continuous operation.

(vi) After 24 hours, the contractor shall check the site for grout settlement and that day add more grout to fill any settlement depression.

(vii) Repeat this process until firm grout remains at ground surface.

(viii) Incremental quantities of grout added in this manner shall be recorded as added and the data submitted to the Contracting Officer through USATHAMA on the well diagram (or addendum).

(b) When no bentonite seal is used (unusual occurrence requiring specific Contracting Officer approval):

(i) The contractor shall mix, place, monitor, and report grout usage as described above: III.A.10.c.(1) to (3)(a)(viii), but position the rigid tremie pipe just above the granular filter pack.

(ii) Place the grout so as to avoid grout penetration into the underlying granular filter pack and screen.

(4) If field conditions permit, the contractor may incrementally place grout and remove drill casing so as to constantly maintain 10 feet of grout (minimally) within the casing yet to be removed from the ground. Using this method requires at least 20 feet of grout to be within the casing before removing 10 feet of casing.

(5) For grout placement at depths less than ten feet in a DRY hole, the grout may be poured in place from ground surface.

d. Granular Filter Pack. For this discussion, refer to section III.C.5.

e. Well Screens, Casings, and Fittings. For a discussion of these materials, see section III.C.2.

f. Well Caps and Centralizers. These items are discussed in sections III.C.3. and 4, respectively.

g. Well Protection. Elements of well protection are covered in section III.C.8.

h. Tracers, dyes, or other substances shall not be used or otherwise introduced into borings, wells, grout, backfill, groundwater, or surface water unless specifically required by contract.

i. Summarize the usage of these and any other drilling/well construction materials which potentially could have a bearing on subsequent interpretation of the analytical results. Include this summary within the geotechnical report. An example summary is provided at Table 1.

11. Abandonment. Abandonment is that procedure by which any boring or well is permanently closed. Abandonment procedures shall preclude any current or subsequent discharges from entering the abandoned boring or well and thereby terminate access to the subsurface environment.

a. The abandonment of any borings or wells not scheduled for abandonment per contract, must be approved by the Contracting Officer prior to any casing removal, sealing, or backfilling. Abandonment requests shall be submitted telephonically through USATHAMA to the Contracting Officer with the following data, III.A.11.a.(1)-(3), plus recommendation. Allow four consecutive hours from the time of receipt by USATHAMA for request evaluation and decision. Frequently, resolution is made within minutes. Infrequent circumstances may preclude a four-hour resolution. A written followup memorandum shall be submitted by the contractor within five working days of the telephonic request. This document shall be forwarded through USATHAMA to the Contracting Officer and contain the following data:

(1) Designation of well/bore in question.

(2) Current status (depth, contents of hole, stratigraphy, water level, etc.).

(3) Reason for abandonment.

(4) Action taken, to include any replacement boring or well.

b. Each boring or well to be abandoned shall be sealed by grouting from the bottom of the boring/well to ground surface. This shall be done by placing a grout pipe to the bottom of the boring/well (i.e., to the maximum depth drilled/bottom of well screen) and pumping grout through this pipe until undiluted grout flows from the boring/well at ground surface. Any open or ungrouted portion of the annular space between the well casing and borehole shall be grouted in the same manner also. Grout composition, equipment, and placement procedures are covered in section III.A.10.c.

c. After 24 hours, the contractor shall check the abandoned site for grout settlement. That day, any settlement depression shall be filled with grout and rechecked 24 hours later. This process shall be repeated until firm grout remains at ground surface.

d. Normally an abandoned well shall be grouted with the well screen and casing in place. However, a lack of data concerning well construction or other factors may dictate the removal of the well materials and a partial or total hole redrilling prior to sealing the well site.

e. For each abandoned boring/well, a record shall be prepared to include the following, III.A.11.e.(1)-(13), as applicable. Report all depths/heights from ground surface. The original record shall be submitted to USATHAMA within three working days after abandonment is completed.

(1) Boring/well designation.

(2) Location with respect to the replacement boring or well (if any); e.g., 20 feet north and 20 feet west of Well 14.

(3) Open depth prior to grouting and depth to which grout pipe placed. This includes the depth of open hole, open depth to the bottom of the well, and the open depth in the well-borehole annulus.

(4) Casing left in hole by depth, composition, and size.

(5) Copy of the boring log.

(6) Copy of construction diagram for abandoned well.

(7) Drilled and sampled depth prior to decision to abandon site.

(8) Items left in hole by depth, description, and composition.

(9) Description and total quantity of grout used initially.

(10) Description and daily quantities of grout used to compensate for settlement.

(11) Dates of grouting.

(12) Water or mud level (specify) prior to grouting and date measured.

(13) Remaining casing above ground surface: height above ground, size, and composition.

f. Ideally, replacement wells/borings (if any) will be offset at least 20 feet from any abandoned site in a presumed up- or cross-gradient groundwater direction. Site-specific conditions may necessitate variation to this placement.

12. Soil Samples.

a. Unless otherwise specified in the contract, intact soil samples for physical descriptions, retention, and potential physical analyses shall be taken and retained every five feet or at each major change of material, whichever occurs first. The contractor may propose an alternate sampling frequency in his technical plan. These samples shall be representative of their host environment and are to be obtained with driven (e.g., split spoon), pushed (e.g., thin wall), or rotary (e.g., Denison) type samplers. Auger flight or wash samples will not satisfy this requirement.

b. At the detection of any unusual odors off the auger turnings or intact samples, drilling shall cease for an evaluation of their nature and crew safety. After the field crew completes this evaluation and implements any appropriate safety precautions, drilling shall resume. If the odors are judged by the field crew to be contaminant-related, intact samples shall be continuously taken until the odors are no longer detected in the samples. At that time, normal sampling shall resume. Specific procedures shall be detailed in the contractor's proposal and Safety Plan.

c. Representative soil samples from each sampler shall be placed in half- or one-pint glass jars with air-tight, screw-type lids (canning jars). These jars shall be stored in individual compartments in cardboard boxes. A single box shall not contain more than 24 one-pint jars or 48 half-pint jars. For thin wall (shelby) samples, retain a sample from each tube as described above. The remaining portion may be wasted or sealed in the tube, as per testing requirements. Minimum information on each sample container shall include the boring and sample number. No geotechnical data shall appear on the container that is not specified on the boring log. Jars and tubes shall be kept from freezing.

d. Physical soil testing shall be conducted on ten (10) to twenty (20) percent of the soil samples using procedures and equipment described in the current U.S. Army Corps of Engineers Manual, EM 1110-2-1906: Laboratory Soils Testing, or current Annual Book of ASTM Standards, American Society of Testing and Materials, Part 19. Tested samples shall be representative of the range and frequency of soil types encountered. In addition, they shall be obtained from borings that cover the geographic and geologic range within the study area of the host Army installation. The contractor shall select the particular samples. Tests shall include Atterberg Limits, sieve grain size distribution, and assignment of Unified Soil Classification System symbols. Laboratory and summary sheets shall be submitted to the COR within ten working days of final test completion. The contractor shall address any contaminant-related safety precautions for the physical analysis of these samples in his proposal and Safety Plan.

e. Soil samples for chemical analysis taken from borings shall be obtained in a manner to provide intact specimens; using a split spoon or solid barrel sampler, Denison sampler, etc. These samples shall be extracted from their host environment in as near an intact, undisturbed condition as technically practical. Once at the surface, the sampler shall be opened, sample extracted, peeled, and bottled in as short a time as possible. "Peeling" is a process whereby that portion of the sample which was in direct contact with the sampler, as well as the ends of the sample, are removed and discarded. Samples for volatile analysis shall be peeled, bottled, and capped within fifteen (15) seconds from the time of opening the sampler. Additional acquisition, preservation, and handling criteria for the chemical analysis of soils are found in the current Quality Assurance Program.

f. All soil samples, except those for physical and/or chemical analysis and reference shall remain onsite, neatly stored at a USATHAMA-designated location. The disposition of these samples will be arranged between USATHAMA and the host installation.

13. Rock Core. The preferred method of drilling bedrock is through coring. This method, using a diamond or carbide studded bit, produces a generally intact sample of the bedrock lithology, structure, and physical condition. The use of a gear-bit, tricone, etc., to penetrate bedrock should only be considered for the confirmation of the "top of rock" (where penetration is limited to a few feet), the enlargement of a previously cored hole, or the drilling of highly fractured intervals.

a. The coring of bedrock or any firm stratigraphic unit shall be conducted in a manner to obtain at least 90% intact recovery. The physical character of the bedrock; i.e., fractures, poor cementation, weathering, or solution cavities, may lessen the desired recovery, even with the best of drillers and equipment.

b. While drilling in bedrock, and especially while coring, drilling fluid pressures shall be adjusted to minimize drilling fluid losses and hydraulic fracturing.

c. Rock cores shall be stored in covered wooden boxes in such a manner as to preserve their relative position by depth. Intervals of lost core shall be noted in the core sequence with annotated wooden blocks. Boxes shall be marked inside and out to provide boring number, cored interval, and box number in cases of multiple boxes. The weight of each fully loaded box shall not exceed 75 pounds. No geotechnical data shall appear on or within the box that is not specified on the boring log. As a minimum, the estimated number of boxes required for each boring shall be on hand prior to coring that site.

d. The core within each completed box shall be photographed after the core surface has been cleaned/peeled and wetted. Photos shall be taken using color film (ASA as appropriate), 35mm camera, 55mm (minimum) lens, light meter, with one box per frame. Each photo shall be in sharp focus and contain both a legible scale in feet and tenths of feet (or centimeters) and a USATHAMA-supplied photographic color chart for color comparison. The core shall be oriented so that the top of the core is at the top of the photo. One set of 3 x 5 inch glossy color prints plus all negatives shall be sent to USATHAMA via registered mail within 2 weeks of the last coring. Each photo shall be annotated on the back as to the bore/well designation, box number, and cored depths denoted in the photograph. The photos shall be used to enhance the interpretation of core sketches and corresponding narrative descriptions.

e. All rock core, except that for analysis and reference, shall remain onsite, neatly stored at a USATHAMA-designated location. The disposition of these samples will be arranged between USATHAMA and the host installation.

14. Drilling in Contaminated Areas. Many borings and wells are drilled in areas that are clean relative to the deeper horizons of interest. However, circumstances do arise which require drilling where the overlying soils or shallow aquifer may be contaminated relative to the underlying environment. This situation requires the placement of, at least, double casing: an outer permanent (or temporary) casing sealed in place and cleaned of all previous drill fluids prior to proceeding into the deeper, "cleaner" environment. These situations shall be addressed by the contractor on a case-by-case basis in the technical plan.

15. Equipment Cleaning. The steam cleaning of all drilling equipment to include rigs, water tanks (inside and out), augers, drill casings, rods, samplers, tools, recirculation tanks, etc., shall be done prior to project site (installation) arrival followed by onsite steam cleaning with approved water (III.A.10.b.) upon site arrival and between boring/well sites. Prior to use onsite, all casings, augers, recirculation and water tanks, etc., shall be devoid both inside and out of any asphaltic, bituminous, or other encrusting or coating materials, grease, grout, soil, etc. Paint, applied by the equipment manufacturer, need not be removed from drilling equipment. To the extent practical, all cleaning shall be performed in an area that is remote from and surficially cross- or downgradient from any site to be sampled.

16. Work Area Restoration, Disposal of Borehole Cuttings and Well Water. All work areas around the wells and/or borings installed as part of this contract shall be restored to a physical condition equivalent to that of preinstallation. This includes cuttings removal or spreading and rut removal. Borehole cuttings, drilling fluids, and water removed from a well during installation, development, aquifer testing, and presample purging shall be disposed of in a manner approved by the Contracting Officer and the host installation. The contractor shall suggest a disposal procedure and location(s) as part of his technical plan.

17. Physical Security.

a. On Post: While physical security measures are present on most Army properties, the contractor has the ultimate responsibility for securing his own equipment. The contractor shall address any special needs to the onsite installation personnel and include these items in his technical plan.

b. Off Post: For any operations off post, the contractor is totally responsible for his own physical security.

B. Borehole Logging. Each boring log shall fully describe the subsurface environment and the procedures used to gain that description.

1. Format. The format of the boring log shall be determined by the contractor. A suggested format is presented in Figure 4.

III.B.

2. Submittal. Each original boring log shall be submitted directly from the field to the Contracting Officer's designated office within three working days after the boring is completed. In those cases where a monitor well or other instrument is to be inserted into the boring, both the log for that boring and the installation diagram must be submitted within three working days after the instrument is installed.

3. Originals. Only the original boring log (and diagram) shall be submitted from the field to fulfill the above requirement. Carbon, typed, or reproduced copies shall not suffice.

4. Time of Recording. Logs shall be recorded directly in the field without transcribing from a field book or other document. This technique reduces offsite work hours for the geologist, lessens the chance for errors of manual copying, and allows the completed document to be field-reviewed closer to the time of drilling.

5. Routine Entries. In addition to the data desired by the contractor and uniquely required by contract, the following information shall be routinely entered on the boring log or attached to the log:

a. Depths/heights shall be recorded in feet and fractions thereof (tenths or inches). Metric measurements are acceptable if typically used by the geologist. The DMS does not accept entries in inches.

b. Soil classifications shall be in accordance with the Unified Soil Classification System (equivalent to ASTM D 2487-69).

c. Soil classifications shall be prepared in the field at the time of sampling by the geologist and are subject to change based upon laboratory tests and/or subsequent review. The mere difference between laboratory and field classification is not sufficient to change the field classification. Additional factors to consider before changing a field determination include the expertise of the field geologist and laboratory personnel, representative character of the tested sample, labeling errors, etc. Any changes made after this consideration shall be discussed and incorporated in the project report(s). The contractor shall also initiate any subsequent corrections to the Data Management System.

d. Each soil sample taken (see III.A.12.) shall be fully described on the log. The descriptions of intact samples shall include the following parameters:

PARAMETER	EXAMPLE
Classification	Sandy Clay
Unified Soil Classification Symbol	CL
Secondary Components and Estimated Percentages	Sand: 25% (Fine sand 5%, Coarse sand 20%)
Color (using Munsell Soil or Geological	Gray: 7.5 YR 5.0 (Munsell)

Society of America (GSA) Rock Color Chart), give both narrative and numerical description and note which chart used.	
Plasticity	Low Plasticity
Consistency (cohesive soil)	Stiff
Density (non-cohesive soil)	Loose
Moisture Content. Use relative term. Do not express as a percentage unless a value has been measured.	Dry, moist, wet, etc.
Texture/Fabric/Bedding and Orientation	No apparent bedding: numerous vertical, iron-stained, tight fractures
Grain Angularity	Rounded
Depositional Environment and Formation, if named	Glacial till, Twin Cities Formation

e. In the field, visual numeric estimates shall be made of secondary soil constituents; e.g., "silty sand with 20 percent fines" or "sandy gravel with 40 percent sand." If such terms as "trace," "some," "several," etc., are used, their quantitative meaning is to be defined on each log or within a general legend.

f. When used to supplement other sampling techniques, disturbed samples; e.g., wash samples, cuttings, and auger flight samples, shall be described in terms of the appropriate soil/rock parameters to the extent practical. "Classification" shall be minimally described for these samples, along with a description of drill action and water losses/gains for the corresponding depth.

g. Rock core shall be visually described for the following parameters:

PARAMETER	EXAMPLE
Classification	Limestone, Sandstone, Granite
Lithologic Characteristics	Shaly, Calcareous, Siliceous, Micaceous
Bedding/Banding Characteristics	Laminated, Thin bedded, Massive, Cross bedded, Foliated
Color (using Munsell Soil or GSA Rock Color Chart), give both narrative and numerical description and note which chart was used.	Mod. brown: 5 YR 3/4 GSA

Hardness	Soft, Very hard
Degree of Cementation	Poorly cemented, Well cemented
Texture	Dense, Fine-, Medium-, Coarse-grained, Glassy, Porphyritic, Crystalline
Structure and Orientation	Horizontal bedding, Dipping beds at 30°, Highly fractured, Open vertical joints, Healed 30° faults/fractures, Slickensides at 45°, Fissile
Degree of Weathering	Unweathered, Badly weathered
Solution or Void Conditions	Solid, Cavernous, Vuggy with partial infilling by clay
Primary and Secondary Permeability, include estimates and rationale	Low primary: Well cemented High secondary: Several open joints
Lost Core, interval and reason for loss	50-51', noncemented sandstone likely

h. For rock core, provide a scaled graphic sketch of the core on or with the log denoting by depth the location, orientation, and nature (natural or coring-induced) of all core breaks. Note also the intervals by depth of all lost core and hydrologically significant details. This sketch shall be prepared at the time of core logging, concurrent with drilling.

i. Record the brand name and amount of any bentonite used for each boring along with the reason for and start (by depth) of this use.

j. The drilling equipment used shall be generally described either on each log or in a general legend. Record such information as rod size, bit type, pump type, rig manufacturer and model.

k. Each log shall record the drilling sequence; e.g.:

(1) Opened hole with 8" auger to 9'.

(2) Set 8" casing to 10'.

(3) Cleaned out and advanced hole with 8" roller bit to 15' (clean water, no water loss).

(4) Drove standard sampler to 16.5'.

III.B.5.k.

(5) Advanced with 8" roller bit to 30', 15 gallon water loss.

(6) Drove standard sampler to 31.5'.

(7) Hole heaved to 20'.

(8) Mixed 25 pounds of ABC bentonite in 100 gallons of water for hole stabilization and advanced with 8" roller bit to 45', etc.

l. Record all special problems and their resolution on the log; e.g., hole squeezing, recurring problems at a particular depth, sudden tool drops, excessive grout takes, drilling fluid losses, unrecovered tools in hole, lost casings, etc.

m. The dates for the start and completion of borings shall be recorded on the log along with notation by depth for drill crew shifts and individual days.

n. Each sequential boundary between the various soils and individual lithologies shall be noted on the log by depth. When depths are estimated, the estimated range shall be noted along the boundary.

o. The depth of first encountered free water shall be indicated along with the method of determination; e.g., "37.6' from direct measurement after drilling to 40.0';" or "40.1' from direct measurement in 60' hole when boring left overnight, hole dry at end of previous shift;" or "25.0' based on saturated soil sample while sampling 24-26'." Allow the first encountered water to partially stabilize (5 to 10 minutes) and record this secondary level and time between measurements before proceeding. Also describe any other distinct water level(s) found below the first.

p. The estimated interval by depth for each sample taken, classified, and/or retained shall be noted on the log. For each driven (split spoon), thin wall (shelby), and cored sample, record the length of sampled interval and length of sample recovery. Record the sampler type and size (diameter and length).

q. Record the blow counts, hammer weight, and length of hammer fall for driven samplers. For thin wall samplers, indicate whether the sampler was pushed or driven. Blow counts shall be recorded in half foot increments when standard (1 3/8" ID by 2" OD) samplers are used. For penetration less than a half foot, annotate the count with the distance over which the count was taken.

r. When drilling fluid is used, quantitatively record fluid losses and/or gains and the interval over which they occur. Adjust fluid losses for spillage and intentional wasting (e.g., recirculation tank cleaning) to more accurately estimate the amount of fluid lost to the subsurface environment.

s. Record the pumping pressures typically used during all rotary drilling operations.

t. Note the total depth of drilling or sampling, whichever is deeper, on the log.

u. Record significant color changes in the drilling fluid return, even when intact soil samples or rock core are being obtained. Include the color change (from and to), depth at which change occurred, and a lithologic description of the cuttings before and after the change.

v. Special abbreviations used on a log and/or well diagram shall be defined either in the log/diagram where used, or in a general legend. The general legend, if used, shall be forwarded to USATHAMA with the first log/diagram submittal. An addendum, if required, shall be sent to USATHAMA with the last log/diagram.

C. Well Installation. In the Geotechnical Requirements, the term "monitor well" is used in a generic sense to include observation wells and piezometers. Observation wells differ from piezometers in the length of the open or screened section of the well and location of the well seal (usually bentonite) in relation to the potentiometric or phreatic surface of the aquifer being measured (see Figure 10). Each monitor well is intended for use as a mechanism through which to obtain a representative sample of groundwater and measure the potentiometric surface seen by that well. The installation of either well type is covered by these Requirements. These Requirements are also applicable to other types of hydrogeologic instrumentation; e.g., lysimeters and well points (see Figure 10). The criteria for these and other special instrumentation will be discussed in the specific RFP/RFQ, contract, task, and/or amendment. Any questions regarding these items should be addressed to the COR.

1. Beginning Well Installation.

a. The installation of each monitor well shall begin within 12 consecutive hours of boring completion for holes uncased or partially cased with temporary drill casing. Installation shall begin within 48 consecutive hours in holes fully cased with temporary drill casing. Once installation has begun, no breaks in the installation process shall be made until the well has been grouted and drill casing removed. Anticipated exceptions shall be requested in writing by the contractor to the Contracting Officer through USATHAMA for consideration prior to drilling. Allow three working days from the time of receipt by USATHAMA for request evaluation and recommendation. Data to include in this request are:

(1) Well(s) in question.

(2) Circumstances.

(3) Recommendation and alternatives.

b. In cases of unscheduled delays such as personal injury, equipment breakdowns, sudden inclement weather; or scheduled delays such as borehole geophysics, no advance approval of delayed well installation is needed. In those cases, resume installation as soon as practical. In cases where a partially cased hole into bedrock is to be partially developed prior to well insertion (III.D.11.), the well installation shall begin within 12 consecutive hours after this initial development.

c. Once begun, well installation shall not be interrupted due to the end of the contractor's/driller's work shift, darkness, weekend, or holiday.

d. The contractor shall ensure that all materials and equipment for drilling and installing a given well are available and onsite prior to drilling that well. The contractor shall have all equipment and materials onsite prior to drilling and installing any well if the total well drilling and installation effort is scheduled to take 14 consecutive days or less. ("Consecutive days" refers to the continuous combination of "working" and "nonworking days;" i.e., "calendar days."). For longer schedules, the contractor shall ensure that the above materials needed for at least 14 consecutive days of operation are onsite prior to well drilling. The balance of materials shall be either on order or in transit prior to well drilling.

2. Screens, Casings, and Fittings.

a. Typically, only polyvinyl chloride (PVC), polytetrafluoroethylene (PTFE), and/or stainless steel shall be used. All PVC screens, casings, and fittings shall conform to National Sanitation Foundation (NSF) Standard 14 for potable water usage (or American Society for Testing and Materials (ASTM) equivalent) and bear the appropriate rating logo. If a contractor uses a screen and/or casing manufacturer or supplier who removes or does not apply this logo, the contractor shall include in the Technical Plan a written statement from the manufacturer/supplier (and endorsed by the contractor) that the screens and/or casing have been appropriately rated by NSF/ASTM. Specific materials will be specified in the RFP/RFQ or proposed by the contractor in his RFP/RFQ response for the Contracting Officer's approval. All materials shall be as chemically inert with respect to the site environment as technically possible and practical.

b. All well screens shall be commercially fabricated, slotted or continuously wound, and have an inside diameter equal to or greater than the well casing. For PVC and PTFE screens, their schedule/thickness shall be the same as that of the well casing. Stainless steel screens may be used with PVC or PTFE well casing. No fitting shall restrict the inside diameter of the joined casing and/or screen. All screens, casings, and fittings shall be new.

c. All well screens and well casings shall be free of foreign matter (e.g., adhesive tape, labels, soil, grease, etc.) and washed with approved water prior to use. Pipe nomenclature stamped or stenciled directly on the well screen and/or blank casing within and below the bentonite seal shall be removed (via SANDING). Solvents shall NOT be used for marking removal. Washed screens and casings shall be stored in plastic sheeting or kept on racks prior to insertion.

d. Well screens shall be placed no more than three feet above the bottom of the drilled borehole.

e. All screen bottoms shall be securely fitted with a threaded cap or plug of the same composition as the screen. This cap/plug shall be within 0.5' of the open portion of the screen (see Figures 5 and 6). No solvents or glues shall be permitted for attachment.

f. Silt traps (also called "cellars") shall not be used. A silt trap is a blank length of casing attached to and below the screen. Their use fosters a stagnant environment which could influence analytical results for trace concentrations.

g. Joints within and between the casing and screen shall be compatibly threaded. Thermally welded joints or couplings shall not be used. This prohibition includes threaded or slip joint couplings thermally welded to casing by the manufacturer or in the field. Solvent welded joints may be used only to make casing repairs or to adjust casing height. Any glue or solvent usage shall be described on the log or well diagram. During these repairs or adjustments which require solvent/glue usage, a clean rag should be tightly fit into the intact well casing to catch any glue spillage. This rag shall be attached to a strong twine for ease of rag removal and to preclude rag loss down the well. The rag and twine shall be removed upon repair completion.

h. Gaskets shall not be used on monitor wells.

i. The top of each well installed under these Requirements shall be level such that the difference in elevation between the highest and lowest part of the well casing/riser shall be less than or equal to 0.02'.

3. Caps and Vents. The tops of all well casings shall be telescopically capped with loosely fitting PVC, PTFE, or stainless steel covers. These covers shall be constructed to preclude binding to the well casing due to tightness of fit, unclean surface, or frost and secure enough to preclude debris and insects from entering the well. No vents shall be placed in these caps (or well risers/stickup). Therefore, the caps shall be loose enough to allow pressure equalization between the well and atmosphere.

4. Centralizers. Well centralizers, when used, shall be of PVC, PTFE, or stainless steel and attached to the casing via stainless steel fasteners or strapping. Centralizers shall not be attached to the well screen or to that part of the well casing exposed to the granular filter or bentonite seal.

5. Granular Filter Pack.

a. All granular filters must be approved by the Contracting Officer prior to drilling. A one-pint representative sample of each proposed granular filter pack, accompanied by the data below, III.C.5.a.(1)-(6), shall be submitted by the contractor to the Contracting Officer through USATHAMA for consideration prior to drilling. Allow eight working hours for evaluation and recommendation once all of the above data are received by USATHAMA. Each sample shall be described, in writing (see Figure 3), in terms of:

(1) Lithology.

(2) Grain size distribution.

(3) Brand name, if any.

(4) Source, both manufacturing company and location of pit or quarry of origin.

(5) Processing method; e.g., pit run, screened and unwashed, screened and washed with water from well/river/pond, etc.

(6) Slot size of intended screen.

b. Granular filter packs shall be chemically and texturally clean (as seen through a 10X hand lens), inert, siliceous, and of appropriate size for the well screen and host environment.

c. The filter pack shall extend above the top of the screen by at least five feet, unless otherwise specified in the statement of work.

d. The final depth to the top of the granular filter shall be directly measured (via tape or rod) and recorded. Final depths are not to be estimated; as, for example, based on volumetric measurements of placed filter.

6. Bentonite Seals.

a. Bentonite seals shall be composed of commercially available pellets. Pellet seals shall be a minimum of five feet thick as measured immediately after placement, without allowance for swelling.

b. Slurry seals shall be used only as a last resort, as when the seal location is too far below water to allow for pellet or containerized-bentonite placement or within a narrow well-borehole annulus. Slurry seals shall have a thick, batter-like (high viscosity) consistency with a placement thickness of five feet maximum.

c. In wells designed to monitor bedrock, the top of the bentonite seal shall be located at least three feet below the top of firm bedrock, as may be determined by drilling. "Firm bedrock" refers to that portion of solid or relatively solid, moderately to unweathered bedrock where the frequency of loose and fractured rock is markedly less than in the overlying, highly weathered bedrock. The interval between the top of the bentonite seal and the top of the highly weathered bedrock shall be filled with grout. Figure 6 denotes the seal location.

d. The final depth to the top of the bentonite seal shall be directly measured (via tape or rod) and recorded. Final depths are not to be estimated; as, for example, based on volumetric measurements of placed bentonite.

7. Grouting. Grout mix design and placement are detailed in paragraph III.A.10.c.

8. Well Protection.

a. Protective casing shall be installed around each monitor well the same day as initial grout placement around that well. Any annulus formed between the outside of the protective casing and borehole shall be filled to ground surface with grout as part of the grouting procedure. Requests for exceptions in usage, design, and timing of placement will be considered on a case-by-case basis by the Contracting Officer. Request in writing shall be made prior to drilling. Include in the request the well(s) involved, reason for request, cost savings, recommendation, and alternatives. Allow six working days for evaluation and recommendation after the request is received by USATHAMA.

b. All protective casing shall be steam cleaned prior to placement, free of extraneous openings, devoid of any asphaltic, bituminous, encrusting, and/or coating materials (except the black paint or primer applied by the manufacturer).

c. Minimum elements of protection design include:

(1) A 5-foot minimum length of new, black iron/steel pipe extending about 2.5 feet above ground surface and set in grout (see Figures 5, 6 and 7).

(2) An 8" protector pipe for 5" wells.

(3) A 6" protector pipe for 4" wells.

(4) A 5" protector pipe for 3" wells.

(5) A 4" protector pipe for 2" wells.

(6) A hinged cover or loose fitting telescoping cap to keep direct precipitation and cover runoff out of the casing.

(7) All protective casing covers/caps secured to the casing by means of a padlock from the date of protective casing installation.

(8) All padlocks at a given site (Army installation) opened by the same key. The contractor shall provide two of these keys to a Contracting Officer's designated representative at the installation and two keys to USATHAMA upon the conclusion of well placement.

(9) No more than .2' from the top of protective casing to the top of well casing. This, or a smaller spacing, is critical for subsequent water level determination via acoustical equipment.

(10) The outside only of the protective casing, hinges (if present), and covers/caps painted orange with a paint brush (not aerosol can). Painting required to be completed and dry prior to initially sampling that well. Any color deviations will be conveyed to the contractor by the COR.

(11) The painting of the well designation on the outside of the protective casing, using white paint and a brush. The identification shall be done after the casing is painted as described above. Painting required to be completed and dry prior to initially sampling that well.

(12) The erection of four steel pickets, each radially located 4 feet from each well, placed 2 to 3 feet below ground surface, having 3 feet minimally above ground surface with flagging in areas of high vegetation (see Figure 7). The pickets shall be painted orange, using a brush. Installation and painting shall be completed (and dry) prior to sampling the well.

(13) The above pickets (III.C.8.c.(12)) shall be supplemented with three-strand barbed wire in livestock grazing areas. Installation required prior to sampling.

(14) The placement of an internal mortar collar within the well-protective casing annulus from ground surface to 1/2 foot above ground surface with a 1/4" diameter hole (drainage port) in the protective casing centered 1/8" above this level (see Figures 5 and 6). The mortar mix shall be (by weight) 1 part cement to 2 parts sand (the granular filter used around the well screen), with minimal water for placement. Placement required at least 48 consecutive hours prior to well development.

(15) The application of an approximately .5' thick coarse gravel (3/4" to 3" particle size) blanket extending 4' radially from the protective casing (see Figure 8 for layout and dimensions). Application required prior to development.

(16) Unique specifications for flood protection, if applicable, will be covered on a case-by-case basis.

9. Drilling Fluid Removal. When a borehole, made with or without the use of drilling fluid, contains an excessively thick, particulate-laden fluid which would preclude or practically hinder contractual well installation, the borehole fluid should be removed or displaced with approved water (section III.A.10.b.). This removal is intended to remove or dilute the thick fluid and thus allow the proper placement of casing, screen, granular filter, and seal. Fluid losses in this operation shall be initially recorded on the well diagram or boring log and later on the well development record (also see III.D.6., 11., and 14.). Any fluid removal prior to well placement is contingent upon the driller's and the geologist's evaluation of hole stability long enough for the desired well and seal placement.

10. Drilling Fluid Losses in Bedrock. For an option to remove drilling water from bedrock prior to well insertion, see paragraph III.D.11.

11. Schematic Well Construction. Figures 5 and 6 depict schematic well construction. Specific contract requirements described in the statement of work may alter some of the components and/or values shown.

12. Well Construction Diagrams.

a. Each installed well shall be depicted in a well diagram. This diagram shall be attached to the bore log for that installation and shall graphically denote, by depth from ground surface (unless otherwise specified):

(1) The bottom of the boring (that part of the boring most deeply penetrated by drilling and/or sampling) and boring diameter(s).

(2) Screen location.

(3) Joint locations.

(4) Granular filter pack.

(5) Seal.

(6) Grout.

(7) Cave-in.

(8) Centralizers.

(9) Height of riser without cap/plug above ground surface (stickup).

(10) Protective casing detail.

(a) Height of protective casing without cap/cover (above ground surface).

(b) Base of protective casing.

(c) Drainage port location and size.

(d) Internal mortar collar location.

(e) Gravel blanket height and extent.

(f) Picket configuration.

b. Describe on the diagram or on an attachment thereto:

(1) The actual quantity and composition of the grout, seals, and granular filter pack used for each well.

(2) The screen slot size (in inches), slot configuration, total open area per foot of screen, outside diameter, nominal inside diameter, schedule/thickness, composition, and manufacturer.

(3) The outside diameter, nominal inside diameter, schedule/thickness, composition, and manufacturer of the well casing.

(4) The joint design and composition.

(5) Centralizer design and composition.

(6) Protective casing composition and nominal inside diameter.

(7) The use of solvents, glues, and cleaners to include manufacturer and type (specification).

(8) Special problems and their resolutions; e.g., grout in wells, lost casing and/or screens, bridging, etc.

(9) Dates for the start and completion of well installation.

c. Each diagram shall be attached to the boring log and submitted from the field to the Contracting Officer's designated office within three working days after well installation. Do not delay this submission until all elements of well protection have been installed. Submit a supplemental diagram for well protection elements to the same designated office within three working days after all elements of well protection are installed.

d. Only the original well diagram and log shall be submitted to fulfill the above requirement. Carbon, typed, or reproduced copies shall not suffice. A legible copy of the well diagram may be used as a base for the supplemental protection diagram.

e. For abbreviations in the diagrams, see section III.B.5.v.

D. Well Development and Presample Purging.

1. Development: Definition and Purpose. As used herein, "well development" is that process by which one restores the aquifer's hydraulic conductivity and removes well drilling fluids, solids, and other mobile particulates from within and adjacent the newly installed well. "Development" can also refer to that process whereby one removes sediment or other built-up materials from a "clogged," older well. The resulting inflow should be as physically and chemically representative of the host aquifer as the following procedures allow for a newly installed well.

2. Timing and Record Submittal. The development of monitor wells shall be initiated not sooner than 48 consecutive hours after nor longer than 7 calendar days beyond internal mortar collar placement. The record of well development (see section III.D.14.) shall be submitted to the COR within three working days after development.

3. Pump and Bailer Usage. Development shall be accomplished with a pump and may be supplemented with a bottom discharge/filling bailer (for sediment removal) and surge block. A bottom discharge/filling bailer may be used in lieu of a pump in 2-inch wells. Bailers shall not be left inside the wells after development is completed.

4. Development Criteria. Development shall proceed in the manner described herein and continue until all the following are met:

a. The well water is clear to the unaided eye.

b. The sediment thickness remaining within the well is less than 1% of the screen length.

c. The conditions of paragraph III.D.5. (below) are met.

5. Volumetric Removal. In addition to minimally removing five times the standing water volume in the well (to include the well screen and casing plus saturated annulus, assuming 30% porosity), the following apply:

a. For those wells where the boring was made by the use of cable tool, auger, or air rotary methods and without the use of drilling fluid (mud and/or water), only the five volumes plus five times any water used in granular filter pack placement need be minimally removed. Should recharge be so slow that the required volume cannot be removed in 48 consecutive hours, the water remains discolored, or excess sediment remains after the five volume removal; contact the Contracting Officer's designated office for guidance.

b. For those wells where the boring was made or enlarged (totally or partially) with the use of drilling fluid (mud and/or water), remove five times the measured amount of total fluids lost while drilling plus five times the combined amount of standing water,annular water, and that used in filter pack placement as above. The same procedures apply here as above with respect to slow recharge, discoloration, and sediment thickness.

c. See sections III.C.9., III.D.6., and III.D.11. for optional procedures and the requirements if these options are used.

6. Water Additions and Wells with Thick Fluids. Water shall not be added to a well as part of development once the initial seal is placed. However, when a bore, made with or without the use of drilling fluid, contains an excessively thick, particulate-laden fluid which would preclude or practically hinder contractual well installation, the contractor should purge or dilute this fluid with clean water from the approved source (also see III.C.9.). A record of purging fluid losses shall be made on both the log or diagram and well development record (III.D.14.). Five times the volume of this loss shall be added to the other volumetric removal requirements for well development.

7. Agents and Additives. No dispersing agents, acids, disinfectants, or other additives shall be used during development or at any other time introduced to the well.

8. Development-Sampling Break. Well development shall be completed at least fourteen consecutive days before well sampling.

9. Pump/Bailer Movement. During development, water shall be removed throughout the entire water column by periodically lowering and raising the pump intake (or bailer stopping point).

10. Development Water Sample. For each well, a one-pint sample of the last water to be removed during development shall be obtained and given to the installation environmental coordinator (or USATHAMA-specified individual) for disposition, within three working days of developing that well. No preservation of these samples is required. However, the contractor shall ensure that these samples do not freeze while in his possession.

11. Partial Bedrock Development. If large drilling water losses occur in bedrock and if the hole is cased to bedrock, the contractor may remove at least five times this volumetric loss prior to well insertion. The intent here is to allow the placement of a larger pump in the borehole than otherwise possible in the well casing thereby reducing the development time and removing the lost water closer to the time of loss. Development of the completed well could then be reduced by a volume equal to that which was removed as above. However, the requirement shall still remain to remove at the time of well development at least five times the combination of standing water, water in the saturated annulus, plus that which was added during filter pack placement. Record the amount removed per above on the well diagram and in the well development record (III.D.14.).

12. Well Washing. Part of well development shall be the washing of the entire well cap and the interior of the well casing above the water table using only water from that well. The result of this operation shall be a well casing free of extraneous materials (grout, bentonite, sand, etc.) inside the riser, well cap, and blank casing between the top of the well casing and the water table. This washing shall be conducted before and/or during development, not after development.

13. Problems. If problems are encountered during development, contact the COR within 24 consecutive hours for guidance.

14. Well Development Record Requirements. The following data shall be recorded as part of development and submitted per section III.D.2.:

a. Well designation.

b. Date(s) of well installation.

c. Date(s) of well development.

d. Static water level from top of well casing before and 24 consecutive hours after development.

e. Quantity of mud/water:

(1) Lost during drilling.

(2) Removed prior to well insertion (III.D.11.).

(3) Lost during thick fluid displacement (III.C.9. and III.D.6.).

(4) Added during granular filter placement.

f. Quantity of fluid in well prior to development.

(1) Standing in well.

(2) Contained in saturated annulus (assume 30% porosity).

g. Field measurement of pH before, twice during, and after development using an electrometric device (EPA 150.1-Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020).

h. Field measurement of specific conductance (electrical conductivity) before, twice during, and after development using a conductivity meter (EPA 120.1-Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020). Obtain conductance and pH readings concurrently.

i. Depth from top of well casing to bottom of well (from diagram).

j. Screen length (from diagram).

k. Depth from top of well casing to top of sediment inside well, before and after development.

l. Physical character of removed water, to include changes during development in clarity, color, particulates, and odor.

m. Type and size/capacity of pump and/or bailer used.

n. Description of surge technique, if used.

o. Height of well casing above ground surface.

p. Typical pumping rate.

q. Estimated recharge rate.

r. Quantity of fluid/water removed and time for removal (present both incremental and total values).

15. Presample Purging: Definition and Purpose. "Presample purging" refers to the removal of water from a well IMMEDIATELY prior to sample acquisition. This ensures a fresh and representative sample for analysis. In general, the USATHAMA Installation Restoration Program, Quality Assurance Program requires five times the calculated volume of water in the well and saturated well annulus to be removed immediately prior to sampling. Therefore, any water removed from a well as part of "development" shall not be counted toward the volumetric removal required in presample purging. Additional presample purging requirements are discussed in the current USATHAMA Quality Assurance Program.

E. Water Levels.

1. Measurement and Datum. The depth to groundwater shall be measured from the highest point on the rim of the well casing or riser (not protective casing). This same point on the well casing shall be surveyed for vertical control (see III.I.2). The depths to groundwater shall be converted to elevations for report usage. To enter the depths into the Data Management System, the well riser height above ground surface (stickup) must be subtracted from the above measured depth.

2. Contour Requirements. For contouring and reporting purposes, at least one complete set of static water level measurements shall be made over a single, consecutive 10-hour period for all wells (newly installed and specified) in the project. Static levels in borings not converted to wells shall be included if practical and technically appropriate.

3. Ground and Surface Water. Determine and report the elevations, to within $\pm$ 0.1 foot, of any streams, lakes, or open water bodies (natural and man-made), within 300 feet of monitor wells used in this contract or task. Use these data for the refinement of the groundwater contours in the vicinity of surface water if a hydrological connection is believed to exist.

F. Well and Boring Acceptance Criteria.

III.F.

1. Well Criteria. Wells must be acceptable to the Contracting Officer. Well acceptance shall be on a case-by-case basis. The following criteria shall be used along with individual circumstances in the evaluation process.

a. The well and material placement shall meet the construction and placement specifications of these Geotechnical Requirements as modified, if at all, by the contract/task.

b. Wells/boreholes shall not contain portions of drill casing or augers unless they are contractually required as permanent casing.

c. All well casing and screen materials shall be free of any unsecured couplings, ruptures or other physical breakage/defects before and after installation.

d. The annular material (filter pack, bentonite, and grout) surrounding each installed well shall form a continuous and uniform structure, free of any fractures or cracks.

e. Any casing or screen deformation or bending shall be minimal to the point of allowing the insertion and retrieval of the pump and/or bailer optimally designed for that size casing (e.g., a 4-inch pump in a 4-inch schedule 40, PVC casing is optimal; a 2-inch pump in a 4-inch casing is not optimal).

f. All joints shall be constructed to provide a straight, nonconstricting, and water-tight fit.

g. Installed wells (fully or partially cased) shall be free of extraneous objects or materials (e.g., tools, pumps, bailers, packers, excessive sediment thickness, grout, etc.).

h. For those monitor wells where the screen depth was determined by the contractor, the well shall have sufficient free water at the time of water level measurement (III.E.2.) to obtain a representative groundwater level for that site. These same wells shall have sufficient free water, at the time of initial sampling, which is representative of the desired portion of the aquifer for the intended chemical analysis.

i. Data for all required geotechnical files in the Data Management System shall be acceptably entered and verified by the contractor.

2. Abandoned Borings and Wells. Borings not completed as wells shall be abandoned per section III.A.11. and the data therefrom acceptably entered and verified by the contractor into the Data Management System.

3. Well and Boring Rejection. Wells and borings not meeting these criteria are subject to rejection by the Contracting Officer.

G. Geophysics. The use of geophysical techniques, if required, will be specified in the RFP/RFQ. In the absence of this specification, the contractor should consider these techniques for site-specific applicability to enhance the technical acuity and cost-effectiveness of his efforts. Special applications may be useful in unexploded ordnance detection, disturbed area delineation, contaminant detection, depth to bedrock, buried drum detection, borehole and well logging, etc. When proposed for Contracting Officer approval, the contractor shall include the purpose, particular method(s) and equipment, selection rationale, methods and procedural assumptions, limitations (theoretical and site-specific), resolution, and accuracy. The contractor shall also address the safety aspects of geophysical applications in his proposal and Safety Plan, especially for those areas where induced electrical currents or seismic waves could detonate unexploded ordnance or other explosive materials. If geophysical techniques are used, the same topics shall be addressed in the geotechnical report.

H. Vadose Zone Monitoring. Data acquisition from the vadose (unsaturated) zone shall be addressed on a case-by-case basis. The use of lysimeters in a silica flour matrix, soil-gas monitors, and analysis of bulk soil samples are mechanisms which may be employed by the contractor. When proposed for Contracting Officer approval, the contractor shall include the purpose, particular method(s) and equipment, selection rationale, methods and procedural assumptions, limitations (theoretical and site-specific), and analytical variances from the current USATHAMA Quality Assurance Program.

I. Topographic Survey.

1. Horizontal Control. Each boring and/or well installed under this contract shall be topographically surveyed by a licensed surveyor to determine its map coordinates using a Universal Transverse Mercator (UTM) or State Planar grid to within $\pm$ 3' ($\pm$ 1 meter).

2. Vertical Control. Elevations for the natural ground surface (not the top of the coarse gravel blanket) and the highest point on the rim of the uncapped well casing (not protective casing) for each bore/well site shall be surveyed by a licensed surveyor to within $\pm$ 0.05' ($\pm$ 1.5 centimeters) using the National Geodetic Vertical Datum of 1929.

3. Field Data. The topographic survey shall be completed as near to the time of last well completion as possible, but no longer than five weeks after well installation. Survey field data (as corrected), to include loop closure for survey accuracy, shall be included within the geotechnical or final report. Closure shall be within the horizontal and vertical limits given above. These data shall clearly list the coordinates (and system) and elevation (ground surface, top of well, and protective casings) as appropriate, for all borings, wells, and reference marks. All permanent and semipermanent reference marks used for horizontal and vertical control (bench marks, caps, plates, chiseled cuts, rail spikes, etc.) shall be described in terms of their name, character, and physical location.

J. Data Management System.

1. Usage of the Data Management System (DMS) is a means to record and monitor contract performance; store, compare, and evaluate data; and provide cost-efficient, report quality tables and graphics. The System is thereby useful to both administrative and technical users.

2. The geotechnical data acceptably entered in the computer shall be regarded as having the technically best quality for evaluation and decision making. Any deviation from the field data shall be specified and discussed by the contractor in the geotechnical report (see III.B.5.c. and III.K.3.j.(6)).

3. To computerize all of the field-generated data would be neither useful nor cost-effective for most projects. Therefore, only those items specified in III.J.6. shall be acceptably entered on a routine basis by the contractor for each contract or task. These data shall be entered for new borings, wells, and other sampling points; e.g., existing wells, surface water, sediment, and soils, specified in the contract or task. If the contractor wishes to use additional geotechnical files or entries, the contractor shall first receive COR's approval.

4. The items selected for DMS entry shall be entered in one or more of four geotechnical files:

a. Map File (GMA).

b. Field Drilling File (GFD).

c. Well Construction File (GWC).

d. Groundwater Stabilized File (GGS).

5. These files, and others, along with data entry procedures are fully described in Sections 3 and 4 of the Installation Restoration Data Management User's Guide. Additional geotechnical files are available but are not routinely used. The contract or task will specify additional files to be completed, if required.

6. The following lists, arranged by file, denote those items which the contractor shall acceptably enter and verify. Consult the DMS User's Guide for specific coding.

a. Map File (GMA).

(1) Installation.

(2) Site Type.

(3) Site Identification/Site Number.

(4) Coordinates and Coordinate System.

(5) Ground Surface Elevation.

(6) Source and Accuracy of Mapping Data.

(7) Aquifer.

(8) Pointer Information (cross reference for each boring and associated well(s)).

(9) Source of Data (company and individual).

b. Field Drilling File (GFD).

(1) Installation.

(2) Site Type.

(3) Site Identification.

(4) Depth to First Encountered Water.

(5) Depth to Bedrock.

(6) Depth to Deepest Part of Boring.

(7) Unified Soil Classification System Symbol (expanded for bedrock lithologies).

(8) Lithologic Intervals (by depth and thickness).

(9) Source of Data (company and individual).

(10) Dates.

c. Well Construction File (GWC). The abbreviations in parentheses which follow are the "Action Measurements," as explained in the <u>User's Guide</u>.

(1) Installation.

(2) Site Type.

(3) Site Identification.

(4) Stickup (STKUP).

(5) Bentonite Seal Interval (BSEAL).

(6) Blank Well Casing Interval (CASE).

(7) Well Casing Diameter (CASED).

(8) Length of Overburden Casing (CSEAL).

(9) Overburden Casing Diameter (CASES).

(10) Total Depth of Boring (DPTOT).

(11) Filter Pack Interval (GFILT).

(12) Grout Interval (GROUT).

(13) Screen Interval (SCREN).

(14) Dates.

(15) Source of Data (company and individual).

d. Groundwater Stabilized File (GGS).

(1) Installation.

(2) Site Type.

(3) Site Identification.

(4) Depth to Water (from ground surface).

(5) Date(s) Measured.

(6) Source of Data (company and individual).

7. Figures 11 to 15 are provided as examples of completed DMS coding sheets for each of the above files using the example boring log and well diagram (Figures 4 and 6, respectively). Additional data required for coding but not shown on Figures 4 or 6 follow:

a. Abbreviations:

GP = General AAP
PALEO = Code used for aquifer at General AAP.

b. Field Data:

(1) Surveyed coordinates for boring in UTM system are:

X : 54321 centimeters
and Y : 99876 centimeters.

(2) Surveyed ground surface elevation for boring is 4321 centimeters, using National Geodetic Vertical Datum of 1929.

(3) Well 87-14 is located in the same hole made by boring 87-14.

(4) Cement grout proportioned per these Requirements (cement:bentonite = 20:1).

(5) Well screen: 4" PVC, Schedule 40, .01 inch slot.

(6) Well installed 8 Nov 87.

(7) Water levels recorded by Mr. Smith after development were as follows:

Date	Depth from Top of Riser (ft)
12 Nov 87	9.0

20 Dec 87	9.7
04 Jan 88	11.4

K. Geotechnical Reports.

1. General. Requirements of the geotechnical report are discussed herein along with required guidelines for the technical writing style. When a separate geotechnical report is not required per contract, the elements herein shall be incorporated into the final contract/task report(s).

2. Report Contents. The geotechnical report shall contain as a minimum:

a. Title page.

b. Disclaimer.

c. DD Form 1473.

d. Abstract.

e. Table of Contents.

f. Background.

g. Regional Geology.

h. Site Geology.

i. Methodology.

j. Significant Conclusions.

k. Geotechnical Analysis.

l. Recommendations.

m. References.

n. Bibliography.

o. Appendices.

(1) Boring Logs.

(2) Well Diagrams.

(3) Well Development.

(4) Water Levels.

(5) Special Problems and Resolution.

(6) Aquifer Testing and Hydraulic Parameters.

(7) Geophysical Data.

(8) Vadose Zone Monitoring data.

(9) Physical Analyses.

(10) Topographic Survey Data.

p. Distribution List.

3. Content Details. Details of the above items are listed below:

a. Title Page. The title page contains the following:

(1) Title.

(2) Author(s).

(3) Company (prime contractor).

(4) Report Date.

(5) Report/Contract Number (provided by USATHAMA).

(6) Distribution Statement (statement indicating the agency authorized to release the report, provided by USATHAMA).

(7) Organization(s) for which report was prepared (typically a Department of the Army installation and USATHAMA).

(8) USATHAMA Address.

b. Disclaimer. The following "DISCLAIMER" shall immediately follow the title page:

<u>"DISCLAIMER"</u>

"The views, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision unless so designated by other documentation.

The use of trade names in this report does not constitute an official endorsement or approval of the use of such commercial products. This report may not be cited for purposes of advertisement."

c. Department of Defense (DD) Form 1473. This form shall be completed by the contractor. The data for blocks 1, 2, 3, 5, and 20 will be furnished by USATHAMA. A blank form is shown in Figure 9.

d. Abstract. The abstract is a summary of purpose, setting, and significant conclusions. This abstract should be more detailed than that given on the DD Form 1473.

e. Table of Contents. This item shall contain:

(1) Major Headings.

(2) Page Numbers.

(3) Figures, Tables, Plates (separately listed).

f. Background. Provide the objective of the geotechnical effort and a discussion of the contractor's corporate involvement within total survey.

g. Regional Geology. Include a discussion of the following topics for adjacent counties and states (as appropriate).

(1) Setting. Include maps and graphics for:

(a) Topography.

(b) Geomorphology.

(c) Physiography.

(d) Drainage.

(2) Stratigraphy. Include a complete, ideal sequence.

(3) Structure and Seismic Activity. Include cross sections.

(4) Hydrology. Include a discussion of surface and groundwater occurrences, drainage area, cross sections, and contour plots of potentiometric surfaces.

h. Site Geology. Discuss site specifics and how the site conforms and/or departs from the regional discussion based upon the knowledge gained from this study.

(1) Setting. Include local aspects of the regional setting.

(2) Stratigraphy. Discuss the sequence encountered.

(3) Structure and Seismic Activity. Include cross sections and local seismic history.

(4) Hydrology. Include hydrostratigraphic cross sections, contour plots, and a discussion of the relationship(s) between surface water and each aquifer encountered.

i. Methodology.

(1) Geotechnical Approach. Discuss literature and field considerations, provide boring and well placement rationale for each drilling site, note drilling locations on a detailed installation map and the largest scale U.S. Geological Survey topographic map depicting the installation.

(2) Drilling techniques. Specify the equipment, water source, procedures, and contractor.

(3) Borehole logging. Describe the procedures and specify the contractor.

(4) Well installation. Describe the materials (casing, screen, bentonite, cement, water, filter pack, etc. (see Table 1), construction procedures, and contractor.

(5) Well development. Specify the equipment, procedures, and contractor.

(6) Geophysical techniques. Provide the purpose, methods and equipment, selection rationale, method and procedural assumptions, limitations (theoretical and site-specific), resolution, accuracy, and contractor(s).

(7) Vadose Zone Monitoring. Provide the purpose, particular method(s) and equipment, selection rationale, method and procedural assumptions, limitations (theoretical and site-specific) and contractor(s).

(8) Topographic surveying. Specify the equipment, control systems, procedures, and contractor.

(9) Aquifer Tests. Specify the type of tests, literature reference, equipment, general procedure, and contractor.

(10) Physical Analyses. Provide the type of tests, literature references, and contractor.

j. Geotechnical Analysis.

(1) Provide indepth discussions of those geotechnical areas which were significant to the development of the report's conclusions. Describe any uncertainties or extrapolations of data and their relative importance to the conclusions drawn. Provide the data base, references, and actual calculations (in an appendix if over three pages) for quantitative discussions.

(2) Detail the integration of potential contaminant source locations, geologic, hydrologic, and available chemical data. Include how known or estimated groundwater velocities, directions, and chemical quality correspond to known or suspected up-, down-, and cross-gradient contaminant locations. For example, evaluate the occurrence of contaminants at a down-gradient well in terms of most likely up-gradient source, groundwater velocity and direction known or estimated in that area.

(3) Discuss each contaminant site in terms of the geologic, hydrologic, and (when available) chemical data generated by this study. Combine these individual site presentations into a total installation environmental discussion. Relate the installation environmental setting to the regional level. This site to regional development shall be done graphically with narratives to cover key and subtle points.

(4) Present and evaluate the results of any geophysical efforts in terms of design versus actual results, and actual results versus confirmatory/ground truth data; e.g., water levels, chemical analyses, borehole stratigraphy, etc.

(5) Discuss and evaluate the results of any vadose zone monitoring.

(6) Specify and discuss any soil classifications and any other geotechnical data which were changed from the original field descriptions (see III.B.5.c.).

k. Significant Conclusions. Provide summary discussions of those project results which bear upon the intended survey objectives and related areas. Avoid quantitative conclusions based upon qualitative data. Highlight the limitations imposed upon the extrapolation of quantitative conclusions.

l. Recommendations. In addition to any specific recommendations requested within the Statement of Work, the contractor shall recommend those actions (if any) to refine or fill key data gaps and areas of uncertainty relative to the project objective. Additional recommendations should be made for those areas where a change in technique, methodology, or approach could result in a technical or cost benefit in any future efforts at the installation. The COR will specify whether the recommendations shall be included as part of the geotechnical or final report or be provided under a separate cover.

m. References. List by author, title, publication, volume, date, etc., those sources specifically referenced within the geotechnical report.

n. Bibliography. List as above those sources which provided or could provide general project-related data.

o. Appendices. Include data too bulky to be presented within the main body of the report; e.g., extensive tables or figures, or groups of data covering more than three pages. Where these data are in the DMS, they shall be presented in tabular and/or graphic form by the contractor directly from this System. The contractor shall coordinate with the COR to accomplish this requirement.

(1) Boring Logs. Provide legible copies of the "as submitted" field logs, uncorrected by office review and any lab analyses.

(2) Well Diagrams. Provide a detailed graphical presentation for each well with data per contract, to include hole depth, locations of screen, joints, centralizers, top of riser, top of protective casing, cave-in, granular filter pack, bentonite, grout, etc. Include an adjacent staff with appropriate Unified Soil Classification Symbols/rock classification for the entire length of drilled hole. Also graphically detail the protective measures at the well head; protective casing, pickets, caps, locks, etc. Key these sketches to both ground surface (depths below/heights above) and elevation (National Geodetic Vertical Datum of 1929).

(3) Well Development. Provide contractual data in tabular form.

(4) Water Levels. Provide, in tabular form, a listing of water levels (depths and elevations) for each well to include: well number, ground surface elevation, riser height above ground surface (stickup), riser elevation, first encountered water, initial 24-hour level after development, and subsequent static levels measured during the course of the contract. Each level must be annotated as to date of measurement and point from which measured. At least one complete set of static level measurements must be made and included for all project wells over a ten-hour period.

(5) Special Problems and Resolution. Discuss any special geotechnical problems and their resolution. This topic may be addressed in a separate letter to the COR.

(6) Aquifer Testing and Hydraulic Parameters. For the procedures and parameters required by contract, provide a detailed discussion of methodology used, assumptions made, and accuracy measured. Discuss how field conditions varied from those assumed in the method used. Evaluate the values measured against values reported in similar environments and against the setting and manner in which the values of this study were measured. Include references, field data, graphs of field data (e.g., time vs. drawdown plots), sample calculations for each parameter, and a graphical sketch of the relation between field and equation parameters. Present results in tabular form.

(7) Geophysical Data. Provide the data obtained during the study and any lengthy discussions better suited for an Appendix rather than in the main text.

(8) Vadose Zone Monitoring. Provide the data from any monitoring and any detailed discussions more appropriate for Appendices.

(9) Physical Analyses. Provide the references for all tests run. Include the method and procedures for any permeameter tests. Present the results in tabular form. Also, include grain-size graphs. Provide a discussion of these analyses with respect to permeability, both alone and as a comparison with aquifer test results.

(10) Topographic Survey Data. Provide a corrected, legible copy of the field topographic data; and in tabular form, the corrected coordinates and elevation of each surveyed and key feature, including, bores and wells, bench marks, key control points, etc. For each well, include the elevations of the top of the well riser, protective casing, and ground surface. See paragraph III.I. for more guidance. Provide a statement of closure, indicating the amount of error (in feet) to be expected for each set of coordinates and elevations.

p. Distribution List. This list will be provided by the Contracting Officer.

4. Technical Writing Style.

III.K.4.

a. Be quantitative. Use single, numerical values or ranges to convey magnitude, size, extent, etc. When ranges are used, denote the most probable value or a narrower, subrange of most probable occurrence. If qualitative terms must be used, define them within a numerical range.

b. Express confidence. Discuss the degree of confidence within the quantitative values generated. This confidence may be a function of field or lab conditions, technique, equipment, practice vs. theory, experience, personal bias, etc. Quantify the degree of confidence for key parameters such as elevations, velocities, permeabilities, porosities, gradients, etc. This shall be done through the use of (a) ranges with a most probable value, or (b) a single number with a plus-or-minus value attached.

c. For each point raised, provide a complete discussion. Do not leave the reader with unanswered questions which could have been naturally anticipated.

d. For maps, cross sections, boring staffs, well sketches, contour plots, etc., provide graphic scales (both vertical and horizontal) and a north arrow, as appropriate. Orient maps, contour plots, etc., with north toward the top of the page/sheet and orient the legend in the same manner as the map. Orient each graphic and its legend so that both can be easily read without rotating the graphic. Expand the graphics to cover the full paper size. Make all graphics fully and easily legible. Avoid any color coding on graphics. Provide vertical scales on both sides of each cross section and a horizontal scale along the base.

e. Adjust groundwater contours for topography (hills and valleys), streams (discharging, recharging), impermeable bedrock, and other obvious expressions of or alterations to the plotted groundwater contours.

f. Number all pages and denote those intentionally left blank.

g. Make sure separate graphics containing similar data agree. Make sure the field data, as corrected, agree with the graphical, tabular, and narrative presentations. Specify and discuss any changes made to the field data.

h. Address the four dimensional aspects of groundwater flow (X, Y, Z components and time) for each aquifer. The use of flow nets to supplement groundwater profiles and contours is desired.

i. Based on presurvey and survey data, provide hydrogeologic cross sections for the installation. These sections should include boring staffs with Unified Soil (and rock) Classification Symbols, summary well diagrams (with screen and seal locations noted), estimated stratigraphic correlation between borings, and estimated groundwater profiling.

j. <u>USE TABULAR FORMATS WHEREVER PRACTICAL.</u>

k. Provide literature/source credits for all data used or modified by the contractor. Credits shall appear in the text, on graphics, and in the list of references.

III.

L. Summary Lists.

1. Procedural and Material Summary. Table 2 denotes those geotechnical procedures and materials requiring specific USATHAMA-COR approval prior to their usage and the expected times for geotechnical evaluation and recommendations.

2. Document Submission Summary. In addition to those items to be submitted for approval per III.L.1., various documents and items discussed in these Geotechnical Requirements are to be submitted to the COR designated office (typically USATHAMA) after a particular action is completed. These materials and their submission times are summarized in Table 3.

III.

M. FIGURES

BENTONITE APPROVAL REQUEST

Army Installation for Intended Use:

1. Bentonite Brand Name:

2. Bentonite Manufacturer:

3. Manufacturer's Address and Telephone Number:

4. Product Description (from package label or attach brochure):

5. Intended Use:

SUBMITTED BY:

Company:

Person:

Telephone:

Date:

USATHAMA APPROVAL/DISAPPROVAL: (check one)

Project Officer/Date: A D

Project Geologist/Date: A D

BENTONITE APPROVAL REQUEST
FIGURE 1

WATER APPROVAL REQUEST

Army Installation for Intended Use:

1. Water source:

   Owner:

   Address:

   Telephone Number:

2. Water tap location:

   Operator:

   Address:

3. Type of source:

   Aquifer:

   Well depth:

   Static water level from ground surface:

   Date measured:

4. Type of treatment prior to tap:

5. Type of access:

6. Cost per gallon charged by Owner/Operator:

WATER APPROVAL REQUEST

FIGURE 2

7. Attach results and dates of chemical analyses for past two years. Include name(s) and address(s) of analytical laboratory(s).

8. Attach results and dates of duplicate chemical analyses for project analytes by the laboratory certified by, or in the process of being certified by, USATHAMA for those analytes.

SUBMITTED BY:

Company:

Person:

Telephone Number:

Date:

USATHAMA APPROVAL/DISAPPROVAL:	(check one)	
Project Officer:	A	D
Project Geologist/Date:	A	D
Project Chemist/Date:	A	D

WATER APPROVAL REQUEST

FIGURE 2

GRANULAR FILTER PACK APPROVAL REQUEST

Army Installation for Intended Use:

1. Filter Material Brand Name:

2. Lithology:

3. Grain Size Distribution:

4. Source:

   Company that made product:

   Location of pit/quarry of origin:

5. Processing Method:

6. Slot Size of Intended Screen:

Submitted by:

Company:

Person:

Telephone:

Date:

USATHAMA APPROVAL/DISAPPROVAL:	(check one)	
Project Officer Name/Date:	A	D
Project Geologist Name/Date:	A	D

GRANULAR FILTER PACK APPROVAL REQUEST
FIGURE 3

BORING LOG GENERAL DATA

Project: GENERAL AAP Boring: 87-14 Page: 1 of 3

Driller & Company: JACK JONES OF ACME CO

Geologist/Logger & Company: J. SMITH OF ACE CO Signature: J Smith

Date Boring Started: 7 NOV 87 Completed: 8 NOV 87

Water Levels (from Ground Surface) Drilling Rig: ABC 20

First Encountered: 7.0' Date: 8 NOV 87

While Drilling: 7.0 Date: 8 NOV 87

At Boring Completion: NOT MEAS. Date: 8 NOV 87

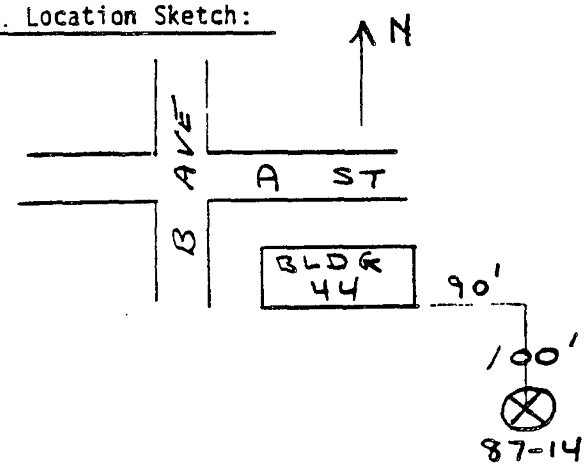
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
1987	Start	End	Start	End		Start	End	Start	End
7 NOV	1500	1700	0	5					
8 NOV	0800	1700	5	18.5					

Abbreviations:

Abbr	Meaning
3x3½, 2x2½	ID & OD OF SPL BBL SAMPLER
STD	1 3/8 x 2 STANDARD SAMPLER
R	RECOVERY
C/B	CORING INDUCED BREAK
NB	NATURAL BREAK
LC	LOST CORE
3X	3x3½ SAMPLER
2X	2x2½ SAMPLER

Location Sketch:



BORING LOG FORMAT

FIGURE 4

Project: GENERAL AAP | Boring: 87-14 | Page: 2 of 3

Depth/ Elevation (FT)	USCS Symbol/ Core Sketch	Soil/Rock Description (GROUND SURFACE)	Sample Number & Depth	Blow Count & Recovery	Drilling Data
0	OL	ORG CLAY, SANDY DK RED BRN 5YR 3/4 (MUNSELL) V MOIST, L PLAST ROOTMAT, TOPSOIL	0 S# 1 .8	3X3½ 3	NOTES: 1- ALL SAMPLERS DRIVEN BY 140LB HAMMER, FALLING 30" 2- ALL DEPTHS & RECOVERIES IN FT 3- DEPTHS FROM GROUND SURFACE
.8 1 2 3 4	SM	TRANSITIONAL .8 - 1.5 SILTY SAND 20% FINES F-M SAND < 60% F, 20% M MOIST, LOOSE YEL BRN 10YR 5/4 FAINTLY BEDDED FLAT LYING & X-BEDDED < 5% SILTY CLAY (CL) LAMINAE FLUVIAL SHARP	1.5 S# 2 3.0 3.5 S# 3 4.6	2 R1.5 2X2½ 4 6 R1.5 STD 2 4	NOTE 0' 1. DROVE 3X TO 1.5' 2. DROVE 2X TO 3.5' 3. DROVE STD TO 5' 4. SET HSA W/PLUG TO 5', PULLED PLUG (HSA: 3¼" ID, 7" OD)
.6 5 6 7	SP	SAND < 5% FINES F-C SAND { 60% C, 10% M, 25% F V MOIST - SAT NO APPARENT BEDDING LOOSE LT RED BRN 5YR 6/4 V MOIST SAT FLUVIAL SHARP	5.0 S# 4 6.0 6.5 S# 5 7.5	5 R1.5 3X 10 5 R1.0 2X 8 10	END 7 NOV 87 START 8 NOV NOTE 5' 1. HOLE DRY + OPEN TO 5' 2. DROVE 3X TO 6.5' 3. DROVE 2X TO 8.5' 4. FREE WATER ON SAMPLER & IN SAMPLE 5. MEAS. WATER AT 7.0 W/ ELEC TAPE. AFTER 5 MIN, STILL AT 7.0 6. DROVE STD TO 10' 7. SET HSA W/ PLUG TO 10', PULL PLUG
8 9 10	GP	SANDY GRAVEL 20% F-C SAND 80% F GRAVEL LT RED BRN 5YR 6/4 MED DENSE SAT, NO APP BED FLUVIAL	8.5 S# 6 9.8	R1.0 STD 2 4 8	

BORING LOG FORMAT

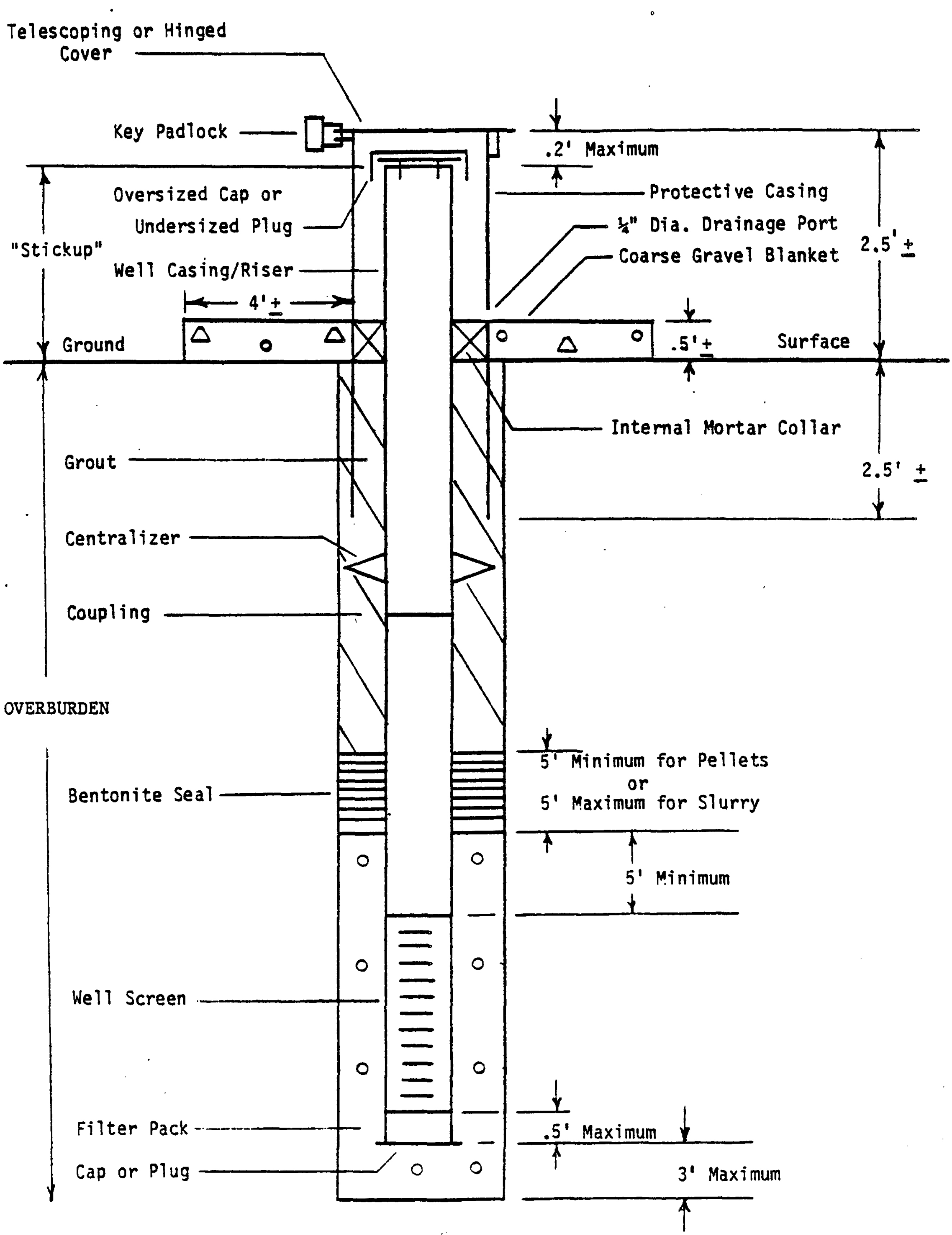
FIGURE 4

Project: GENERAL AAP	Boring: 87-14	Page: 3 of 3

(FT) Depth/ Elevation	USCS Symbol/ Core Sketch	Soil/Rock Description	10 Sample Number & Depth	10 Blow Count & Recovery	Drilling Data
10	GP	SANDY GRAVEL (CONT'D) APPROXIMATE	S#7 10.5	3X 100 R.5 10.9	NOTE 10' 1. DROVE 3X TO 10.9' (REFUSAL)
11 .9	L C	TOP OF WEATHERED ROCK LIMESTONE (LM) BASED ON CUTTINGS 1.1' LOST DUE TO DRILLING METHOD		12.0	2. PULLED ALL HSA SET 6" CSG TO 11.5' 3. DRILLED W/ ROLLER BIT (6") TO 12.0, WATER LOSS 30 GAL 11.5'-12.0'
12	L C	LM, .5 LOST DUE TO WEATHERING & FRACTURES TOP OF SL. WEAT. ROCK	12.5		
13	CIB	LIMESTONE SANDY (SILICEOUS) FOSSILIFEROUS, NUMEROUS CORALS &		RUN #1 R1.5	NOTE 12 1. START CORE, RUN #1 AT 12' W/ 4" DOUBLE TUBE & DIAM. BOT. DISCH. BIT
14	CIB	GASTROPODS THIN, HORIZONTAL BEDDING	BOX 1 OF 1	14.0	2. RUN #1 40 GAL LOST 12-12.5
15	NB NB	YEL BRN 10YR5/4 HARD WELL CEMENTED		RUN #2	0 LOST 12.5-14
16	NB	DENSE - COARSE GRAINED SCAT (<5%) TIGHT 45° FRACTURES			SOUNDED, HOLE 14.0' NOTE 14
17	CIB	NO STAINING SOLID, LOW PRIMARY & SECONDARY PERM. ST. GEORGE FM	18.0		1. RUN #2, COMPLETE, WATER LOSS 18-18.5 (50 GAL)., SH 18.5 NOTE 18.5 1. TOO FRACTURED TO CORE, USE GEAR BIT TO 30',
18	L C	.5' LOST LM BADLY FRACTURED	18.5	R4.5 18.5	2. LOST 500 GALS 3. HOLE OPEN TO 30' 4. SET WELL, PULLED ALL CASING END 8 NOV 87
.5		11.5' LOST, HIGHLY FRAC. LM (CUTTINGS) V. ROUGH DRILLING	S#8		
30		BOTTOM OF HOLE 30.0			

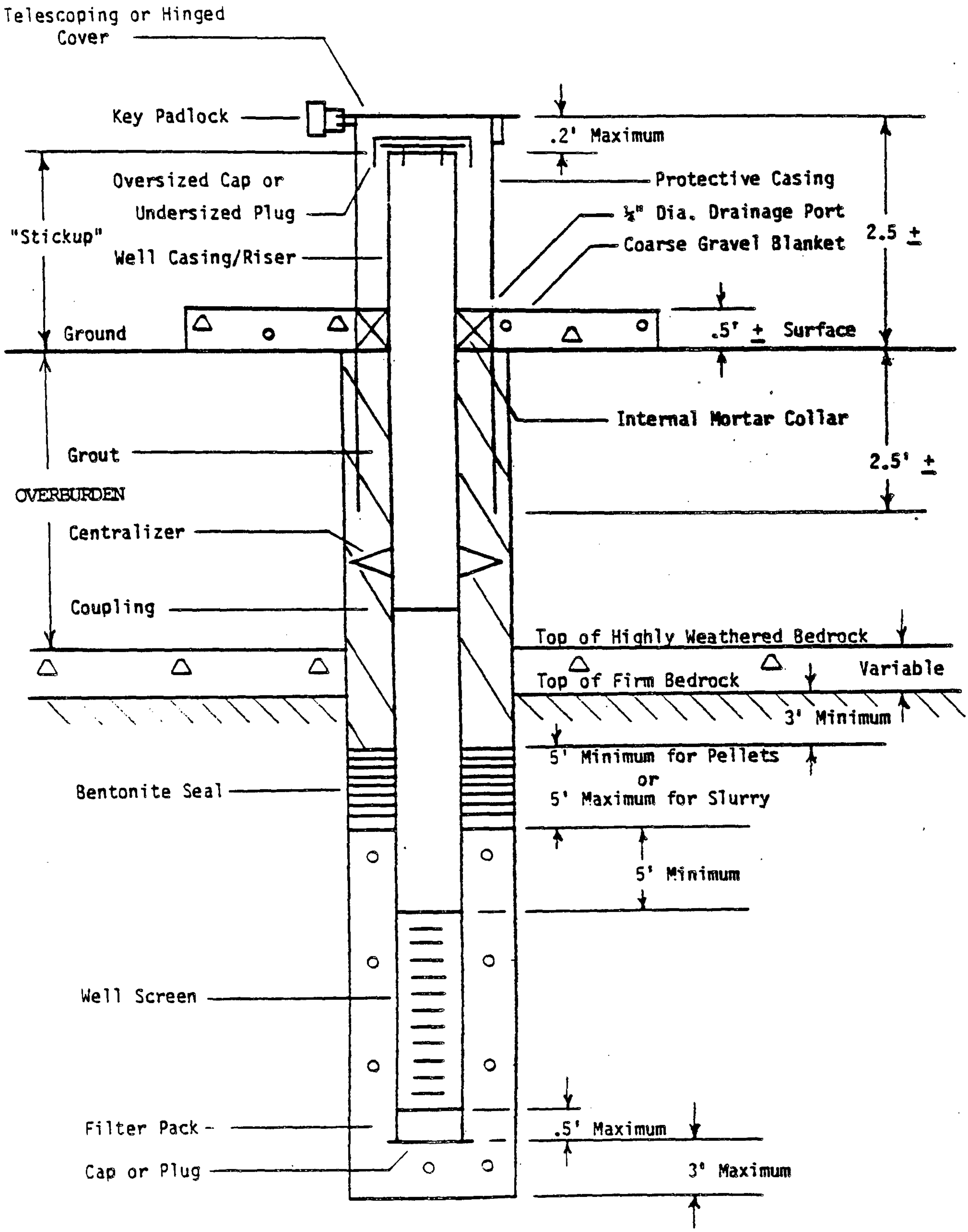
BORING LOG FORMAT

FIGURE 4



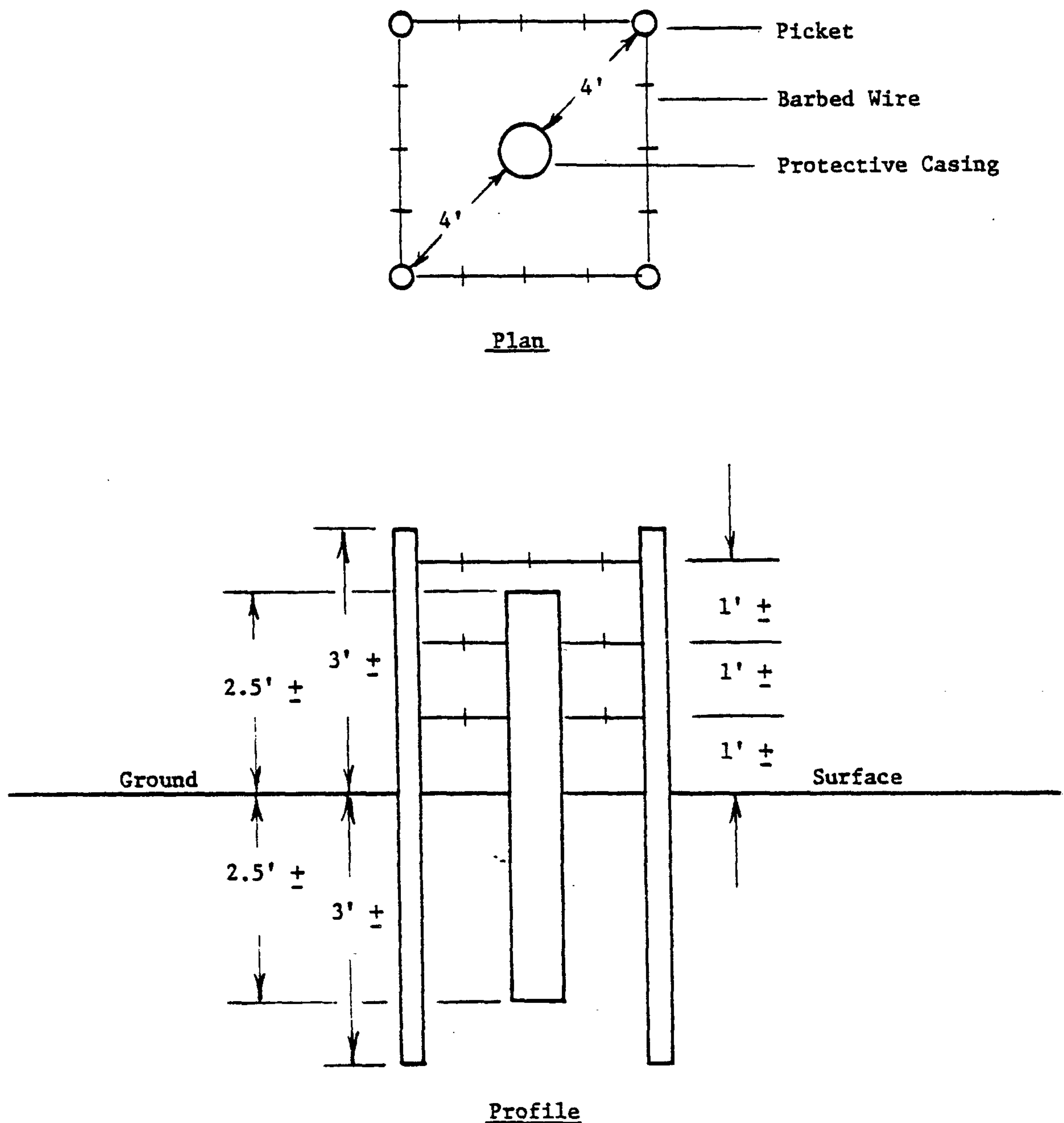
SCHEMATIC CONSTRUCTION OF
OVERBURDEN WELL

FIGURE 5

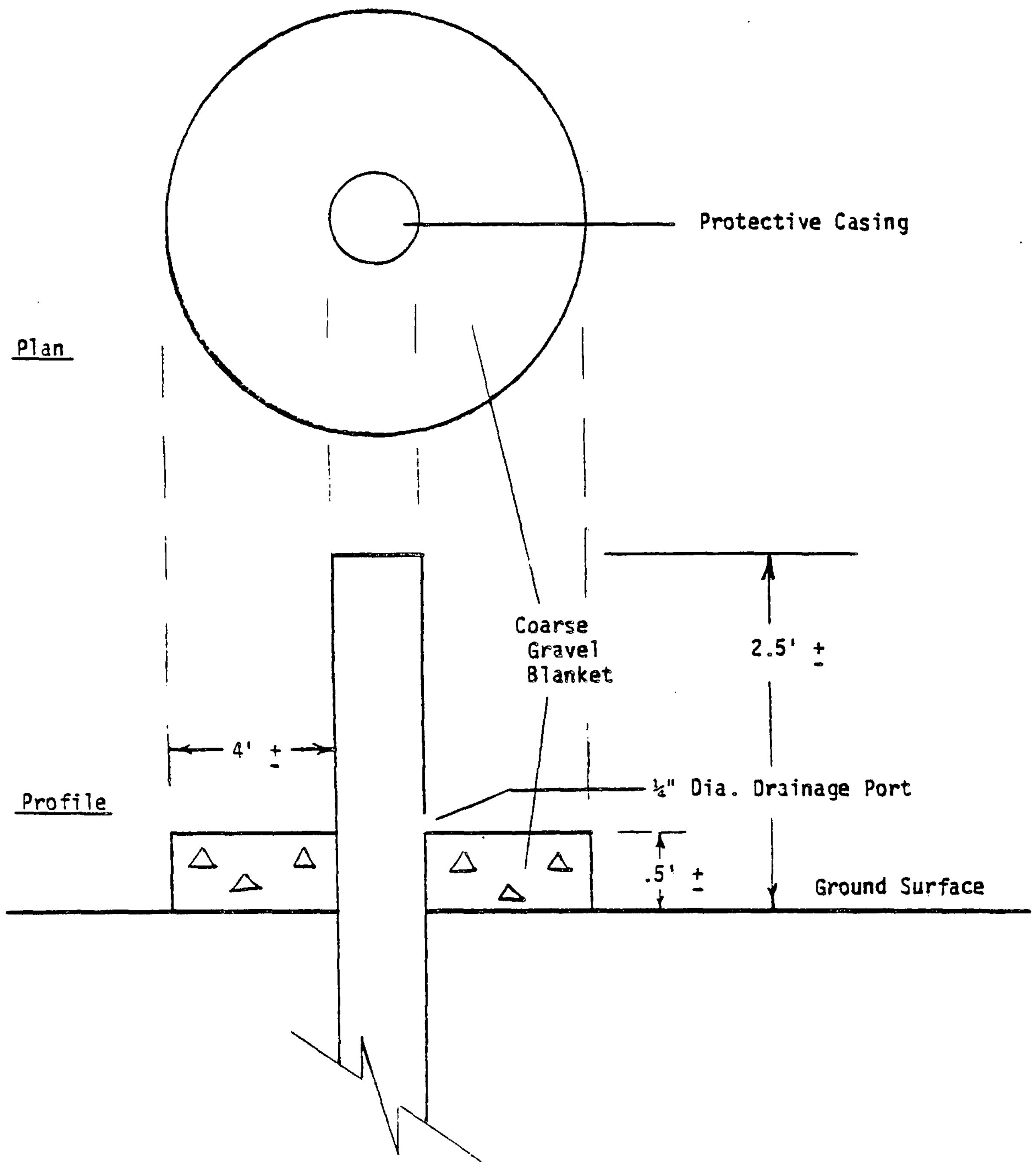


SCHEMATIC CONSTRUCTION OF
BEDROCK WELL

FIGURE 6



PICKET PLACEMENT AROUND WELLS
FIGURE 7



COARSE GRAVEL BLANKET LAYOUT

FIGURE 8

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3 DISTRIBUTION / AVAILABILITY OF REPORT
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE	
4 PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION / 6b. OFFICE SYMBOL *(If applicable)*	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (*City, State, and ZIP Code*)	7b. ADDRESS (*City, State, and ZIP Code*)
8a. NAME OF FUNDING / SPONSORING ORGANIZATION / 8b. OFFICE SYMBOL *(If applicable)*	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (*City, State, and ZIP Code*)	10. SOURCE OF FUNDING NUMBERS: PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO.

11 TITLE *(Include Security Classification)*

12 PERSONAL AUTHOR(S)

13a. TYPE OF REPORT	13b. TIME COVERED FROM ______ TO ______	14. DATE OF REPORT *(Year, Month, Day)*	15. PAGE COUNT

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS *(Continue on reverse if necessary and identify by block number)*
FIELD	GROUP	SUB-GROUP	

19. ABSTRACT *(Continue on reverse if necessary and identify by block number)*

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FIGURE 9

Page 1 of 2

20. DISTRIBUTION / AVAILABILITY OF ABSTRACT ☐ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION
22a. NAME OF RESPONSIBLE INDIVIDUAL	22b. TELEPHONE *(Include Area Code)* / 22c. OFFICE SYMBOL

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SECURITY CLASSIFICATION OF THIS PAGE

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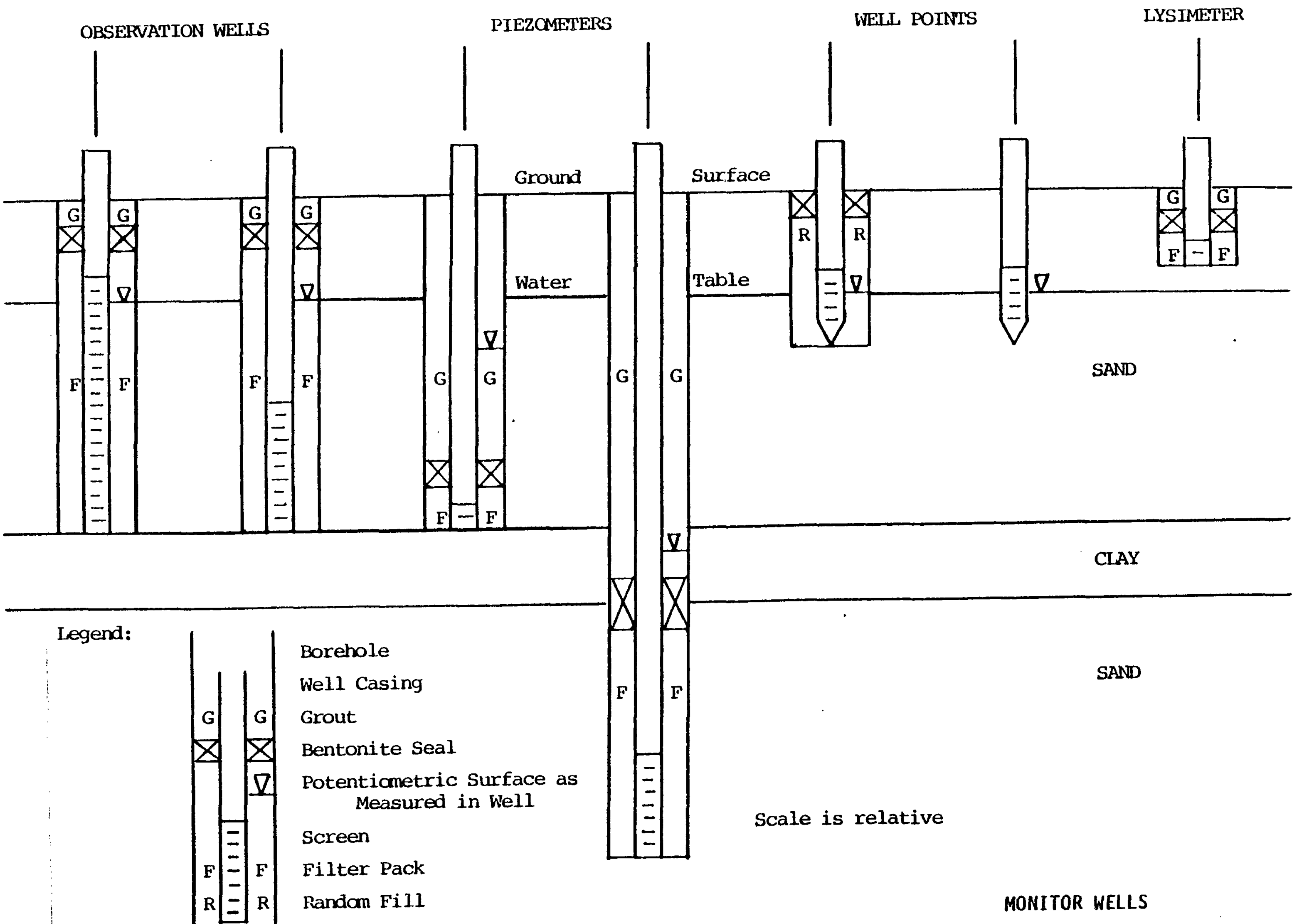
FIGURE 9

Page 2 of 2



MONITOR WELLS
FIGURE 10

MAP CODING FORM

Installation GP Site Type BORE Site Id 87-14

Description Information :

Pointer Information:
Pointer Site Type: WELL
Pointer Site Id: 87-14
Aquifer id: PALEO

Area Information:
Coord Sys: Acc Source Code: Exp: No.Points:

Coordinate	X	Y	Coordinate	X	Y
1			10		
2			11		
3			12		
4			13		
5			14		
6			15		
7			16		
8			17		
9			18		

LSMP Information:
Coordinate System: UTM Accuracy Source Code: S Exponent: Ø
Coordinate — X 54321 Y 99876

Elevation Information:
Elevation Source: S
Elevation Accuracy: Ø
Elevation: 4321

MAP FILE CODING SHEET (BORE)

FIGURE 11

MAP CODING FORM

Installation GP Site Type WELL Site Id 87-14

Description Information :

Pointer Information:
Pointer Site Type: BORE Pointer Site Id: 87-14
Aquifer id: PALEO
Area Information:
Coord Sys: Acc Source Code: Exp: No.Points:

Coordinate	X	Y		X	Y
1			10		
2			11		
3			12		
4			13		
5			14		
6			15		
7			16		
8			17		
9			18		

LSMP Information:
Coordinate System: UTM Accuracy Source Code: S Exponent: Ø
Coordinate — X 54321 Y 99876

Elevation Information:
Elevation Source: S
Elevation Accuracy: Ø
Elevation: 4321

MAP FILE CODING SHEET (WELL)

FIGURE 12

INST	FILE TYPE	LAB	INITIALS
GP	GFD	AC	JS

GEOTECHNICAL DATA ENTRY CODING FORM

FIELD DRILLING AND WELL CONSTRUCTION

SITE TYPE	SITE ID
BORE	87-14

DATE	ACTION MEAS	METHOD	DEPTH	INTERVAL	VALUE	UNITS	ENTRY
11/08/87	GRDWT	01			7.0	FT	
11/08/87	DBRK	01			11.9	FT	
11/08/87	DPTOT	01			30.0	FT	
11/07/87	USCS	01	0.0	.8		FT	OL
11/07/87	USCS	01	0.8	3.8		FT	SM
11/08/87	USCS	01	4.6	3.4		FT	SP
11/08/87	USCS	01	8.0	3.9		FT	GP
11/08/87	USCS	01	11.9	18.1		FT	LMSN
/ /							

FIELD DRILLING FILE CODING SHEET
FIGURE 13

INST	FILE TYPE	LAB	INITIALS
GP	GWC	AC	JS

GEOTECHNICAL DATA ENTRY CODING FORM

FIELD DRILLING AND WELL CONSTRUCTION

SITE TYPE	SITE ID
WELL	87-14

DATE	ACTION MEAS	METHOD	DEPTH	INTERVAL	VALUE	UNITS	ENTRY
11/08/87	STKUP	01			2.3	FT	
11/08/87	BSEAL	01			5.0	FT	
/ /	CASE	01			25.0	FT	
/ /	CASED	01			.33	FT	
/ /	DPTOT	01			30.0	FT	
/ /	GFILT	01			10.0	FT	
/ /	GROUT	04			15.0	FT	
/ /	SCREN	02			5.0	FT	
/ /							

WELL CONSTRUCTION FILE
CODING SHEET
FIGURE 14

GEOTECHNICAL DATA ENTRY CODING FORM

INST	FILE TYPE	LAB	INITIALS
GP	GGS	AC	JS

UNITS
FT

GROUND WATER STABILIZED *

SITE TYPE	SITE ID	DATE	DEPTH
WELL	87-14	11/12/87	6.7
WELL	87-14	12/2Ø/87	7.4
WELL	87-14	Ø1/Ø4/88	9.1
		/ /	
		/ /	
		/ /	
		/ /	
		/ /	
		/ /	
		/ /	
		/ /	
		/ /	

* - Depth measured from ground surface

GROUNDWATER STABILIZED FILE
CODING SHEET
FIGURE 15

III.

N. TABLES

TABLE 1

WELL CONSTRUCTION MATERIALS

Material (Example Entries)	Brand/Description (Example Entries)	Source/Supplier (Example Entries)
PVC Casing	4.0" ID, Schedule 40, flush threaded; 2" ID, Schedule 40, flush threaded.	ABC Mfg; Aville, Minnesota
PVC Screen	.05" slot, 4.0" ID, Schedule 40, flush threaded, .02" slot, 2" ID, Schedule 40, flush threaded	ABC Mfg; Aville, Minnesota
Bentonite (drilling fluid and grout)	Tru-gel	A. O. Bentonite, Bville, Wyoming
Granular Bentonite (seal)	Gran-Bent	White Mud, Cville, Montana
Bentonite Pellets (seal)	(No brand name available)	PELBENT, Dville, Utah
Sand (filter pack)	8-12 silica sand	State Sand, Mville, Colorado; supplier: EFG Co. Eville, Utah
Cement (grout)	Portland Type II	A. Lumber Co., Eville, Utah
Drilling Water	St. Peter Sandstone	Production Well #1, Tap at well house General AAP
Drilling Rod Lubricant	Slick Turn	Oil Products Co., Fville, Texas
Air Compressor Oil	Oil #40	Oil Products Co., Fville, Texas

TABLE 2

PROCEDURAL AND MATERIAL APPROVAL SUMMARY

Items Requiring Approval	Reference Section	Time for Approval	Turn Around Time for Geotechnical Evaluation and Recommendation
Drilling Method	III.A.1.c.	Prior to contract/task award	During Proposal/ Bid Evaluation
Air Usage	III.A.2.	Prior to contract/task award	During Proposal/ Bid Evaluation
Bentonite	III.A.10.a.	Prior to drilling equipment arrival onsite	6 Working Days
Water	III.A.10.b.	Prior to drilling equipment arrival onsite	3 Calendar Weeks
Abandonment	III.A.11.	Prior to casing removal or backfilling	4 Consecutive Hours
Borehole Fluids, Cuttings, and Well Water Disposal	III.A.16.	Prior to technical plan acceptance	During Plan Evaluation
Time of Well Installation	III.C.1.	Prior to drilling	3 Working Days
Well Screen and Casing Materials	III.C.2.a.	Prior to contract/task award	During Proposal/ Bid Evaluation
Granular Filter Pack	III.C.5.a.	Prior to drilling	8 Working Hours
Protective Casing, Exceptions	III.C.8.a	Prior to drilling	6 Working Days
Geophysical Procedures	III.G.	Prior to use	Time not specified
Vadose Zone Monitoring	III.H.	Prior to use	Time not specified

TABLE 3

CONTRACTOR DOCUMENT/ITEM SUBMISSION SUMMARY

Document/Item	Reference Section	Submission Time	Submission To
Geotechnical Requirements (modified per contract)	II.A.	With Technical Plan (or equivalent document)	USATHAMA-COR
Licenses of Surveyor and Driller	III.A.5.	With Technical Plan (or equivelent document)	USATHAMA-COR
Submissions to State and/or local authorities	III.A.5.	As required	State and/or local offices coordinated through USATHAMA
Abandonment memorandum (written)	III.A.11.	Within 5 working days of telephonic request	Contracting Officer through USATHAMA
Abandoned boring and/or well record	III.A.11.	Within 3 working days of abandonment	USATHAMA-COR
Soil physical testing results	III.A.12.d.	Within 10 working days of final test	USATHAMA-COR
Rock core photography	III.A.13.	Within 2 weeks of last coring	USATHAMA-COR
Boring logs	III.B.2.	Within 3 working days after boring completion or instrumentation completely installed	USATHAMA-COR
Boring log abbreviations, general legend	III.B.5.v.	With first or last log, as appropriate	USATHAMA-COR
Two keys to padlocks	III.C.8.c.(8)	Upon completion of last well placement	Installation Representative and USATHAMA
Well diagram	III.C.12.c.	Within 3 working days of well/protective measure completion	USATHAMA-COR

TABLE 3 (Cont'd)

Document/Item	Reference Section	Submission Time	Submission To
Well development record	III.D.2.	Within 3 working days after development	USATHAMA-COR
Well development water sample	III.D.10.	Within 3 working days after developing that well	USATHAMA-designated individual
Geotechnical Report(s)	III.K.	As required per contract or task	Contracting Officer through USATHAMA