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NAVAL AIR STATION
MOFFETT FIELD, CALIFORNIA

FINAL ADDITIONAL PETROLEUM SITES INVESTIGATION FIELD WORK PLAN

Prepared by

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January 21, 1994

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Subject: **Final Additional Petroleum Sites Investigation Field Work Plan, Naval Air Station Moffett Field, CLEAN Contract Number N62474-88-D5086, Contract Task Order 0236**

Dear Camille:

Enclosed please find three copies of the above referenced report prepared by PRC Environmental Management, Inc. (PRC). Comments on the draft field work plan were received from the Navy, the San Francisco Bay Regional Water Quality Control Board, the U.S. Environmental Protection Agency, and the California Environmental Protection Agency Department of Toxic Substances Control. These comments have been addressed in this final report, and responses to the comments are included under this cover. By cover of this letter, copies of the final field work plan and responses to comments have been sent to the appropriate project personnel and regulatory agencies.

If you have any questions or comments, please call us at (303)295-1101.

Sincerely,

Steve Annecone
Environmental Engineer

Joshua D. Marvil
Project Manager

SA/mkf

Enclosure

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DISTRIBUTION

Final Additional Petroleum Sites Investigation Field Work Plan

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1.0 INTRODUCTION

PRC Environmental Management, Inc. (PRC), under Contract Task Order (CTO) 0236, is providing technical support to the Navy for feasibility study (FS) and remedial design (RD) activities at Naval Air Station (NAS) Moffett Field, Santa Clara County, California. CTO 0236 is part of the Comprehensive Long-term Environmental Action Navy (CLEAN) program for the environmental restoration of Navy facilities. Task 6 of this CTO includes conducting field investigations for selected petroleum sites to further define the extent of contamination. In addition to the petroleum sites, this CTO also addresses the wastewater sumps and tanks originally thought to contain only petroleum products. Existing data from these wastewater sumps and tanks have been discussed in the final petroleum sites (and wastewater tanks and sumps) characterization report (PRC 1993a). This field work plan presents the technical approach for conducting additional petroleum sites investigations, including methods and procedures.

The field work plan is organized as follows. Section 2.0 presents the purpose of the additional petroleum and wastewater tanks and sumps investigation. Section 3.0 presents the site background. Section 4.0 describes the field activities, including sampling locations, methods, and procedures. Section 5.0 presents the quality assurance project plan (QAPjP). Section 6.0 presents the health and safety plan (HSP). Section 7.0 presents a tentative schedule for completion of the activities.

2.0 PURPOSE AND SCOPE

The purpose of the additional petroleum and wastewater tanks and sumps investigation is to gather information necessary to further assess the vertical and lateral extent of contamination at these sites. This will entail collecting soil samples, installing groundwater monitoring wells, collecting groundwater samples, and analyzing the resulting soil and water samples to further evaluate the extent of contamination in areas that are inadequately characterized. As indicated in the petroleum sites characterization report (PRC 1993a), site contamination data gaps exist that preclude the completion of a final corrective action plan (CAP). Implementation of this field work plan should result in the acquisition of information necessary to complete the final CAP and will aid in the design of any remedial measures that may be necessary.

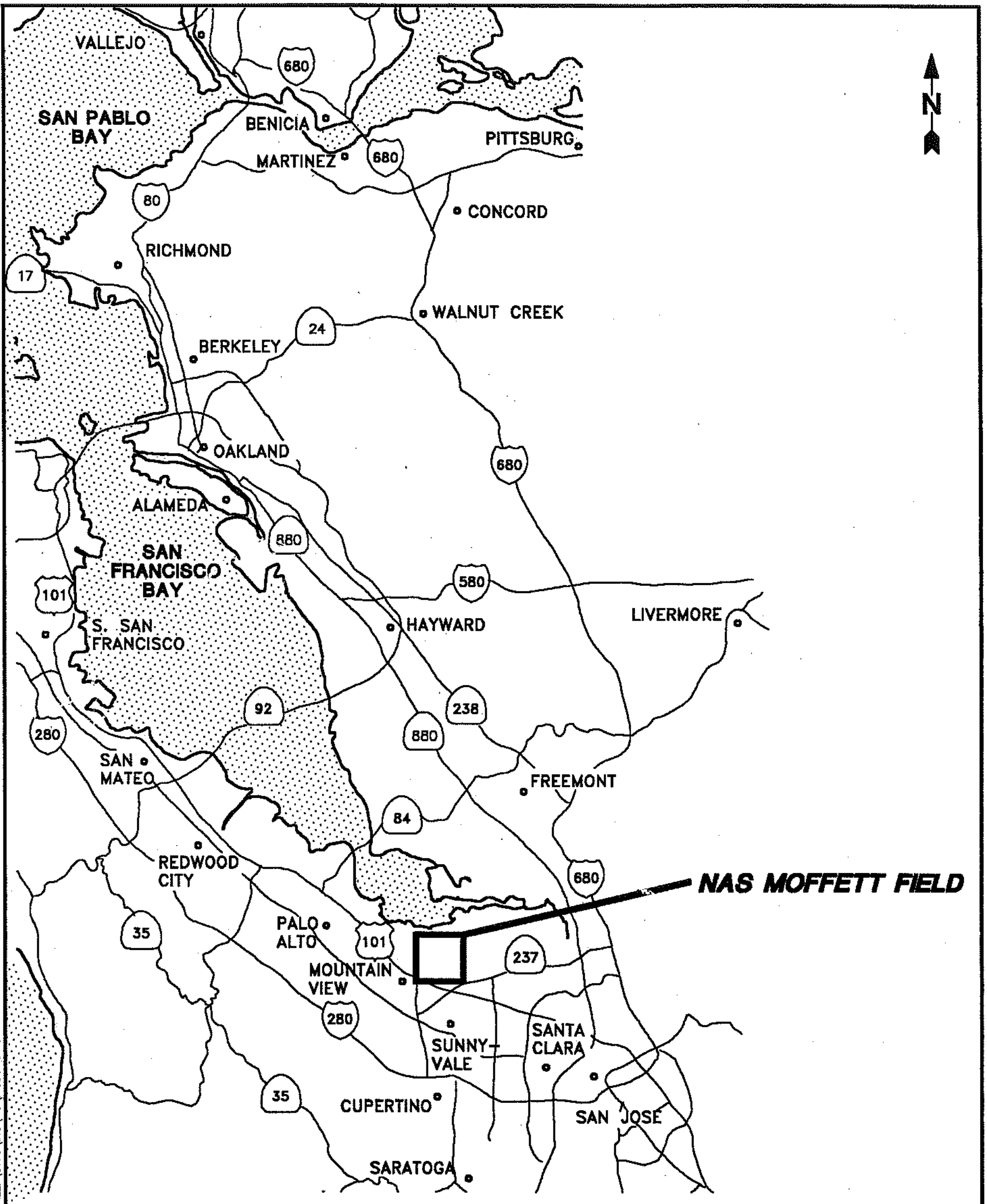
The petroleum sites and wastewater tanks and sumps addressed in this field work plan have been designated as Installation Restoration Program (IRP) Sites 5, 9, 15, and 19 (see Plate 1). The Navy has produced reports from previous investigations at these sites, including the initial assessment study (NEESA 1984), the operable unit 2 remedial investigation report (IT 1993), the tank and sump removal summary report (PRC 1991), and the additional tank and sump field investigation technical memorandum (PRC 1993b) among others. However, further information is required for these sites to complete a final CAP. Specific areas addressed by this field work plan include Site 5 soils and groundwater, Site 9 soils, Site 15 soils and groundwater, and Site 19 soils and groundwater (Tanks 2, 43, and 53). The specific recommended field activities for investigation of these sites are discussed in detail in Section 4.0.

Approximately 4,000 cubic yards of fuel-contaminated soils at Site 12 were excavated in November and December 1993. This soil is currently being treated to reduce total petroleum hydrocarbon (TPH) concentrations to less than 100 parts per million (ppm). The excavation pit will be backfilled with treated soils when treatment goals have been met. During November and December 1993, sidewall soil samples were collected and currently are being analyzed for petroleum contamination. A technical memorandum summarizing the activities will be prepared after soils are treated and backfilled and analytical data are available. This technical memorandum will include recommendations for any further investigations at Site 12. Because of these ongoing activities, additional Site 12 investigations are not included in this field work plan.

To the extent possible, this investigation will incorporate data gathered during other site inspection investigations either planned, in progress, or already conducted at NAS Moffett Field. Coordination with other agencies conducting similar investigations will be maintained to minimize duplication of effort.

3.0 SITE BACKGROUND

NAS Moffett Field is located about 1 mile from the southern end of San Francisco Bay, adjacent to the cities of Mountain View and Sunnyvale, California (Figure 1). The facility encompasses 2,200 acres in Santa Clara County. Since the 1950s, the primary mission of NAS Moffett Field has been to support antisubmarine warfare training and patrol squadrons. NAS Moffett Field is designated for closure as an active military base under the Department of Defense (DOD) Base Realignment and Closure (BRAC) program. The National Aeronautics and Space Administration (NASA), which operates the Ames Research Center on the northern side of NAS Moffett Field, is scheduled to assume control of the facility by October 1994.



0 3.75 7.5 11.25 15

SCALE: 1" = 7.5 MILES

FIGURE 1
NAS MOFFETT FIELD
REGIONAL LOCATION MAP

DATE: 12/14/93 JLH DN FILE: \0170\IRS\ITS\FIG007.DWG

The U.S. Environmental Protection Agency (EPA) proposed NAS Moffett Field as a National Priorities List (NPL) site in June 1986 and placed it on the NPL in July 1987. Placement on the NPL initiated the remedial investigation and feasibility study (RI/FS) process under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Environmental investigation and restoration activities at NAS Moffett Field are coordinated under a federal facilities agreement (FFA) signed by the EPA, the California EPA Department of Toxic Substances Control (DTSC), and the California Regional Water Quality Control Board, San Francisco Bay Region (RWQCB).

The Navy, as part of the IRP, has been identifying and evaluating past hazardous waste sites and controlling the spread of contaminants from these sites. The Navy began its environmental investigation of NAS Moffett Field in 1984 with an IAS to gather data on the past use and disposal of hazardous materials (NEESA 1984). Nineteen sites have been identified as potential sources of waste, including nine sites identified in the IAS and 10 sites added during subsequent investigations (ERM and AR 1986a, 1986b; ESA and JMM 1986; ERM 1987). Data collected during these studies were used to plan the RI/FS for NAS Moffett Field. In December 1991, the Navy, EPA, DTSC, and RWQCB formally agreed to the division of NAS Moffett Field into six operable units (OUs) and modified the FFA to incorporate them. The OUs, as originally identified, included:

OU1	-	IRP Sites 1 and 2 soils
OU2	-	IRP Sites 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 14, 16, 17, 18, and 19 soils
OU3	-	IRP Sites 12 and 15 soils
OU4	-	Aquifers on the western side of the station
OU5	-	Aquifers on the eastern side of the station
OU6	-	Wetland areas

In October 1992, EPA determined that the aquifers on the western side of NAS Moffett Field were affected by the regional volatile organic compound (VOC) plume emanating from the Middlefield Ellis Whisman (MEW) Superfund sites and that these aquifers were subject to the 1989 record of decision (ROD) already written for the MEW sites to direct the remediation of these aquifers. Consequently, OU4 was deleted and OU5 was modified to include all aquifers not part of the regional VOC plume. Similarly, EPA considered the IRP soil sites overlying the regional VOC plume also subject to the MEW ROD. Therefore, OU2 was separated into OU2-West (Sites 8, 9, 10, 14, 16, 17, 18, and 19, which overlie the regional VOC plume) and OU2-East (Sites 3, 4, 6, 7, 10, 11, 13, and 19, which do not overlie the regional VOC plume). Because some of the IRP sites are large or composed of multiple subsites, some are included in both divisions of OU2. In October 1993, the

Navy and the regulatory agencies agreed that OU1 also should include groundwater. Therefore, OU1 was redefined as soil and groundwater at Sites 1 and 2 and OU5 was further modified to exclude the groundwater associated with OU1.

In addition, petroleum-contaminated soils (primarily OU3) and groundwater were removed from the RI/FS process pursuant to the CERCLA petroleum exclusion. Regulatory requirements for petroleum sites and wastewater tanks and sumps will be evaluated on a site-specific basis. For example, although excluded from CERCLA, investigation and closure of petroleum tanks should be consistent with the state and federal regulations cited in the FFA: Sections 6001, 7003, and 9007 of the Resource Conservation and Recovery Act (RCRA); Title 40 Code of Federal Regulations (CFR) Part 280; California Health and Safety Code Division 20, Chapters 6.5, 6.7, 6.75 and 6.8; California Water Code Division 7; Title 23 California Code of Regulations Division 3, Chapter 16; and water quality control plans, as applicable. Additionally, the state has prepared general guidance (RWQCB 1990; SWRCB 1989 and 1993) for petroleum and UST investigations and closures. Investigation and closure of wastewater tanks and sumps are not excluded from CERCLA and will be addressed under the provisions of CERCLA.

4.0 PROPOSED FIELD ACTIVITIES

The following section describes the proposed field activities to be conducted for this investigation. The field activities include ground penetrating radar (GPR) surveys, soil sampling using the Geoprobe®, monitoring well installation, groundwater sampling, surveying, and waste disposal. These tasks are discussed in the following subsections.

4.1 GROUND PENETRATING RADAR

GPR surveys will be conducted to identify subsurface obstacles before any intrusive field activities begin. Each Geoprobe® soil sample, monitoring well, and CPT location will be surveyed using GPR. For each location, the GPR survey will include the area within a 5-foot radius of the intended point of penetration. If the GPR shows an obstruction, the original point will be marked and the safe direction of offset will also be marked. If cleared by GPR, the location will be marked on the ground with a semipermanent marking (spray paint or stake). A map of the final cleared locations of all points will be maintained in the PRC field trailer throughout the field activities. Records maintained in the field trailer will include field notes taken by the personnel conducting the GPR survey.

4.2 SUBSURFACE SOIL SAMPLING

Approximately 61 soil samples will be collected using the Geoprobe® soil coring system and at least two samples will be collected from new groundwater well soil borings, with the exact number depending on contamination detected in the field during sampling. An additional seven samples will be collected for geotechnical properties at Sites 5, 9, and 19. The average depth of soil samples will be approximately 8 feet. The average sample depth illustrates the level of effort planned for this field investigation. A PRC geologist will determine the actual total depth and sample intervals of any coring in the field based on visual examination of sediment samples and on photoionization detector (PID) readings. Corings will penetrate the zone of interest (including depths down to the water table in all cases) and are intended to sample all contaminated soil intervals within the corings.

Soil samples at sites where no or few previous data exist (such as Tank 1 and some Site 15 sumps) will be collected at a minimum of every 5 feet in the unsaturated zone and at major changes in lithology as per state guidance (RWQCB 1990). Soil samples collected at sites where previous soil data exist (Sites 5, 9, and 19) will target the zone where the highest concentration of petroleum is anticipated. This zone typically lies within the region of water table fluctuations. However, any contaminated soil intervals encountered in the vadose zone will also be sampled.

All samples (with the exception of geotechnical samples) from each core will be analyzed at a California-certified laboratory, and the extent of contamination will be evaluated based on these analyses. Duplicate samples will be collected during coring, and these will be analyzed for TPH contamination using the Geoprobe®'s close support analytical laboratory (CSAL). Though the Geoprobe® has accurate analytical capabilities, it will be used in this investigation primarily as a field screening and sample collection tool.

Section 4.2.1 describes the proposed locations of the soil samples. Section 4.2.2 discusses the field procedures associated with collecting and sampling the soil cores. Section 4.2.3 briefly describes the types of chemical analyses proposed for the soil samples.

4.2.1 Locations

Site 5

Many soil data gaps exist at Site 5, as indicated in the petroleum sites characterization report (PRC 1993a). Some of the original soil borings, particularly on the southern half of this site, did not penetrate the water table where petroleum contamination would most likely be located. Additionally, existing soil data are too sparse to define contaminated soil to the extent necessary for implementing corrective action. Approximately 24 soil cores will be taken at this site, and all cores will be sampled, at a minimum, at or near the water table. These sample locations will be labeled GP5-1 through GP5-23 and SB5-35.

Figure 2 shows the proposed locations of additional soil samples at Site 5. Soil sample locations GP5-1 through GP5-9 were selected to further evaluate the vertical and lateral extent of contamination possibly due to the Tank 12 spill, as no other soil data points exist within 100 feet of these locations. Sample locations GP5-10, GP5-11, and GP5-12 were chosen to better characterize the extent of possible contamination due to former Tank 26 as evidenced by excavation sidewall samples. Soil sample locations GP5-13 through GP5-23 were chosen to further evaluate the extent of soil contamination indicated by previous investigations (PRC 1993a), and in most cases the locations are selected near previous shallow soil borings that did not penetrate the water table. Geotechnical soil samples will be labeled GT5-1 and GT5-2. The exact locations may be adjusted somewhat due to subsurface obstructions indicated by the GPR survey.

Site 9

As with Site 5, existing data for soils at Site 9 are insufficient to assess the extent of soil petroleum contamination. Three known petroleum-contaminated soil areas exist at Site 9, near buildings 10, 29, and 31, and 19 soil sample locations are proposed for this investigation. These soil cores will be labeled GP9-1 through GP9-19, and their locations appear in Figure 3. Geotechnical soil samples will be labeled GT9-1 and GT9-2.

Soil sample locations GP9-1 through GP9-8 were selected to further evaluate the extent of contamination around the Building 31 area. In almost all cases, these locations are at least 100 feet from existing soil boring data, near borings that were not sampled within the water table fluctuation

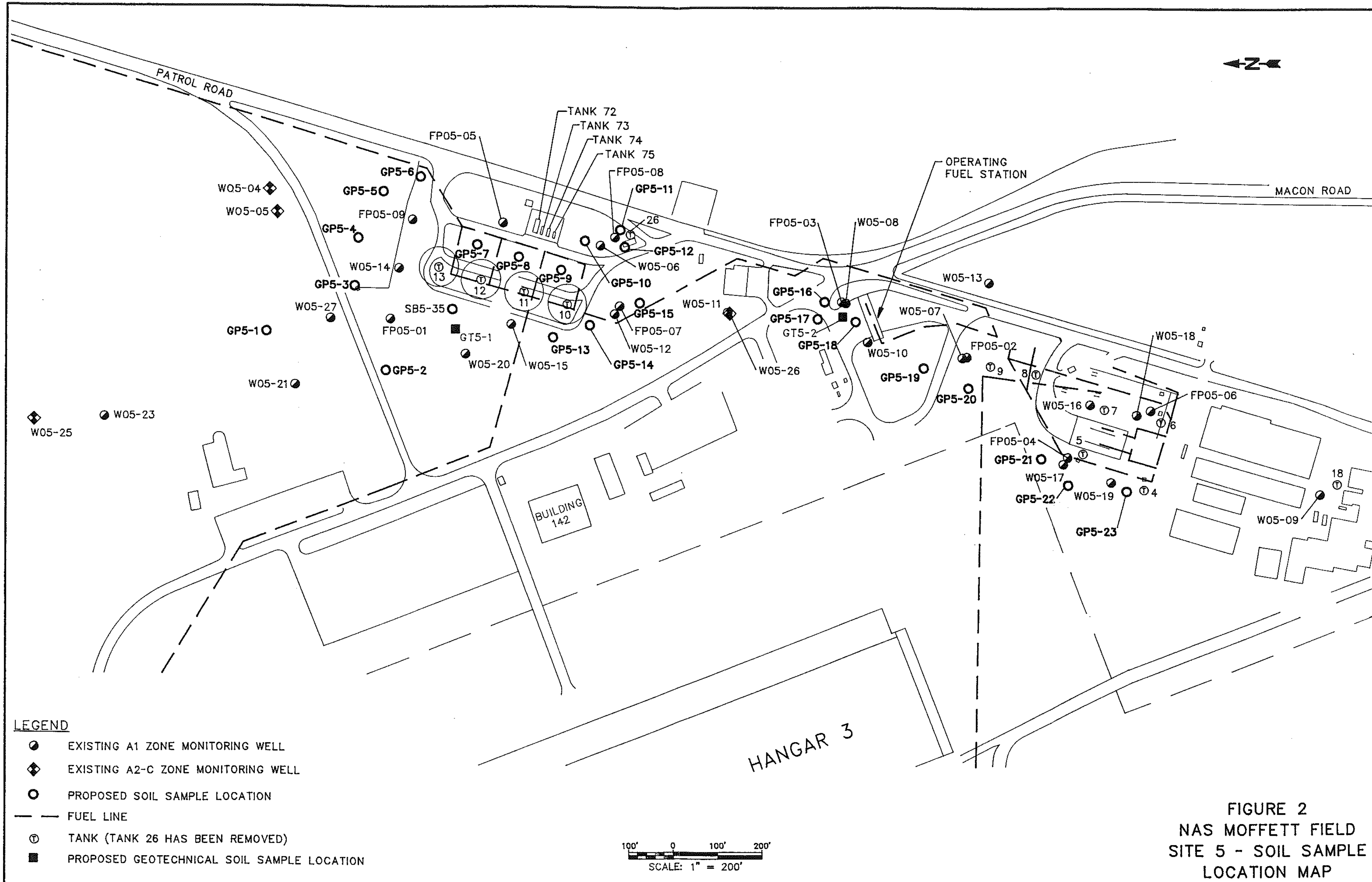


FIGURE 2
NAS MOFFETT FIELD
SITE 5 - SOIL SAMPLE
LOCATION MAP

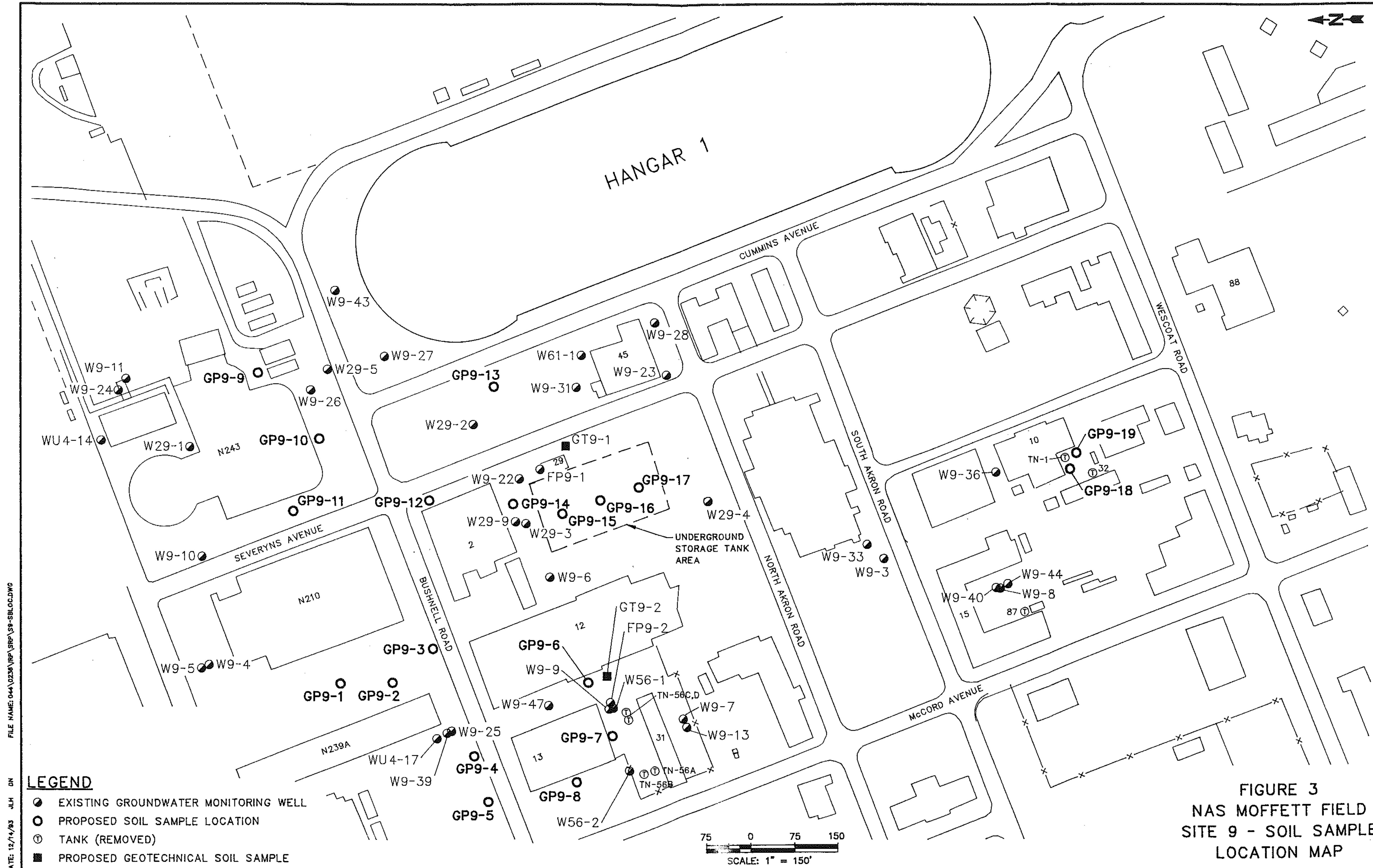


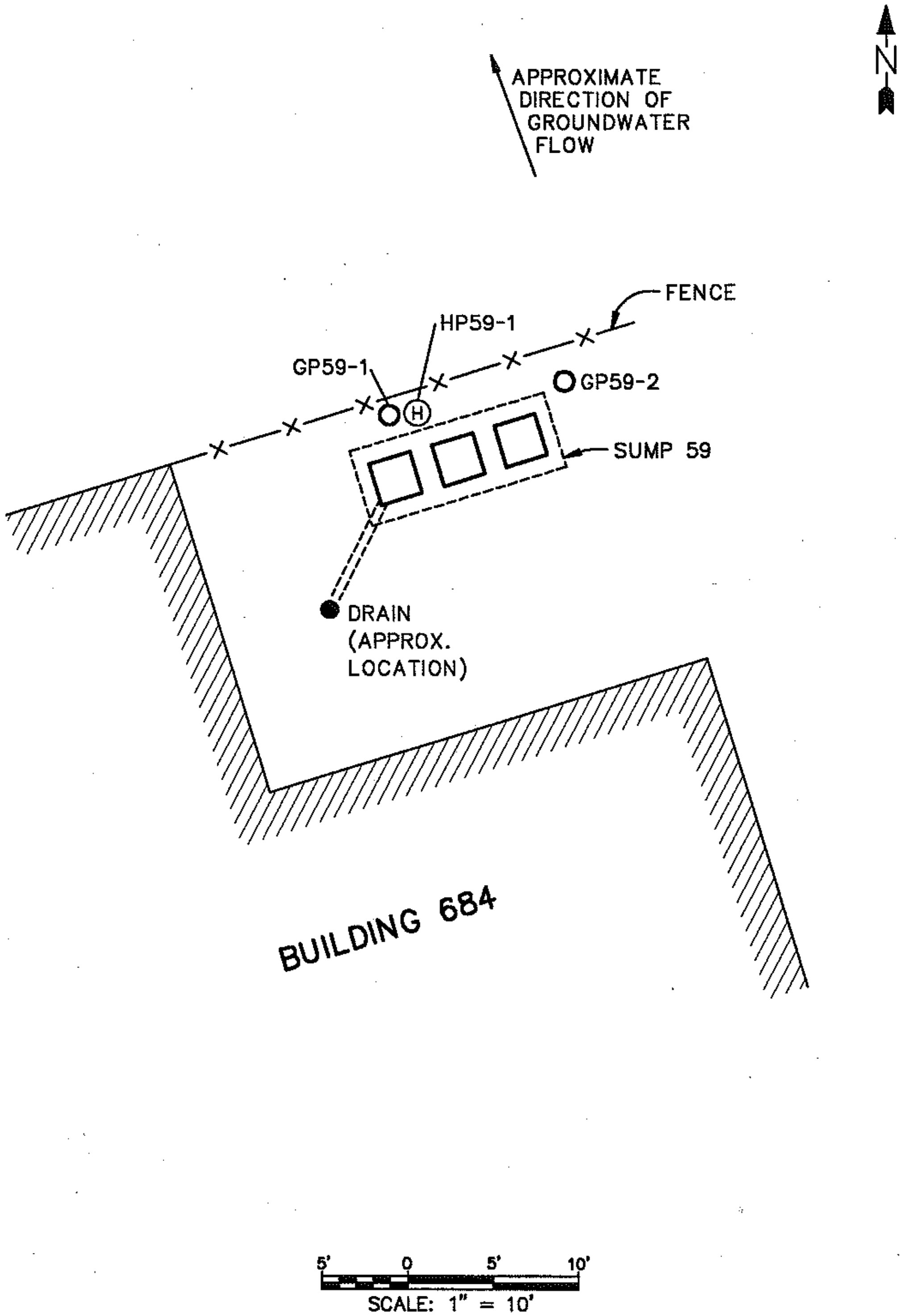
FIGURE 3
NAS MOFFETT FIELD
SITE 9 - SOIL SAMPLE
LOCATION MAP

zone, or near borings that were not sampled for TPH as gasoline. Sample locations GP9-9 through GP9-14 are proposed to better characterize the northern and eastern extent of the Building 29 area contamination for the same reasons listed above. Sample locations GP9-15, GP9-16, and GP9-17 were selected to characterize the Building 29 fuel farm excavation area. Though this area was characterized prior to excavation, the current distribution of potentially contaminated soils is unknown because of excavation activities. Soil sample locations GP9-18 and GP9-19 were selected to evaluate the potential extent of contamination due to Tank 1.

Site 15

Analytical data for soils surrounding Sumps 25, 58, 59, 62, 63, 64, and 65 are not available, as indicated in the petroleum sites characterization report (PRC 1993a). Sumps 25 and 58 are scheduled for removal in March 1994, and soil and groundwater (if applicable) samples will be collected at that time in accordance with state guidance (RWQCB 1990). Sump 42 was removed in 1990, and any contamination resulting from this sump and adjacent underground storage tanks will be evaluated under a separate NEX service station investigation in early 1994. Soil samples under and adjacent to Sump 62 were recently collected by NASA, and analytical results will be available soon. A recent visual inspection was made of Sump 64 and there was no indication of soil contamination. This "sump" is actually an inactive stormwater diversion box that was previously used to divert runoff out of the Lindbergh Avenue Storm Drain Channel. Sump 64 should be removed from further investigations based on visual inspections and prior history of usage, and is scheduled for removal by NASA in early 1994. During the removal action, NASA will collect soil and sediment samples.

Sumps 59 and 63 are active and may be potential sources of contamination, and investigations for these sumps are included in this field work plan. Sump 65 was originally believed to be a neutralizing tank adjacent to the south wall of Building 575. However, investigations by staff from the NAS Moffett Field Staff Civil Engineer office have revealed that this neutralizing tank was never installed, and that battery locker waste has been neutralized in a nearby sanitary sewer sump. This double-chambered sewer manhole just east of Building 575 is Sump 65, and potential contamination resulting from this sump will be investigated in this field work plan. The proposed soil sample locations appear in Figures 4, 5, and 6 for Sumps 59, 63, and 65.



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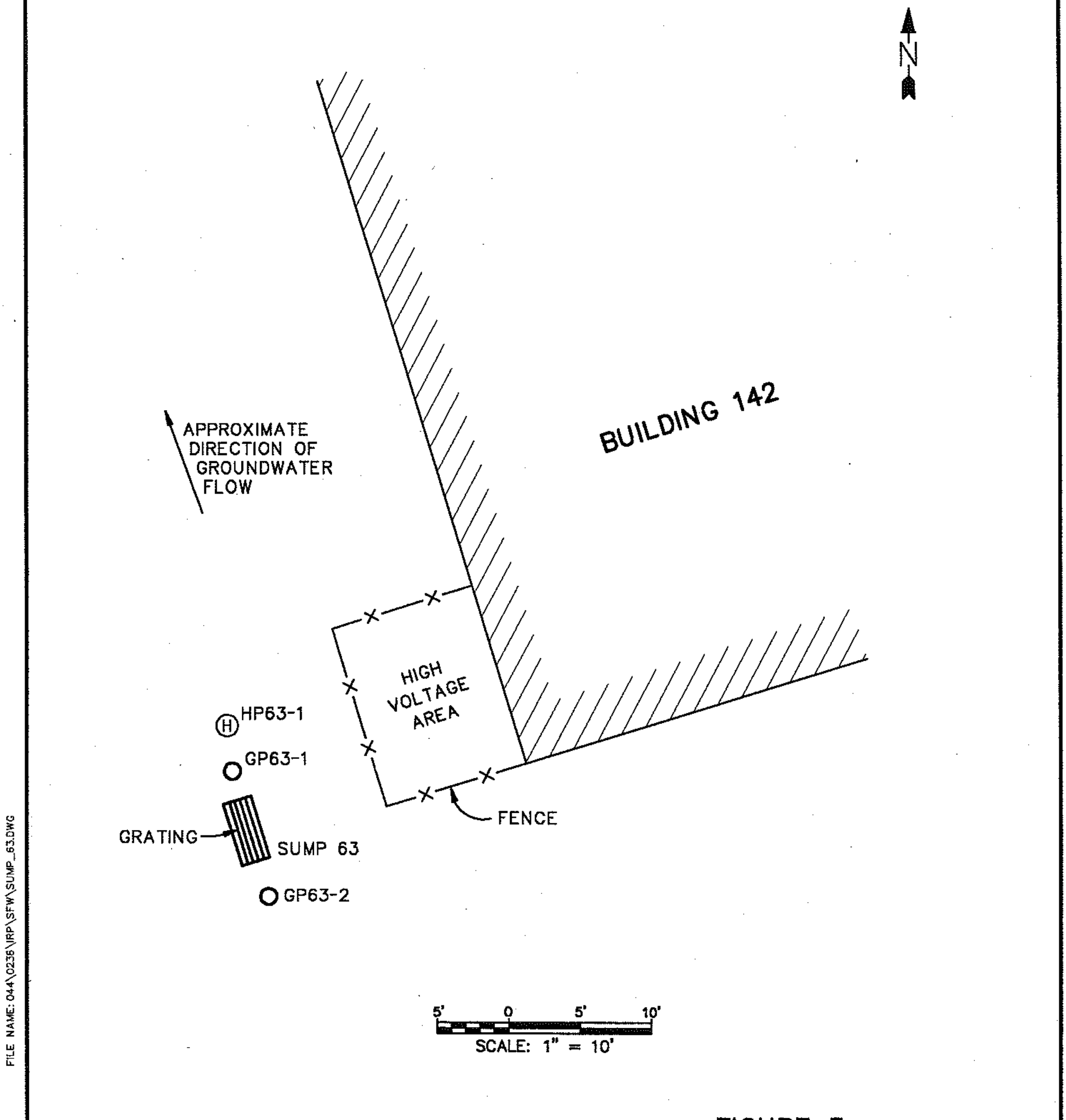
LEGEND

○ PROPOSED SOIL SAMPLE LOCATION

(H) PROPOSED HYDROPUNCH WATER SAMPLE LOCATION

FIGURE 4
NAS MOFFETT FIELD
SITE 15 - SUMP 59
SOIL AND HYDROPUNCH SAMPLE LOCATION MAP



LEGEND

○ PROPOSED SOIL SAMPLE LOCATION

Ⓗ PROPOSED HYDROPUNCH WATER SAMPLE LOCATION

FIGURE 5
NAS MOFFETT FIELD
SITE 15 - SUMP 63
SOIL AND HYDROPUNCH SAMPLE
LOCATION MAP

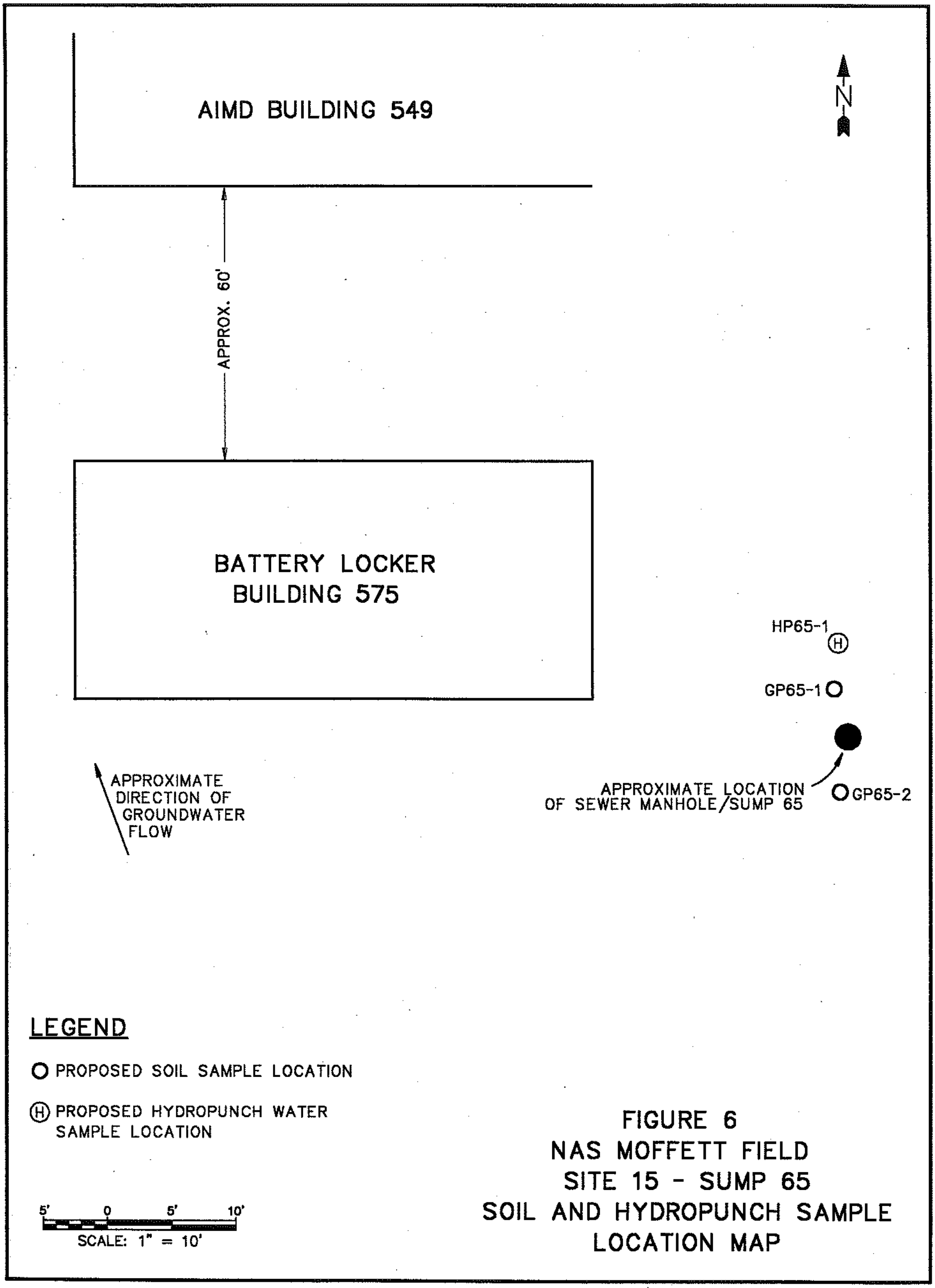


FIGURE 6
NAS MOFFETT FIELD
SITE 15 - SUMP 65
SOIL AND HYDROPUNCH SAMPLE
LOCATION MAP

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Site 19

The soils adjacent to the removed Tanks 2, 43, and 53 are proposed for additional investigation, as existing data are insufficient to evaluate the extent of contamination. Four soil sample locations are proposed near Tank 2 to better evaluate the extent of contamination to the west, north, and east of the tank excavation. The sample location west of the former Tank 2 was chosen since no sidewall soil sample was ever taken from the western edge of the excavation. The locations north and east were chosen since they are beyond existing locations of known soil contamination. Six soil sample locations are proposed in the Tank 43 area to evaluate potential contamination to the north, south, and west of the excavation. The south and west locations were chosen since excavation sidewall samples indicated highest levels of contamination on these sides. The four locations north of the former tank were chosen to better evaluate soil contamination in a downgradient direction, as no other soil data exist within approximately 300 feet downgradient from wells W7-6 through W7-10. Four soil sample locations are proposed to evaluate the southern and eastern extent of Tank 53 contamination, as earlier data indicate a southward and eastward migration of gasoline in the vadose zone. Figure 7 indicates the proposed soil sample locations for the Tank 2 area, Figure 8 shows soil sample locations for the Tank 43 area, and Figure 9 shows soil sample locations for the Tank 53 area.

4.2.2 Procedures

All soil cores will be collected using a Geoprobe® soil sample collection system. Sampling activities will follow PRC standard operating procedure (SOP) 54 (see Appendix A). A 2-foot-long split-barrel sampler will be used to continuously collect soil cores at each designated location (the actual diameter of the sampler may vary slightly depending on the available equipment). After each core is recovered, the sample barrel will be opened to allow monitoring of the sample with a PID and visual classification.

Soil samples collected for geotechnical purposes will be collected using Shelby tubes or a brass-lined split-spoon and be analyzed for grain size distribution (ASTM D422-92), Atterberg limits (ASTM D4318-84), moisture content and density (ASTM D2216-92), and saturated hydraulic conductivity (ASTM D2434-68).

All soil cores will be abandoned by filling the corehole from the bottom to the surface using a cement-bentonite grout. For corehole abandonment, the grout will be a 95 percent cement, 5 percent

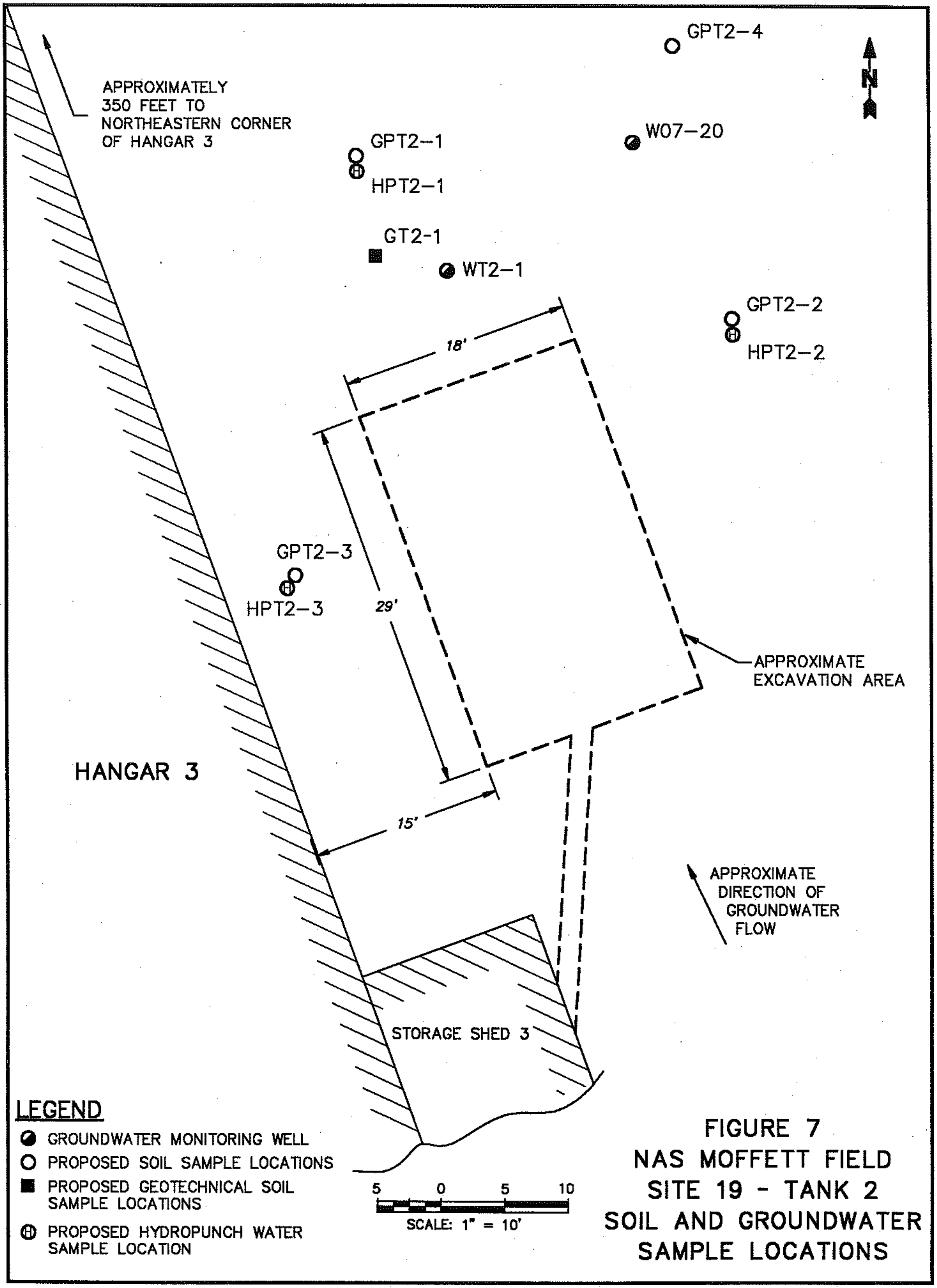
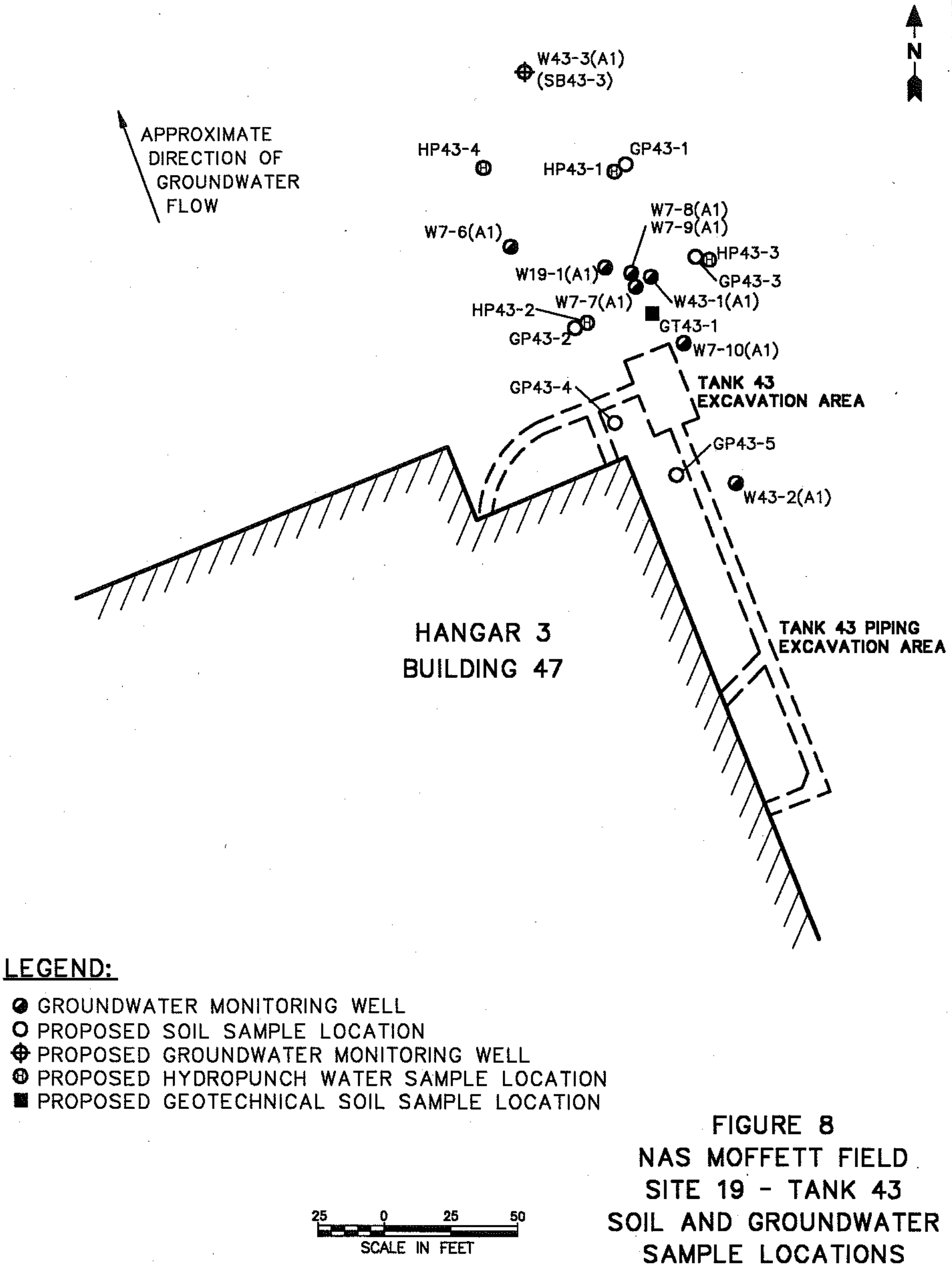


FIGURE 7
NAS MOFFETT FIELD
SITE 19 - TANK 2
SOIL AND GROUNDWATER
SAMPLE LOCATIONS



LEGEND:

- GROUNDWATER MONITORING WELL
- PROPOSED SOIL SAMPLE LOCATION
- PROPOSED GROUNDWATER MONITORING WELL
- PROPOSED HYDROPUNCH WATER SAMPLE LOCATION
- PROPOSED GEOTECHNICAL SOIL SAMPLE LOCATION

FIGURE 8
NAS MOFFETT FIELD
SITE 19 - TANK 43
SOIL AND GROUNDWATER
SAMPLE LOCATIONS

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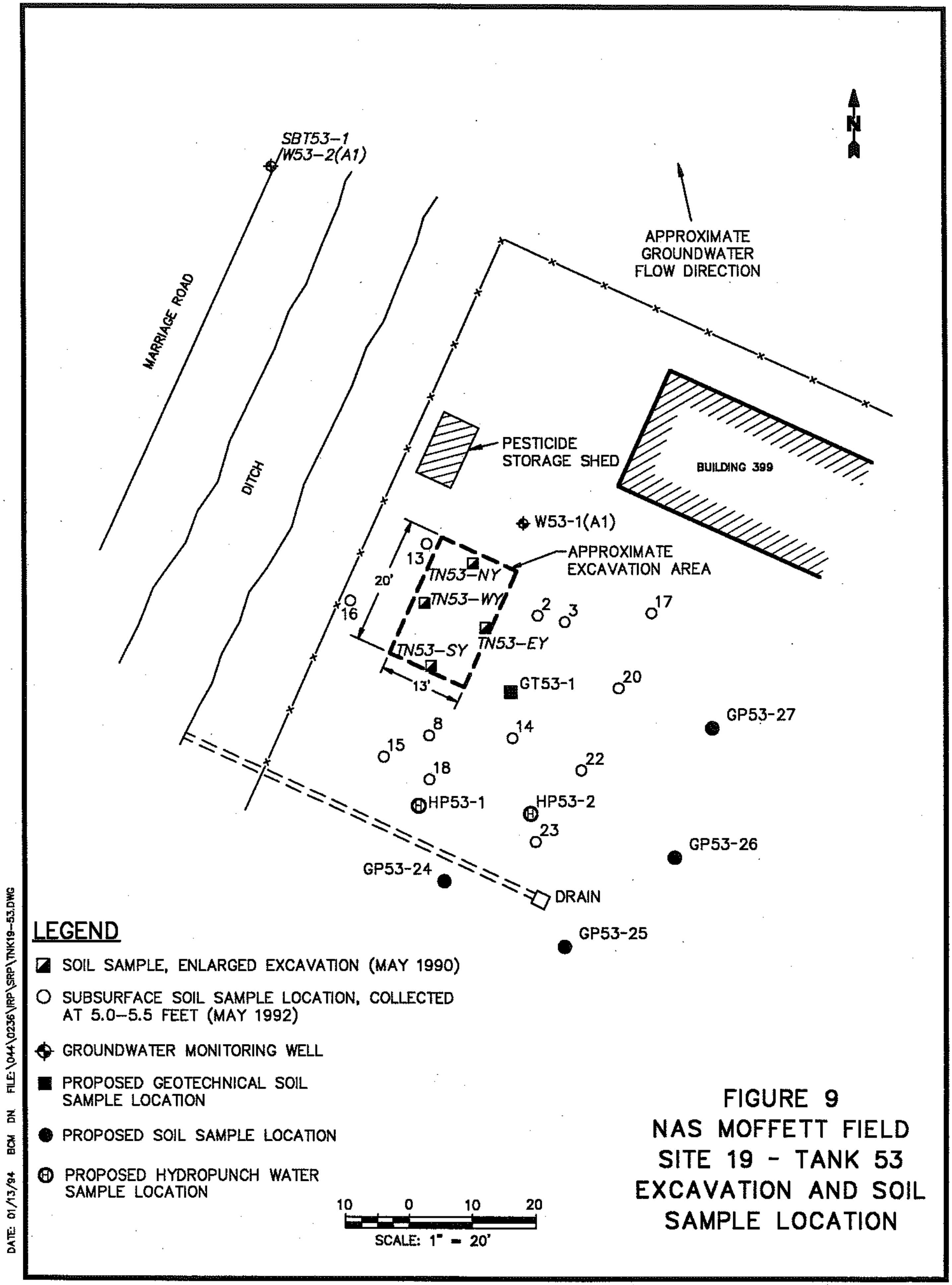

FIGURE 9
NAS MOFFETT FIELD
SITE 19 - TANK 53
EXCAVATION AND SOIL
SAMPLE LOCATION

bentonite mixture. The depth of the corehole will be measured with a tape measure and recorded, and the volume of grout required to fill the hole will be calculated. The corehole will be filled with grout using a tremie pipe to fill the hole uniformly.

4.2.3 Sampling

Samples will be collected for chemical analysis after the PID screening and visual inspection. Soil samples will be collected and handled in accordance with the procedures outlined in the basewide field sampling plan (FSP) and the basewide QAPjP (PRC and JMM 1992a, 1992b). Samples will be collected as summarized in Table 1 and analyzed using methods specified in the base-wide QAPjP. In general, at least one soil sample for chemical analysis will be collected at each core location: one within the historic water table fluctuation range, as petroleum products are expected in this interval, and possibly one within the vadose zone if contamination is indicated. For sites that have not been previously investigated, soil samples will be collected every 5 feet in the unsaturated zone and at major lithology changes. In all cases, the exact depths of soil samples may be modified in the field to sample highly contaminated intervals. The proposed chemical analytes for these soil samples are based on existing knowledge of contaminants at each investigation area. All soil samples will be analyzed for total petroleum hydrocarbons (TPH); either purgeable, extractable, or both, depending on the contamination source. In all cases the TPH purgeable analysis will include analysis of the compounds benzene, toluene, ethylbenzene, and xylene (BTEX). Some samples will also be analyzed for semivolatile organic compounds (SVOCs) to obtain data for risk assessment purposes.

Additionally, soil samples collected near waste oil or mixed waste tanks and sumps will also be analyzed for volatile organic compounds (VOCs) and metals. All samples will be analyzed in a California-certified lab.

4.3 GROUNDWATER SAMPLING

Additional groundwater samples will be collected and analyzed to further evaluate the extent of groundwater contamination. Two groundwater monitoring wells will be constructed and developed at Site 5, and one at Tank 43 (Site 19). The remaining water samples at Sites 5, 15, and 19 will be collected using the HydroPunch®, with cone penetrometer tests (CPTs) being used to assist in the identification of proper sampling depths. In addition, if soil contamination is above 100 ppm TPH or if HydroPunch® water sample analyses indicate significant contamination at sites not previously

TABLE 1

NAS MOFFETT FIELD
ADDITIONAL PETROLEUM SITES INVESTIGATION
SOIL SAMPLING SUMMARY

Soil Sample[1] Number	TPH Extractable	TPH Purgeable[2]	SVOC	VOC	Metals
GP5-1	X				
GP5-2	X				
GP5-3	X		X		
GP5-4	X				
GP5-5	X				
GP5-6	X		X		
GP5-7	X				
GP5-8	X				
GP5-9	X		X		
GP5-10	X				
GP5-11	X		X	X	X
GP5-12	X		X	X	X
GP5-13	X				
GP5-14	X				
GP5-15	X		X		
GP5-16	X				
GP5-17	X				
GP5-18	X		X		
GP5-19	X				
GP5-20	X				
GP5-21	X		X		
GP5-22	X				
GP5-23	X				
SB5-35	X		X		
GP9-1		X			

TABLE 1, Continued

NAS MOFFETT FIELD
ADDITIONAL PETROLEUM SITES INVESTIGATION
SOIL SAMPLING SUMMARY

Soil Sample[1] Number	TPH Extractable	TPH Purgeable[2]	SVOC	VOC	Metals
GP9-2		X			
GP9-3		X			
GP9-4		X			
GP9-5		X			
GP9-6		X			
GP9-7		X			
GP9-8	X	X	X	X	X
GP9-9		X			
GP9-10		X			
GP9-11		X			
GP9-12		X			
GP9-13		X			
GP9-14		X			
GP9-15		X			
GP9-16		X			
GP9-17		X			
GP9-18	X				
GP9-19	X				
GP59-1[3]	X	X		X	X
GP59-2[3]	X	X		X	X
GP63-1[3]	X	X		X	X
GP63-2[3]	X	X		X	X
GP65-1				X	X
GP65-2				X	X
GPT2-1	X	X		X	X

TABLE 1, Continued

NAS MOFFETT FIELD
ADDITIONAL PETROLEUM SITES INVESTIGATION
SOIL SAMPLING SUMMARY

Soil Sample[1] Number	TPH Extractable	TPH Purgeable[2]	SVOC	VOC	Metals
GPT2-2	X	X		X	X
GPT2-3	X	X		X	X
GPT2-4	X	X		X	X
GP43-1	X	X		X	X
GP43-2	X	X		X	X
GP43-3	X	X		X	X
GP43-4	X	X		X	X
GP43-5	X	X		X	X
SB43-3	X	X		X	X
GP53-24		X			
GP53-25		X			
GP53-26		X			
GP53-27		X			

Notes

1 All samples will be identified by soil sample number followed by depth in parentheses, for example "GP5-1(8.0)"
2 This method will include analysis of BTEX constituents
3 These samples will also be analyzed for total recoverable petroleum hydrocarbons as oil and grease

SVOC Semivolatile organic compound
VOC Volatile organic compound
TPH Total petroleum hydrocarbons (purgeable and extractable)

investigated, then downgradient groundwater monitoring wells will be installed. In borderline cases where any doubt exists, the Navy will discuss analytical results with RWQCB and EPA and will seek agreement upon whether or not a well should be installed.

Sand thickness and chemical concentration will be evaluated in selecting monitoring well locations. In addition, CPTs and HydroPunch® will be used to optimize locations of the monitoring wells. Locations will be selected to most accurately characterize the groundwater contamination in the area of interest. The well screen intervals will encompass the range of water table fluctuations (unconfined conditions) or the first permeable zone (confined conditions), and all HydroPunch® samples will be collected within the upper portions of water bearing zones. Section 4.3.1 describes the proposed locations of the HydroPunch® samples and groundwater monitoring wells. Section 4.3.2 describes the procedures for well installation and development, and procedures for the CPT and HydroPunch® sampling. Section 4.3.3 describes the types of chemical analyses proposed for the groundwater samples.

4.3.1 Locations

Site 5

Figure 10 illustrates the proposed locations of HydroPunch® samples and groundwater monitoring wells for Site 5. Well W5-34 was selected to assess potential groundwater contamination downgradient of the Tank 12 spill area, as well as to monitor any future remedial actions. Well W5-35 will be located in the center of the area of highest suspected contamination. No other wells exist within 150 feet of this location. These new wells will be sampled during this investigation, and for at least three more consecutive quarters as per Navy policy at NAS Moffett Field. In addition, the free product wells, FP5-1 through FP5-9, were sampled for the first time in December 1993, and these will be sampled at least three more quarters. Other Site 5 wells, including W05-06, W05-11, W05-14, and W05-27, are also scheduled for sampling in early 1994.

Twenty-one HydroPunch® sample locations, labeled HP5-1 through HP5-21, were selected to further characterize the lateral extent in areas of suspected groundwater contamination. HydroPunch® samples HP5-1 through HP5-9 are located to investigate potential contamination downgradient of and adjacent to the Tank 12 spill area. HydroPunch® samples HP5-10 through HP5-13 are located to investigate potential contamination due to fuel lines and former Tank 26. Samples HP5-14 through HP5-16 are located to investigate possible releases from fuel lines near the operating fuel station.

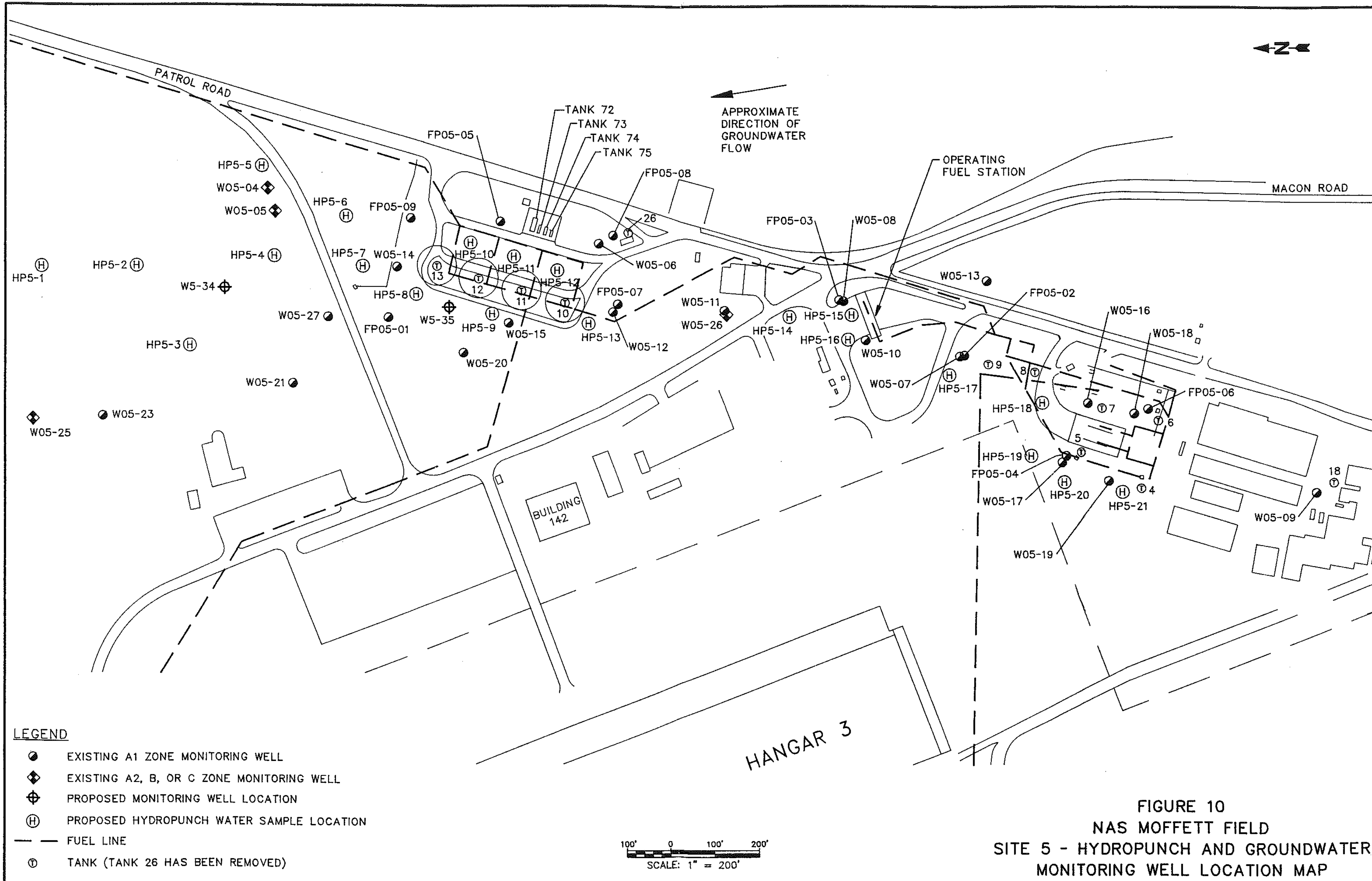

FIGURE 10
NAS MOFFETT FIELD
SITE 5 - HYDROPUNCH AND GROUNDWATER MONITORING WELL LOCATION MAP

Samples HP5-17 and HP5-18 are located to investigate the Tanks 8 and 9 area, and HP5-19 through HP5-21 are located to investigate the Tanks 4 and 5 area. In all cases, these HydroPunch® locations were selected at least 100 feet away from existing wells that are screened to encompass the water table. One water sample will be collected from each of these locations.

Site 15

As with soil sampling, water sampling will be conducted in the immediate vicinity of Sumps 59, 63, and 65. One HydroPunch® water sample will be collected adjacent to each of these three sumps. The locations of samples HP59-1, HP63-1, and HP65-1 appear in Figures 4, 5, and 6, respectively. If the analyses of HydroPunch® samples indicate significant groundwater contamination (as agreed by the agencies and the Navy), downgradient wells will also be installed within 10 feet of the source sumps.

Site 19

Water samples will be collected near former Tanks 2, 43, and 53. These samples will be collected from nine HydroPunch® locations and one new groundwater monitoring well downgradient of Tank 43. The sample locations at Tanks 2 and 43 were selected to better characterize groundwater east and west of the former excavations, as well as downgradient of the excavations. Well W43-3 will be used to evaluate the downgradient extent of contamination and to monitor any future remedial actions. Two HydroPunch® samples will be collected at Tank 53 beneath an area of known soil contamination south of the former tank. The well and HydroPunch® locations are shown in Figures 7, 8, and 9.

4.3.2 Procedures

All groundwater monitoring wells will be installed and developed according to procedures outlined in the basewide FSP (PRC and JMM 1992a), and exact locations will be optimized by use of the HydroPunch® and CPT. This subsection summarizes the procedures for well installation and use of the CPT and HydroPunch®.

The cone penetrometer consists of a stainless steel cone about 1.5 inches in diameter and 5 inches long at the end of a steel drive casing. The penetrometer is driven into the ground by hydraulic pressure. The cone contains a sensor that measures the pressure exerted against the tip (called the tip resistance). It also has a sensor that measures the friction along the cone side as the cone moves through the soil. The readings from these two sensors categorize the soil through which the penetrometer is moving. Sandy, noncohesive soils typically have high values of tip resistance and low friction factors. Clayey, cohesive soils have low values of tip resistance and high friction factors. The cone penetrometer also indicates the degree of soil saturation by measuring the fluid pressure against a sensor located behind a porous stone filter within the tip of the cone. While the cone penetrometer is being pushed into the soil, sensor readings are made continuously and are recorded on charts. These charts graphically depict zones of sands, silts, and clays as well as the location of subsurface water. Upon reaching the final depth of the hole, a grout tube is inserted and the hole is pressure grouted from total depth to ground surface.

HydroPunch® sampling requires a second penetration immediately adjacent to the original CPT hole. The HydroPunch® probe is pushed to the desired depth based on the lithologic interpretation of the CPT log. An intake screen is opened in the probe that allows formation water to fill the probe's sample chamber. A bailer is then used to collect the water for analysis. Similar to the initial CPT hole, the HydroPunch® hole is pressure grouted from total depth to the surface.

In zones where the CPT log indicates the presence of a flowing sand or silt, a sample of this interval may be taken at the discretion of the field geologist using a sampler designed for use with the cone penetrometer. These discretionary cone penetrometer samples will allow collection of samples from flowing sand or silt intervals that are difficult to sample using conventional sampling methods. Similar to HydroPunch® groundwater sampling, collection of cone penetrometer soil samples would require a second penetration slightly offset from the original CPT location.

Monitoring wells will be constructed by installing 2-inch inside diameter, flush jointed, schedule 40 polyvinylchloride (PVC) casing and screen into the borehole. Monitoring wells will be constructed so that the bottom of the well screen is at the base of the well and the screen intervals encompass the range of water table fluctuations. In general, monitoring wells will be installed with 10-foot screens. The screen slot size will be 0.01 inch. The annular space between the screen and the borehole wall will be filled with #3 silica sand to 2 feet above the screened interval. The annulus above the sand pack will be sealed with a 3-foot thick bentonite seal. The remainder of the annulus will be sealed with a cement grout containing 5 percent bentonite. Each well will be completed using a traffic-rated, flush-mounted, protective well head box with a benchmark for measuring groundwater elevation. The casing of the each well will be capped with a water-tight plug and locked upon completion of well construction activities.

The wells will be developed after installation is complete and all cement seals have set for a minimum of 24 hours. Each well will be developed by surging and pumping. Surging will consist of rapid movement of water in and out of the screened interval with a close fitting bailer or surge block. The bailer will also be used to remove debris that has accumulated in the well. After no more debris is recovered during surging, each well will be developed by continued bailing or pumping until the water is no longer visually turbid. Temperature, pH, turbidity, and conductivity will be monitored during well development. Each well will be developed until these field parameters stabilize (that is, the parameters do not change more than about 10 percent between two successive measurements). If any well is completely evacuated and recovers slowly, it will be bailed again. If the recharge rate remains low after this additional development, the well will be bailed to dryness three times.

4.3.3 Sampling

All 33 HydroPunch® samples and three monitoring well samples will be analyzed for TPH, either extractable, purgeable, or both, depending on the source of petroleum contamination. All TPH purgeable analyses will include analysis of BTEX constituents. In addition, samples collected downgradient of sources containing wastewater will also be analyzed for VOCs and SVOCs, and some samples will be analyzed for metals. The samples will be analyzed using methods specified in the basewide QAPjP, and all groundwater samples will be analyzed by a certified lab. Table 2 summarizes the groundwater analyses recommended for each sample.

4.4 SURVEYING

Surveying will be conducted for all Geoprobe® soil corings, groundwater monitoring wells, and HydroPunch® locations. The locations of all of these activities will be determined relative to benchmark H-111 (located at the south end of Hangar 1) to an accuracy of $\pm$ 0.1 foot horizontally, and $\pm$ 0.01 foot vertically.

4.5 WASTE DISPOSAL

All of the investigation-derived wastes will be properly disposed of. The groundwater from well development and sampling activities will be contained in a storage tank. The water will then be sampled and analyzed for discharge into the sanitary sewer system. A permit application will be submitted to the Sunnyvale publicly owned treatment works (POTW) that characterizes the waste

TABLE 2

NAS MOFFETT FIELD
ADDITIONAL PETROLEUM SITES INVESTIGATION
GROUNDWATER SAMPLE SUMMARY

Site	Well or HydroPunch® Number[1]	TPH Extractable	TPH Purgeable[2]	VOC	SVOC	Metals
5	W5-34	X			X	
	W5-35	X			X	
	HP5-1	X				
	HP5-2	X				
	HP5-3	X				
	HP5-4	X				
	HP5-5	X				
	HP5-6	X				
	HP5-7	X				
	HP5-8	X				
	HP5-9	X				
	HP5-10	X				
	HP5-11	X				
	HP5-12	X		X		
	HP5-13	X				
	HP5-14	X				
	HP5-15	X				
	HP5-16	X				
	HP5-17	X				
	HP5-18	X	X			
	HP5-19	X	X			
	HP5-20	X				
	HP5-21	X				
15	HP59-1[3]	X	X	X	X	X
	HP63-1[3]	X	X	X	X	X
	HP65-1			X		X

TABLE 2, Continued

NAS MOFFETT FIELD
ADDITIONAL PETROLEUM SITES INVESTIGATION
GROUNDWATER SAMPLE SUMMARY

Site	Well or HydroPunch® Number[1]	TPH Extractable	TPH Purgeable[2]	VOC	SVOC	Metals
19	HPT2-1	X	X	X	X	
	HPT2-2	X	X	X		
	HPT2-3	X	X	X		
	W43-3	X	X	X	X	X
	HP43-1	X	X	X		
	HP43-2	X	X	X		
	HP43-3	X	X	X	X	
	HP43-4	X	X	X		
	HP53-1		X			
	HP53-2		X			

Notes

1 All samples will be identified by well/HydroPunch® number followed by depth in parentheses
2 This method will include analysis of BTEX constituents
3 These samples will also be analyzed for total recoverable petroleum hydrocarbons as oil and grease

TPH Total petroleum hydrocarbons
VOC Volatile organic compound
SVOC Semivolatile organic compound

stream and the amount of the water to be discharged. All of the soil generated will be characterized based on analytical results from the soil boring samples and disposed of in accordance with applicable state and federal guidelines.

5.0 QUALITY ASSURANCE PROJECT PLAN

This section describes the special quality assurance/quality control (QA/QC) measures that will be implemented during this field investigation. A full description of the QA/QC procedures for all work done at NAS Moffett Field appears in the basewide QAPjP (PRC and JMM 1992b). All aspects of the basewide QAPjP pertain to this field investigation unless specifically noted.

5.1 SAMPLE HANDLING, SHIPMENT, AND CHAIN OF CUSTODY

This section describes sample handling procedures, including sample identification and documentation, sample containerization and preservation, sample packaging, sample shipment, and chain of custody.

5.1.1 Sample Identification and Documentation

A sample numbering scheme has been developed that is compatible with the NAS Moffett Field computerized database management system. The numbering convention identifies each sample uniquely and provides a means of tracking the sample from collection through analysis. The sample identification (ID) number specifies (1) sample type; (2) sample location; and (3) sample depth (or interval depth) for soil samples or depth of the screen midpoint for groundwater samples. The ID number will be entered on sample labels, field sheets, chain-of-custody forms, and other records documenting sampling activities. The template in Table 3 provides an example of the sample numbering convention.

When using the sample numbering scheme, all characters, including dashes, parentheses, and decimal points, must be shown on labels, sample tracking forms, chain-of-custody forms, and any other sampling documents. An example of a completed sample designation is described below. Table 3 presents the sample designation system in more detail.

A soil sample from Geoprobe® soil core 2 at Site 5, collected at a depth of 8 feet will be designated: GP5-2(8.0)

TABLE 3

NAS MOFFETT FIELD
ADDITIONAL PETROLEUM SITES INVESTIGATION
SAMPLE NUMBERING TEMPLATE

Activity Code[1]	Site Code[2]	Specific Location Code[3]	Depth Interval Code[4]
A or AA	B or BB	BB	(99.9) or (99.9-99.9)

A - Alpha character only
B - Either alpha or numeric character
9 - Numeric character only

1 - Activity code. The following activity codes may be used during the field investigation:

GP - Geoprobe® soil sample from a soil core
SB - Soil sample from a soil boring
W - Groundwater sample from a monitoring well
WT - Groundwater sample from a monitoring well near a tank
HP - Groundwater sample collected by HydroPunch®
EB - Equipment blank
TB - Trip blank
DP - Identified field duplicate

2 - Site code. This site code refers to the number for the IRP site, the tank, or the sump.

3 - Specific location code. The specific location codes will correspond to the soil boring, monitoring well, or other specific location designations. Blind duplicate samples will be given a "99" designation.

4 - Depth designation. The depth designation indicates the depth from which a sample is collected. This part of the sample numbering template also provides the option of designating a depth interval. For example, a soil sample collected from a depth of 3 feet will be encoded "3.0." A soil sample collected from a depth interval of 9.5 to 10.0 feet will be encoded "9.5 - 10.0." Also, equipment and trip blanks will be given a "100-series" designation. Groundwater samples will not include a depth interval.

5.1.2 Sample Labels

A sample label will be affixed to each sample container when the sample is collected. The labels will include the sample ID number, an abbreviation of the analysis to be performed (such as VOA for volatile organic analysis), the name of the sampler, the time and date of collection, and the preservatives used, if any. After the label is completed, it will be covered with clear plastic tape to prevent damage.

5.1.3 Sample Containerization and Preservation

This section describes the sample containerization and preservation procedures for sample collection. PRC SOPs 16 and 19 in the basewide FSP (PRC and JMM 1992a) describe in detail appropriate containers and preservation of samples, respectively. Table 4 lists the volumes of sample required for each type of analysis.

Before delivery to the analytical laboratory, all samples will be containerized and packaged to maintain sample integrity and chain of custody. Containers will be cleaned by the supplier to laboratory specifications. Water samples to be analyzed for VOCs will completely fill each container, so that no air is present. Each container will be checked for air bubbles by inverting and tapping the container. If an air bubble is observed, additional sample will be added. The caps, which include Teflon® inner linings, will be tightly sealed.

5.1.4 Sample Documentation

In addition to sample labels, field sampling activities require several other forms of documentation. This additional documentation is necessary to provide an accurate record of sampling events and field observations. This information will be recorded in field logbooks, boring logs, well construction diagrams, groundwater development and sampling logs, photographs, and field daily progress reports. Appendix B includes the sample documentation forms that will be used in the field.

Documentation will be completed legibly in permanent black ink. Errors will be crossed out with a single line, dated, and initialed by the field team member recording the information. Unused portions of pages will be crossed out, and each page will be signed and dated by the field team member who made the entry.

TABLE 4

NAS MOFFETT FIELD
ADDITIONAL PETROLEUM SITES INVESTIGATION
SAMPLE CONTAINERS, VOLUME, AND PRESERVATION

Parameter	Container	Sample Volume	Preservation	Maximum Holding Time
Soil				
VOC	G-TLC	4 oz.	Cool 4°C	10 days
SVOC	G-TLC	8 oz.	Cool 4°C	10 days[1]
TPH Extractable	G-TLC	8 oz.	Cool 4°C	10 days
TPH Purgeable	G-TLC	4 oz.	Cool 4°C	10 days
Water				
VOC	G-TLS	3 - 40 ml	Cool 4°C, HCL	10 days
TPH Extractable	G-TLC	1 liter	Cool 4°C	5 days[2]
TPH Purgeable	G-TLS	3 - 40 ml	Cool 4°C, HCL	10 days
SVOC	G-TLC[3]	1 liter	Cool 4°C	10 days[1]
Metals	Polyethylene	1 liter	HNO_3 to pH < 2	26 days[4]

Notes

1 10 days to extraction, 40 days to analysis
2 5 days to extraction, 40 days to analysis
3 SVOC glass container will be amber-colored
4 26 day holding time for mercury, 6 months for all other metals

G Glass
TLS Teflon-lined septum
TLC Teflon-lined cap
TPH Total petroleum hydrocarbons
VOC Volatile organic compound
SVOC Semivolatile organic compound
HNO_3 Nitric acid
HCL Hydrochloric acid

5.1.5 Sample Shipment and Chain of Custody

The following section describes the packaging, chain of custody, and shipping of samples. Further detail on these activities is provided in PRC SOP 19 in the basewide FSP (PRC and JMM 1992a), and in Section 5.0 of the basewide QAPjP (PRC and JMM 1992b).

After samples are collected, labeled, and sealed, they will be placed in coolers with ice. Chain-of-custody forms will be completed for all samples according to the procedures described in the basewide FSP (PRC and JMM 1992a). Coolers will be stored in a locked vehicle or on-site facility until they are shipped to the analytical laboratory. Before shipment, the field sample custodian will sign the chain-of-custody form and retain a copy for the project files. After being signed by the field sample custodian, the chain-of-custody form will be placed in a plastic bag and taped inside the lid of the cooler. The cooler will be sealed with a custody seal so that the seal must be broken to remove the samples. After chain-of-custody forms have been completed, the sample coolers will be shipped or transported by a courier to the laboratory. The field chain of custody terminates when the laboratory receives the samples. At that time, the laboratory assumes responsibility for the chain of custody. Upon receipt at the laboratory, the laboratory representative will inspect the contents of the cooler, sign the chain-of-custody form, and record the date and time.

5.2 QUALITY CONTROL SAMPLES

Field and laboratory quality control samples will be collected and analyzed as follows:

- Matrix spike/matrix spike duplicate (MS/MSD) samples - 5 percent
- Field duplicate samples - 10 percent
- Equipment rinsate blanks - One per day of groundwater sampling
- Trip blanks - One per cooler containing samples for VOC analysis

6.0 HEALTH AND SAFETY PLAN

A basewide HSP (PRC 1992) was prepared for the activities at NAS Moffett Field. The HSP contains information on the physical and chemical hazards associated with the various field activities to be conducted in this investigation. Currently, data indicate that VOC and TPH contamination is present in some soils and groundwaters. Based on available information, the health hazard is expected to be low. Therefore, work will be performed in EPA Level D personal protective equipment as described in the HSP. The HSP also includes contingencies for upgrading to Level C if air monitoring indicates upgrading is necessary.

7.0 SCHEDULE

A tentative schedule has been developed based on an expected field activity start date of January 24, 1994. The schedule is summarized below.

Activity	Date
Mobilization	January 24, 1994
Ground penetrating radar survey	January 24 - 25, 1994
Cone penetrometer testing and HydroPunch® sampling	January 25 - 27, 1994
Laboratory analysis of HydroPunch® samples	January 28 - February 2, 1994
Geoprobe® soil sampling	January 31 - February 4, 1994
Monitoring well installation and development	February 4 - 5, 1994
Groundwater sampling	February 7 - February 8, 1994
Demobilization	February 8 - 10, 1994
Surveying	February 8 - 10, 1994

8.0 REFERENCES

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APPENDIX A

STANDARD OPERATING PROCEDURE FOR GEOPROBE®

SOP APPROVAL FORM

PRC ENVIRONMENTAL MANAGEMENT, INC.

STANDARD OPERATING PROCEDURE

USING THE GEOPROBE® SYSTEM

SOP NO. 054

REVISION NO. 1

Approved by:

Quality Assurance Officer ______________________ Date ______________________

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LIST OF FIGURES

1.0 BACKGROUND

This standard operating procedure (SOP) details all procedures for using a hydraulically operated sampling probe and its specialized sampling tools manufactured by Geoporbe Systems. SOP 054 replaces former draft SOP 054 entitled "Geoprobe® Soil Gas Sampling" and replaces draft SOP 055 entitled "Geoprobe® Groundwater Sampling." SOP 054 now establishes procedures for using the Geoprobe® system to sample soil, soil gas, and groundwater, and for installing piezometers and vapor sampling implants.

Use of this system (Figure 1) is one of many sampling techniques used by PRC Environmental Management, Inc. (PRC); however, it is the preferred sampling method when certain conditions prevail. Specifically, when sampling is limited to relatively shallow depths and when any of the following conditions are factors: (1) costs must be kept low, (2) sampling time is short, (3) maneuverability is important, and (4) when sampling volume is limited.

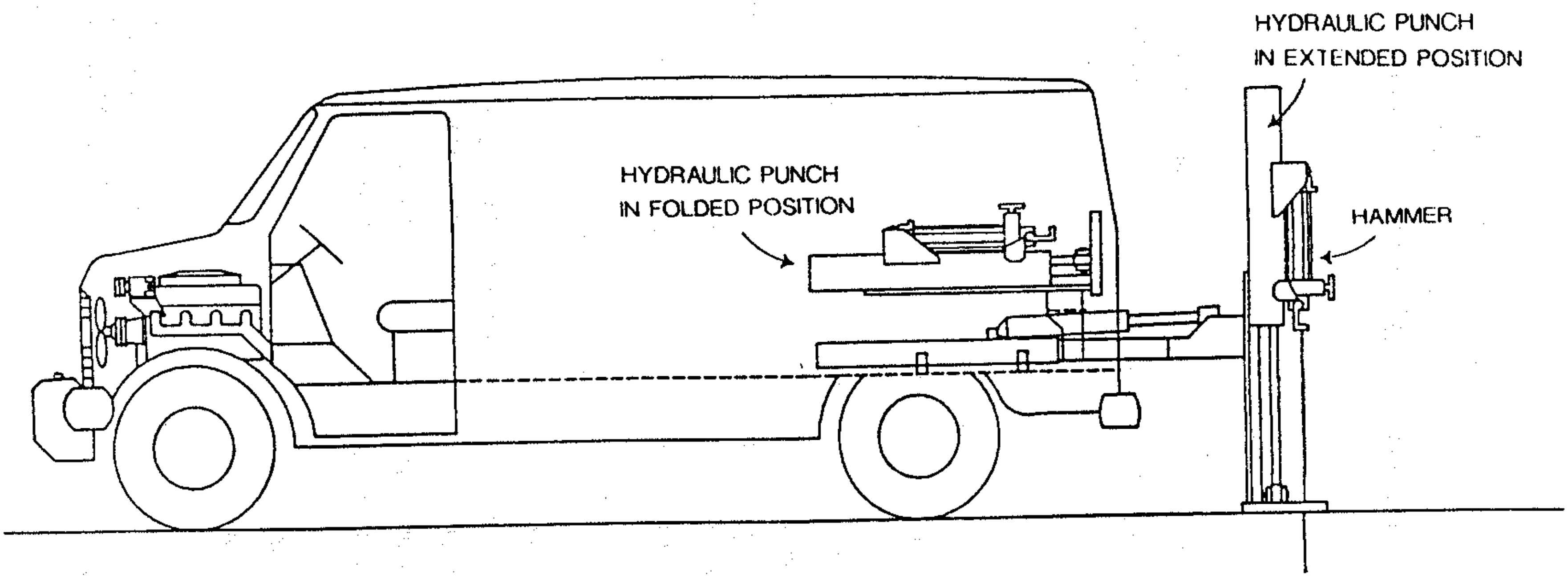
Before using the Geoprobe® system, all buried utility lines and other underground structures must be marked, because this equipment can penetrate buried pipes and tanks.

1.1 PURPOSE

The purpose of SOP 054 is to establish procedures and guidance for field personnel performing soil, soil gas, or groundwater sampling using the Geoprobe® system, and for field personnel using the Geoprobe® system to install piezometers or vapor sampling implants.

1.2 SCOPE

The procedures outlined in SOP 054 apply to all PRC personnel involved in soil gas, soil, or groundwater sampling using the Geoprobe® system or any of its specialized equipment. It also is applies to all personnel using the Geoprobe® system to install piezometers and vapor sampling implants.



SOURCE: GEOPROBE SYSTEMS. 1991. ACCESSORY TOOLS CATALOG.

SOP 54: USING THE GEOPROBE SYSTEM

FIGURE 1

GEOPROBE SYSTEM

PRC Environmental Management, Inc.

1.3 DEFINITIONS

Because Geoprobe® Systems is a corporation specializing in an innovative sampling process, many of the terms used to describe its equipment are unique. For this reason, familiarity with the following terms is necessary.

1.3.1 Hydraulic System Terms

The following terms are used to discuss the basic operation of the hydraulic punch and its major components.

Hydraulic punch -- The main part of the Geoprobe® system, the hydraulic punch looks like a small mobile drilling rig and is usually attached to a truck or van. The hydraulic punch uses the weight of the vehicle for support and uses a hydraulics system installed in the vehicle to advance sampling tools into the soil (Figure 1).

Hammer -- The hydraulic hammer continues to pound sampling tools into the soil after the hydraulic punch is unable to push them farther (Figure 1).

Control panel -- The control panel is located near the hydraulic punch and contains the levers that control the movement of the hydraulic punch (Figure 2).

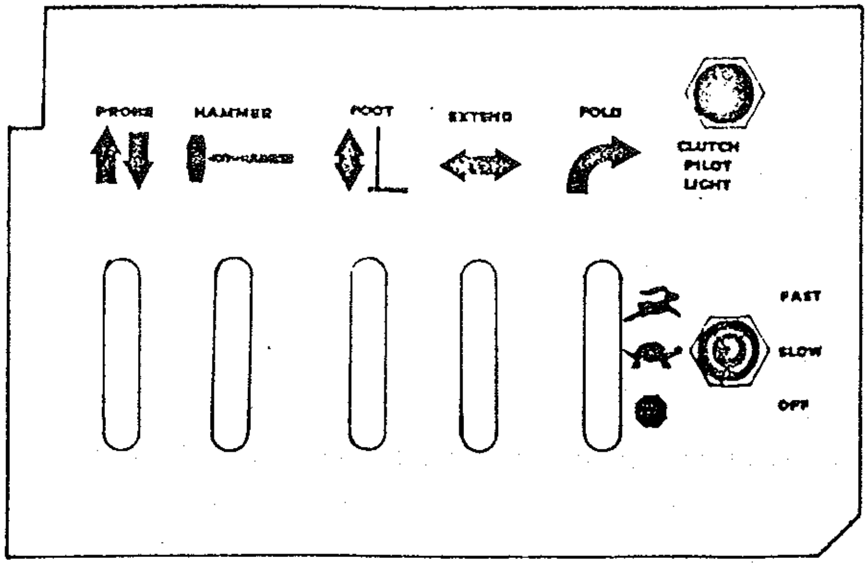
Probe lever -- This is the lever, found on the control panel, that causes the hydraulic punch to push the sampling tools into the soil. This lever controls the vertical movement of the hydraulic punch (Figure 2).

Hammer lever -- This control panel lever engages the hydraulic hammer, when the hammer release valve is moved to its extended position (Figure 2).

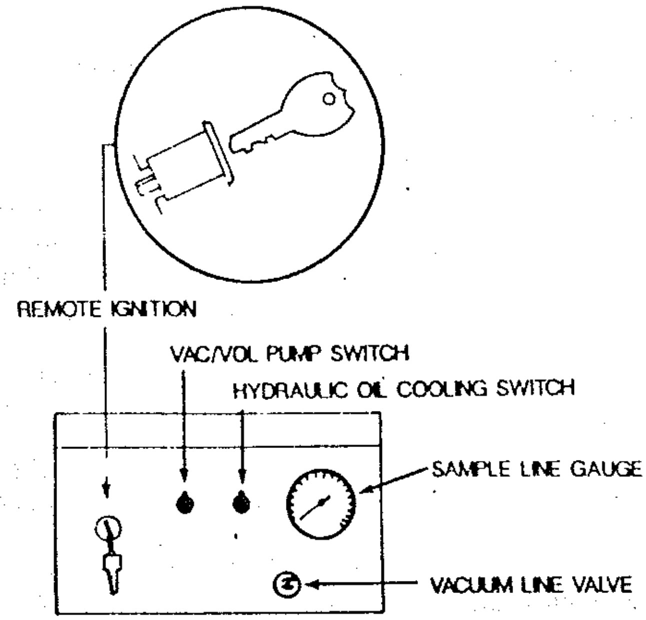
Hammer release valve -- This lever is found on the front of the hydraulic punch and allows the hammer to move when in its extended position. If the valve is not extended, pushing the hammer lever will not engage the hammer.

Foot lever -- This is the lever, found on the control panel, that lowers the foot of the hydraulic punch so that it can stabilize itself (Figure 2).

Extend lever -- Found on the control panel, this lever controls the horizontal movement of the hydraulic punch. It is also used to extend the hydraulic punch 2 feet from the rear of the vehicle (Figure 2).



CONTROL PANEL



VACUUM SYSTEM PANEL

SOURCE: GEOPROBE SYSTEMS. 1991. ACCESSORY TOOLS CATALOG.

SOP 54: USING THE GEOPROBE SYSTEM
FIGURE 2 CONTROL AND VACUUM SYSTEM PANELS
PRC Environmental Management, Inc.

Fold lever -- This lever, found on the control panel, folds and unfolds the hydraulic punch so it can be easily moved and stored (Figure 2).

Electrical control switch -- This switch is found on the control panel and turns the Geoprobe® system's hydraulic system on and off. None of the other levers work until this switch is turned on. It has a slow and fast speed position (Figure 2).

Vacuum system panel -- The vacuum system panel is located near the right rear of the vehicle and contains the vacuum system controls, the hydraulic oil cooling switch, and the remote ignition (Figure 2).

Remote ignition -- Found on the vacuum system panel, the remote ignition allows anyone with a key to start the vehicle's engine from near the hydraulic punch instead of having to walk around the vehicle and climb into the cab to start the engine (Figure 2).

Hydraulic oil cooling switch -- This switch is found on the vacuum system panel and turns on the auxiliary cooling system for the hydraulic oil (Figure 2).

Vacuum/Volume pump switch -- This switch is found on the vacuum system panel and allows pressure to build up in the vacuum tank (Figure 2).

Vacuum line valve -- Found on the vacuum system panel, this valve opens and closes the vacuum line (Figure 2).

Sample line gauge -- This gauge found on the vacuum system panel, registers the sample line pressure in inches of mercury (Hg) (Figure 2).

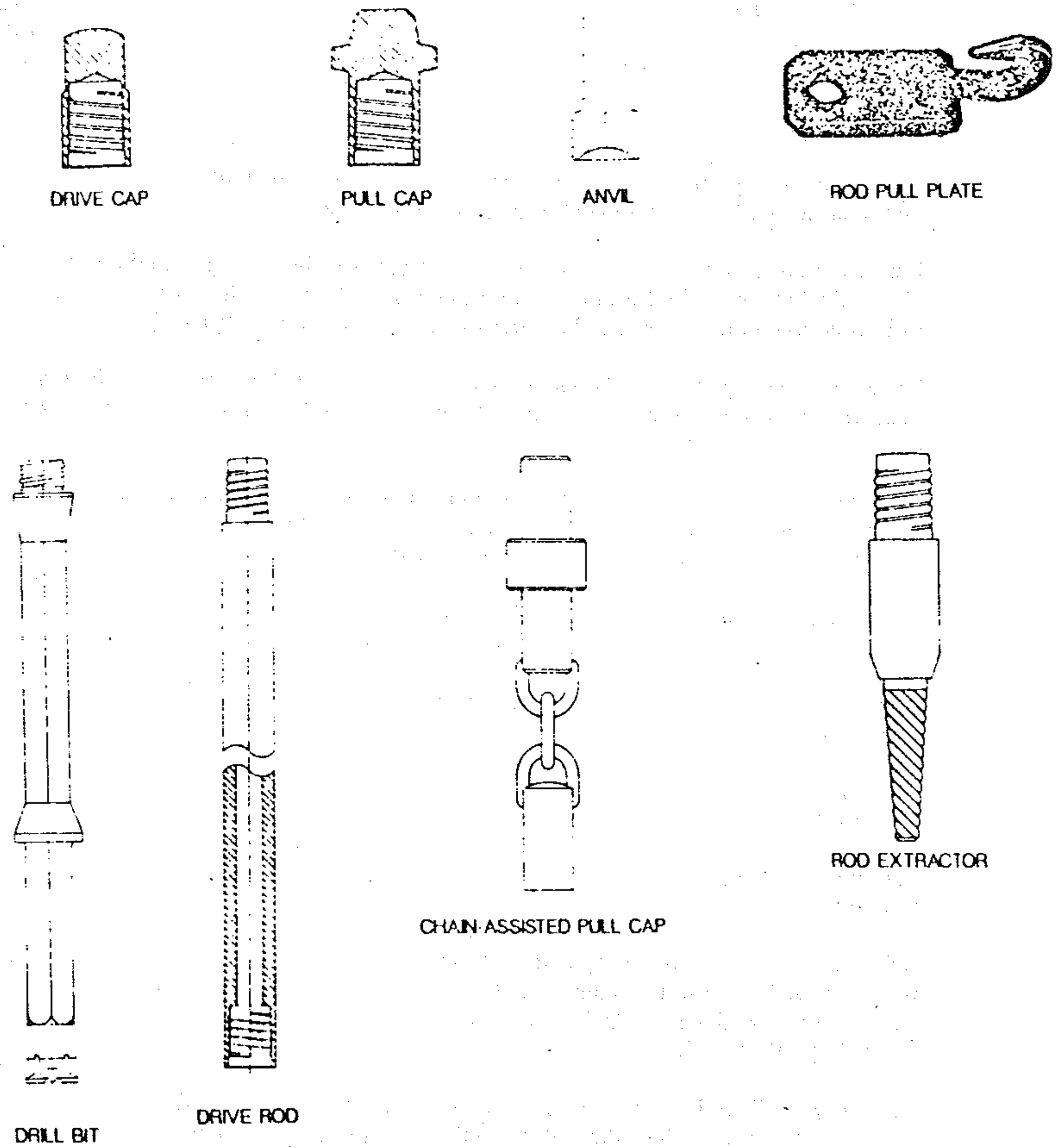
Drive rod -- The high-strength steel drive rod (sometimes called a probe rod) is a hollow tube with a 1-inch outer diameter. Though the rods come in 1-foot, 2-foot, and 3-foot lengths, the standard length is 3 feet. Each rod has both and internal and external threading (Figure 3).

Drive cap -- This is a steel cap screwed onto the external-threaded end of the drive rod to protect the threads when the rod is pushed or hammered into the soil. The drive cap is always installed to the top of the drive rod before advancing sampling tools (Figure 3).

Pull cap -- This is a steel cap that screws into the external-threaded end of the drive rod. It is used to pull the drive rod from the soil once the sample has been collected (Figure 3).

Anvil -- This piece of steel is placed inside the hydraulic punch at the point where it makes contact with the hammer. The hammer forces the anvil into the drive cap, driving the sampling tools deeper into the ground (Figure 3).

Rotary-impact, carbide-tipped drill bit -- Made of steel, this 18- or 24-inch drill bit fits directly into the hydraulic punch and is used to drill through concrete or hard asphalt. The bit does not spin with appreciable torque, but is driven by the hammer, spinning only slightly to clear itself of debris (Figure 3).



SOURCE: GEOPROBE SYSTEMS. 1991. ACCESSORY TOOLS CATALOG.

SOP 54: USING THE GEOPROBE SYSTEM

FIGURE 3

GENERAL ACCESSORY TOOLS

PRC Environmental Management, Inc.

Hammer Rotation Control Knob -- This knob is found on the front of the hydraulic punch. When turned counterclockwise, it allows the drill bit to rotate while using the hammer. If not drilling, it should be turned fully clockwise until it stops.

Chain-assisted pull cap -- This modified pull cap is attached to the hydraulic punch with a chain. It's most useful when the drive rod, for one reason or another, is not aligned directly beneath the hydraulic punch. Using this cap, the rod can still be pulled using the hydraulic punch (Figure 3).

Rod extractor -- This tool threads onto a drive rod that is sent down into the hole made by a drive rod, which has broken while in the soil. The rod extractor, which looks like a drill bit, is hammered into the broken rod and is used to pull the broken rod from the soil (Figure 3).

Rod pull plate -- This is a steel plate with a hole in its center through which a drive rod is inserted. It is used to extract drive rods when installing piezometers and soil gas implants (Figure 3).

O-ring -- An O-ring is a rubber ring used to seal sections of drive rods or various other sampling tools so that they are air and water tight.

Teflon tape -- This is an inert, sticky tape that is used to create airtight seals when pieces of the drive rod or accessories are threaded together. The tape may replace an O-ring seal.

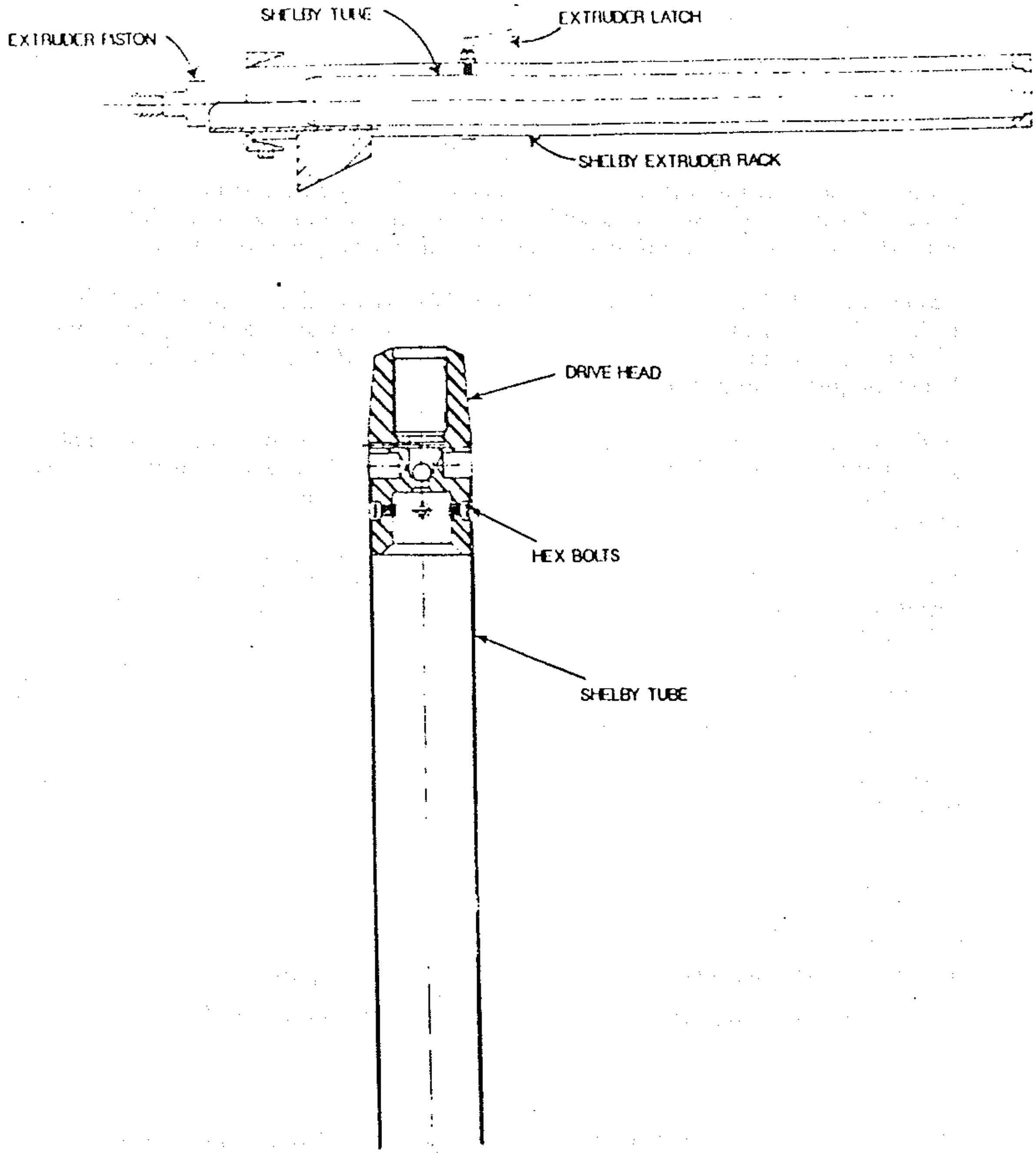
1.3.2 Soil Sampling Terms

These terms are most often used when discussing soil sampling using the Geoprobe® system, however at times they are used when discussing other sampling techniques.

Shelby tube -- This tube is used to collect large cohesive soil samples. Two disadvantages to using this sampling method are that it can not be used for depths greater than about 10 feet and it has no mechanism to stay closed until reaching the proper depth (Figure 4).

Shelby tube drive head -- This 2-inch diameter piece of steel attaches to the Shelby tube using hex bolts. The Shelby tube drive head consists of two parts: a standard 2-inch Shelby tube drive head Geoprobe® sampler sub. This allows the 2-inch-wide Shelby tube to be driven by the hydraulic punch, which is actually designed for 1-inch diameter drive rods (Figure 4).

Hex bolts -- These bolts are used to attach a Shelby tube to a drive head (Figure 4).



SOURCE: GEOPROBE SYSTEMS. 1991. ACCESSORY TOOLS CATALOG.

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FIGURE 4

SHELBY TUBE ACCESSORIES

PRC Environmental Management, Inc.

Extruder latch -- This device secures the Shelby tube to the extruder rack during the extrusion process that removes the soil from the tube (Figure 4).

Extruder piston -- This piston is threaded onto a drive rod and with the help of the hydraulic punch, it extrudes the soil sample from the shelby tube (Figure 4).

Probedrive systems -- These sampling systems allow samples to be taken at deeper depths than the Shelby tube. Each probe-drive sampler remains closed until it reaches the depth desired and then is opened by the hydraulic punch operator by removing a stop pin. The sampler is pushed through the soil to the desired depth and is then removed. There are three types of probedrive samplers: the standard sampler, the Kansas sampler, and the large bore sampler (Figure 5).

Standard sampler -- This probe-drive sampler has a diameter of 1 inch and lengths of 10 inches or 24 inches. It differs from the other probe-drive samplers in that it does not have a removable cutting shoe (Figure 5).

Stop pin -- This is the pin that stops the point of a probe-drive sampler from retracting into the sampler tube. When it is removed the sample can be taken (Figure 5).

Piston rod -- This rod connects the drive head of a probe-drive sampler to the sampler's point. When the stop pin is removed, this rod slides through the sampler allowing the point to retract inside the tube (Figure 5).

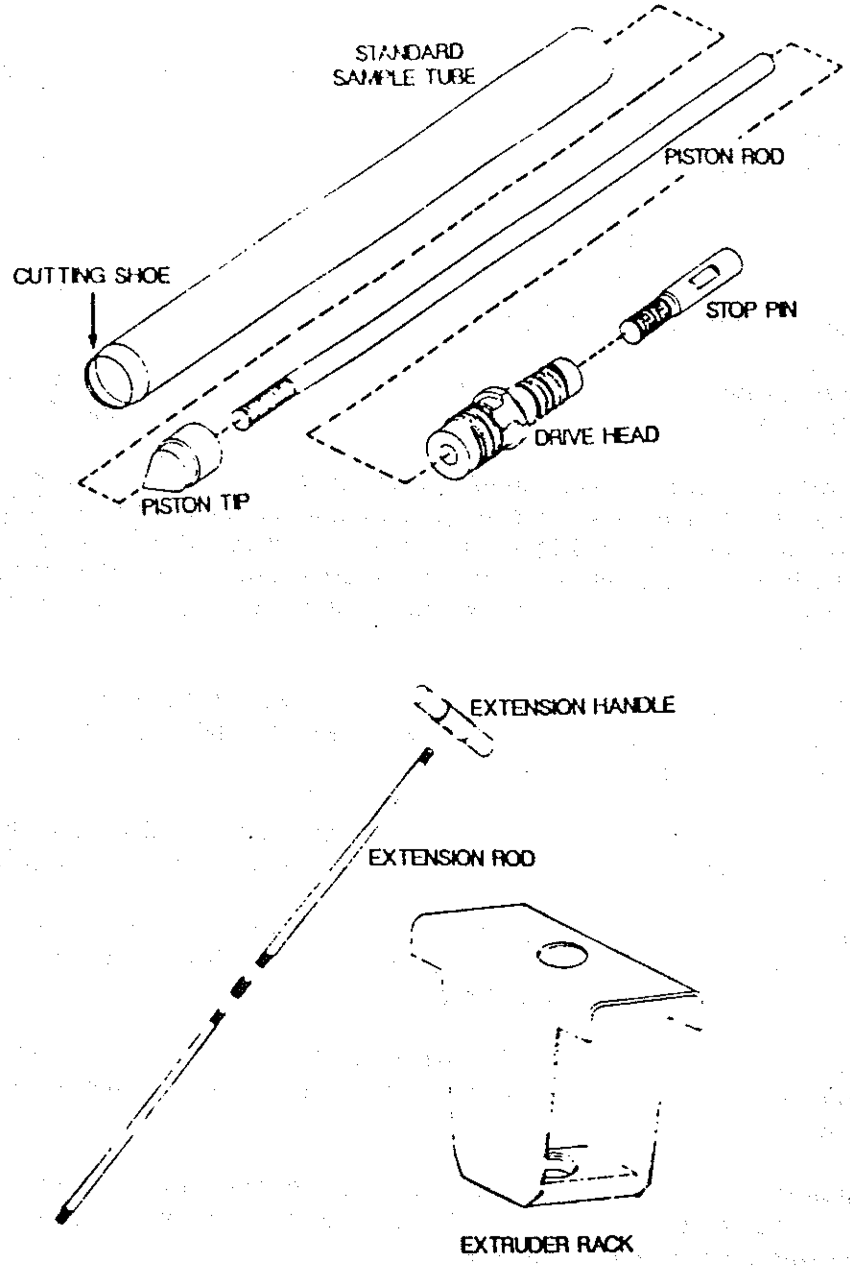
Drive head -- The top of a probe-drive sampler allows the piston rod to slide straight up the sample tube after the piston stop has been removed allowing the drive rod string to advance (Figure 5).

Cutting shoe -- This portion of the probe-drive sampler cuts through the soil once the point is allowed to retract inside. The Kansas samplers and large-bore sampler have removable cutting shoes (Figure 5).

Extruder rack -- This device holds soil samplers in place during extrusion. The shelby tube extruder rack is shown on Figure 4; the standard probe-drive extruder rack is shown on Figure 5.

Extension rod -- This long, thin, threaded, solid rod is dropped through a drive rod to the probe-drive sampler so that the stop pin can be removed. Often more than one extension rod must be put together to reach the stop pin (Figure 5).

Extension rod handle -- This is a small metal handle that screws onto the top of the extension rod string so that it can be turned easily while removing the stop pin (Figure 5).



SOURCE: GEOPROBE SYSTEMS. 1991. ACCESSORY TOOLS CATALOG

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FIGURE 5

PROBE-DRIVE SYSTEM

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Large bore sampler -- This is a probe-drive sampler that is 1-1/8 inches in diameter and 24-inches long. Its larger width allows for larger samples to be taken. The wider diameter also allows for acetate or brass liners to be used in collecting samples. These liners can make viewing the sample easier and preparing it for analysis simpler. This sampler has a removable hardened cutting shoe.

Kansas sampler -- This is a specially designed probe-drive sampler that has a removable hardened cutting shoe. This enables easy extraction of soil and allows for the shoe to be replaced without replacing the complete sampler.

Kansas stainless sampler -- This is a Kansas sampler with a stainless-steel sampling tube. It works the same way as the Kansas sampler.

1.3.3 Soil Gas Sampling Terms

The following terms are used principally when discussing soil gas sampling. Some, however, are used while discussing groundwater sampling as well.

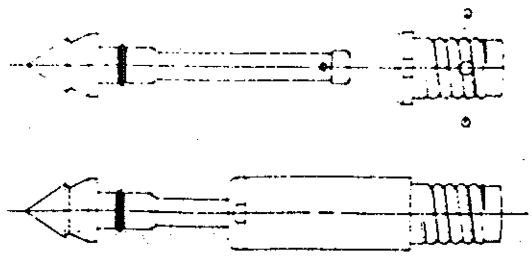
Expendable points -- These points fit into an expendable point holder that has been threaded into the lead drive rod. When the drive rod is pulled back, these points do not move with it, leaving a gap from which the soil gas sample can be taken. The points ultimately are left in the ground (Figure 6).

Standard expendable point holder -- This holder threads into the leading drive rod. It is used for driving expendable points (Figure 6).

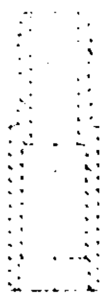
Retractable point holder -- This holder lifts off its point, leaving a gap so that the soil gas sample can be drawn. Unlike expendable points, the holder does not separate completely and ultimately retrieves the point with the lead drive rod (Figure 6).

Gas sampling cap -- When using the standard soil gas sampling method, the gas sampling cap replaces the drive cap on top of the drive rod and allows tubing to be connected to the drive rod. A soil gas sample is drawn through the probe rod, through the cap, and into a sample container (Figure 6).

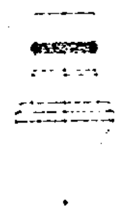
Post-run tubing (PRT) method -- This is a method of collecting soil gas samples that enables the gas to be drawn directly through a tube instead of through the drive rod itself. The method involves one of two specially designed point holders, each threaded on top so that an adapter, which has been attached to the tube, can be screwed into it after being advanced down the drive rod string (Figure 7).



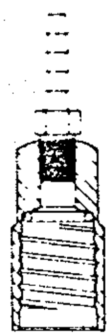
RETRACTABLE POINT HOLDER



EXPENDABLE POINT HOLDER



EXPENDABLE POINT



GAS SAMPLING CAP

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FIGURE 6

STANDARD SOIL GAS TOOLS

PRC Environmental Management, Inc.

SOURCE: GEOPROBE SYSTEMS. 1991. ACCESSORY TOOLS CATALOG.

PRT expendable point holder -- When using the PRT system, this holder is threaded into the leading probe rod and is used for driving expendable points (Figure 7).

PRT adapter -- The PRT adapter attaches the tubing through which the soil gas sample is to be drawn to the point holder, which has been driven to the proper sampling depth (Figure 7).

Polyethylene tubing -- The preferred tubing for connecting the PRT system to the sample container. Its stiff nature, however, sometimes makes it difficult to attach to the container and a coupler of Tygon® tubing is necessary (Figure 7).

Tygon® tubing -- The preferred tubing for connecting soil gas sampling containers to the drive rod and vacuum system. It is also needed as a coupler between the stiff polyethylene tubing used with the PRT system and the sampling container.

Glass bulb -- This is a bulb made of glass with valves on each side and a neoprene septum through which gas can be withdrawn. The bulb is used to collect soil gas samples and can be used as the container in which the gas is taken for analysis (Figure 8).

Tedlar® bag -- This is a small bag with a valve on it. When placed in an airtight chamber, the air in the chamber is evacuated and the bag fills with soil gas. The bags are then taken for analysis (Figure 8).

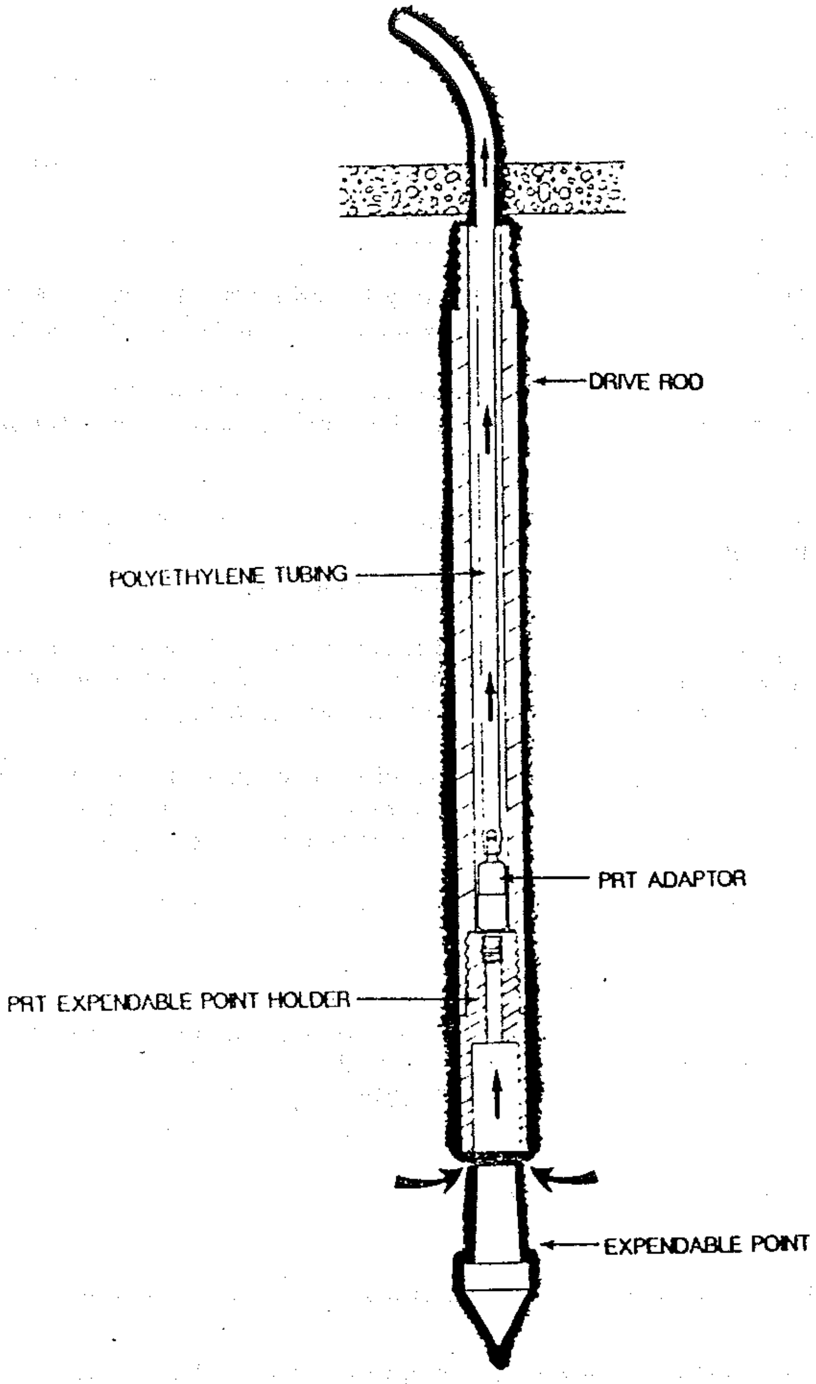
Tedlar® bag chamber -- PRC uses modified, airtight containers as vacuum chambers. The modified containers have nipples on each side that enable the chamber to attach to a vacuum pump, Tedlar® bag, and Tygon® tubing (Figure 8).

1.3.4 Groundwater Sampling Terms

The following terms are used while discussing groundwater sampling.

Mill-slotted well point -- This 3-foot long tube has 15 mill-cut slots in it, each 2 inches long and .020-inches wide. Only the bottom 2 feet of this tube is slotted. Sometimes mill-slotted well points come in two parts: a 2-foot slotted section and a 1-foot unslotted section. The slots allow groundwater to enter (Figure 9).

Geoprobe® screen point sampler -- This sampler has a 19-inch screen, which encases a perforated stainless-steel sleeve. Once in place, the screen allows the water to enter the tube and prevents course sediment from entering the tube (Figure 9).



SOURCE: GEOPROBE SYSTEMS. 1991. ACCESSORY TOOLS CATALOG.

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FIGURE 7

POST-RUN TUBING (PRT) SYSTEM

PRC Environmental Management, Inc.

FIGURE IN PREPARATION

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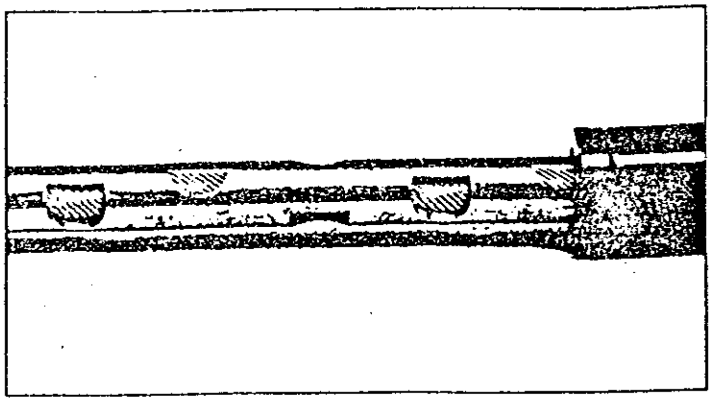
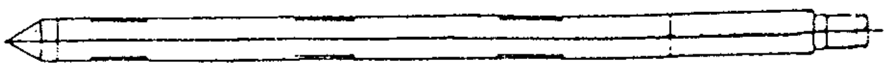
FIGURE 8

SOIL GAS CONTAINERS

PRC Environmental Management, Inc.



SCREEN POINT SAMPLER IN OPEN POSITION



MILL-SLOTTED WELL POINT

SOP 54: USING THE GEOPROBE SYSTEM

FIGURE 9

GROUNDWATER SAMPLING TOOLS

PRC Environmental Management, Inc.

SOURCE: GEOPROBE SYSTEMS. 1991. ACCESSORY TOOLS CATALOG.

Thieving tube -- Used to extract the water from either mill-slotted well points or Geoprobe® screen point samplers. PRC uses polyethylene tubing as thieving tubes. This tubing is lowered into the water, capped on top, and then extracted. The result is like putting a straw into a glass of water, sealing the straw with a finger, and lifting it. This method is used primarily for collecting groundwater samples for volatile organic compound (VOC) analysis.

Well mini-bailer -- This specially designed bailer, drops through the drive rods and into the groundwater in the mill-slotted well point or screen point. A small ball in the bailer floats to the top and then sinks, ultimately sealing the bailer after it fills with about 40 milliliter (mL) of groundwater.

1.4 REFERENCES

The following references were used in preparing this SOP:

Geoprobe® Systems. 1990. 8-M Operations Manual (July 27).

Geoprobe® Systems. 1992. Equipment and Tools Catalog.

2.0 PROCEDURE

The Geoprobe® system uses a hydraulic punch -- usually installed in the back of a van or truck -- first to push and then to hammer its hollow drive rod through soil. Depending on which tools are attached to the end of the drive rod and which sampling equipment is attached to it, the Geoprobe® is used to remove soil, soil gas, or groundwater. It can also be used to drill through cement or concrete and can aid in the installation of piezometer wells and vapor sampling implants. The following sections detail the procedures for using this equipment.

2.1 POSITIONING THE GEOPROBE® UNIT

Before the Geoprobe® system can be used, the hydraulic punch and accessories must be properly positioned near the sample location. The hydraulic punch and need accessories to be prepared. In cases where concrete or other hard surfaces hinder sampling, the Geoprobe® must be used to reach soil. This section details methods to do all of these.

To position and unload the Geoprobe® system do the following:

1. Drive the vehicle containing the Geoprobe® system to the sampling location, aligning the center of the rear of the vehicle with the point at which the sample will be taken. The rear bumper should be 1- to 2- feet from the sampling point so that the foot of the hydraulic punch can be extended over it.

2. Turn off the vehicle.

3. Place the gear shift in park.

4. Set the emergency brake.

5. One person should operate the hydraulic punch and the assembly and disassembly of probe rods and accessories. A second person is usually to handle the samples and to decontaminate equipment. All personnel must wear steel-toed shoes, gloves, and eye protection. When drilling through concrete or using the hydraulic hammer, ear protection is also necessary.

6. When ready to take the sample, start the vehicle engine using the remote ignition located in the right rear of the vehicle. As a safety device, the remote ignition will not work unless the vehicle is in park.

7. Activate the hydraulic system by turning on the electrical control switch. The vehicle's engine must be running for the hydraulic system to work.

8. Slowly extend the Geoprobe® out of the vehicle using the extend lever. Always use the slow speed on the hydraulic controls when positioning the hydraulic punch. Insure the hydraulic punch is extended far enough from the vehicle so that it does not strike the roof when it is unfolded.

9. Unfold the hydraulic punch out of the vehicle using the fold lever. When the punch is lined up perpendicular to the ground surface, lower the foot of the punch using the foot lever until the vehicle itself is raised about a foot on its springs. This stabilizes the vehicle and punch. **Never lift the vehicle completely off the ground using the foot lever.** Doing so destabilizes the vehicle and hydraulic punch and may cause damage to equipment or injury to those nearby. As pressure is placed on the rod, tools, and accessories, the foot of the punch may begin to lift. Do not allow it to lift further than 6 inches from the ground. Allowing it to lift farther than 6 inches may throw the vehicle off balance and cause the rod to bend or break.

The Geoprobe® system is now positioned properly. If it is necessary to drill through solid surfaces, such as concrete or hard asphalt, do the following:

1. Raise the hydraulic punch using the probe lever and then deactivate the hydraulic system by turning the electrical control switch to off. The hydraulic system should always be turned off when the hydraulic controls are not being used.

2. Place the drill bit into the hydraulic hammer. The bit is not used with a drive rod or anvil.

3. Activate the hammer rotation control knob, which is located on the hydraulic hammer, by turning the knob counterclockwise. This allows the drill bit to rotate when the hammer lever on the control panel is pressed.

4. Activate the hammer release valve, which is located on the hydraulic hammer, by pulling the lever out and down.

5. Both the probe and hammer mechanisms of the hydraulic punch must be used to drill through solid surfaces. The hammer mechanism drives the drill bit in a percussion fashion and causes it to turn slightly. The probe mechanism allows the hammer and bit to be raised and lowered so that the bit can clear itself of debris. When ready to begin drilling, turn on the hydraulic system.

6. Fully depress the hammer lever. This lever needs to remain depressed throughout the drilling procedure; it keeps the bit pounding and rotating.

7. Put pressure on the bit by pressing the probe lever down. Using this lever, advance the bit in small increments through the concrete or other hard surface. If advanced too quickly, the bit will bind and stop rotating. Should this happen, raise the punch slightly to allow the bit to rotate. If too little pressure is placed on the bit, too little percussion will occur and drilling will be slow.

8. Continue drilling, in small increments, until soil is reached. Prepare for sampling.

2.2 SAMPLING SYSTEM PREPARATION

Before the hydraulic punch is used to sample, decisions must be made about which type of sample will be taken, whether samples will be taken at varying depths, and which type of Geoprobe® sampling equipment will be used. The following sections discuss the preparation for many of these options.

2.2.1 Soil

The samplers attached to the hydraulic punch for soil sampling come in two forms. The first type is the 2-inch-diameter Shelby tube sampler, which is a common soil sampling method. The second type of sampler uses specially designed probe drives, which remain completely sealed while being pushed or driven to a particular depth. They are then opened to collect a sample.

2.2.1.1 Shelby Tube Sampler

The Shelby tube is a thin-walled, steel tube with four mounting holes encircling its top. The tube measures 2 inches in diameter and 30 inches long in length. It allows large amounts of soil to be sampled at once, but the soil must be relatively cohesive. Because the tube remains open at all times, the tube can not be driven to great depths and must be removed and replaced after coring 30 inches of soil. Usually, the Shelby tube sampler is chosen when large amounts of soil samples are needed at depths no deeper than 10 feet. Rocky or sandy soils are not conducive to this sampling method.

To prepare for sampling using the Shelby tube, use the following procedure:

1. Attach a Shelby tube to the Shelby tube drive head by putting the drive head's hex bolts through the holes in the tube and tightening them.
2. Screw a Geoprobe® sampler sub into the top of the drive head. This allows the 2-inch-wide Shelby tube to be driven by the hydraulic punch and hammer, which are actually made for 1-inch outer diameter drive rods.
3. Screw drive cap onto the top of the sampler sub. The Shelby tube is ready to be attached to the hydraulic punch.
4. Raise the hydraulic punch using the probe lever and then turn off the Geoprobe® hydraulic system.
5. Lift the hammer latch and insert the anvil.
6. Place the assembled Shelby tube so that it is aligned beneath the anvil.

The hydraulic punch is now ready to drive a Shelby tube and collect the soil sample. For collecting soil samples deeper than 30 inches, attach sections of probe rod to an assembled Shelby tube and drive the sampler down the same hole using a new section for each 30 inch increment in depth.

2.2.1.2 Probedrive Samplers

All probedrive samplers work essentially the same. A sampler is attached to a hollow drive rod, inserted into the hydraulic punch, and then punched or hammered into the soil. A stop in, which opens the sampler, is removed when the sampler reaches the desired depth by using an extension rod that has been dropped through the inside of the drive rod. The removal of the stop pin allows the point of the sampler to retract inside the sample tube as the sampler is further advanced into the soil. The probe is then punched through the soil where the sample is to be taken. The rod and probe are then pulled to the surface for sample extraction.

Currently there are three types of probedrive samplers: the standard sampler, the Kansas sampler, and the large bore sampler. Preparation of each sampler is slightly different. Each will be discussed separately in the following sections:

<u>Standard Samplers</u>

The standard sampler comes in 10-inch and 24-inch lengths. The length used is based on the size of the sample desired. The point of this sampler is connected to a piston rod, which will slide through its length. At its top, the piston rod is connected to the drive head that keeps it centered and holds the piston stop pin, which stops the piston from sliding.

To prepare the standard sampler, do the following:

1. Insure that the sampler is assembled and complete, and that the piston stop pin is tightly locked so that the sampler point will not slide into the sampling tube. If you have trouble locking the stop pin, try turning the pin the other way. It is reverse threaded.

2. Attach a shortened Geoprobe® drive rod to the sampler so that the total length is close to the standard 3 feet. This means that if the 10-inch sampler is used, a 2-foot drive rod should be attached; if the 24-inch sampler is used a 1-foot drive rod should be attached.

3. Screw a drive cap onto the top of the shortened drive rod. The sampler is ready to be attached to the hydraulic punch.

4. Raise the hydraulic punch using the probe lever and then turn the hydraulic system off.

5. Lift the hammer latch and insert the anvil.

6. Place the assembled standard sampler and shortened drive rod directly beneath the anvil so that the drive cap touches it and the point of the sampler is aimed at the location where the sample is to be taken. The standard sampler and the hydraulic punch should both be vertical.

7. Drive the sampler to the desired sampling depth.

Kansas samplers

These samplers are similar to the standard sampler. The main difference is that they have removable hardened cutting shoes near their points, which allow them to penetrate rockier soils and to be replaced and decontaminated easier. Kansas samplers come in two versions: The Kansas stainless sampler, which has a stainless-steel tube, and the Kansas sampler, which has an alloy-steel tube.

To prepare a Kansas sampler, do the following:

1. Insure that the hardened cutting shoe is in place.

2. Assemble and install the Kansas sampler in the same manner as the standard sampler (see Procedures 2 through 7 above).

<u>Large Bore Sampler</u>

The large bore sampler is similar to the Kansas samplers in that it has a removable cutting shoe. It works in the same manner as the other samplers. Its greatest difference is that it is slightly larger, usually 24-inches long and 1-1/8 inches wide. The larger size allows acetate or brass liners to be used. The soil, therefore, can be removed easier by removing the liner. The acetate liner allows for easy visual examination of the sample and can be easily cut away so that the sample can be prepared for the laboratory. The brass liner comes in four 6-inch sections, which allows for easy separation and packaging of 6-inch soil samples. Some laboratories accept full 6-inch brass liners. This allows the samples to be collected with a minimal disturbance to the soil matrix.

To prepare a large bore sampler, do the following:

1. Unscrew the cutting shoe and sampler drive head from the two ends and insert the desired liner.

2. Assemble the sampler and attach a 12-inch drive rod.

3. Screw a drive cap onto the top of the drive rod.

4. Place the assembled sampler and drive rod beneath the hydraulic punch as detailed in the section above on preparing standard samplers (see Procedures 5, 6, and 7 above).

2.2.2 Soil Gas Sampling

Two methods are used to collect soil gas using Geoprobe® systems: the traditional method and the PRT system.

To use the traditional method, the drive rod must first be decontaminated and made airtight before being punched into the soil. When the bottom of the probe rod is about 6 inches below the location from where the sample is to be taken, the rod is then lifted those 6 inches. This action causes the drive rod's expendable point to be left behind and a small gap between that point and the end of the rod is creating. A gas sampling cap is then attached to the top of the rod, a vacuum pump removes the necessary volume of gas, and the sample is collected.

The PRT method involves pushing a stiff tubing attached to a stainless-steel adaptor through the drive rod after the rod is in place. The tubing and adaptor are then threaded onto the top of the PRT expendable point, and the gas is collected through the tube. This method increases the accuracy of soil gas sampling, eliminates the potential for leaks in the rod itself, and reduces decontamination time.

2.2.2.1 The Standard Method

Only decontaminated drive rods are used for the standard method. Rods should be decontaminated using the procedures in Section 6.0. To prepare a decontaminated drive rod for soil gas sampling using the standard method, do the following:

1. Screw an expendable point holder into the female-threaded end of a 3-foot drive rod. (Note: a retractable point can also be used with this method; however, decontamination requirements almost always preclude its use.)

2. Place an expendable point into the holder.

3. Screw a drive cap onto the male end of the drive rod.

4. The rod is ready to be placed into the hydraulic punch.

5. Turn off the hydraulic system.

6. Lift the hammer latch and place the anvil inside the hydraulic punch.

7. Place the assembled drive rod directly beneath the anvil so that the drive cap faces the anvil and the expendable point is aimed at the sample location.

The sampler and hydraulic punch are now ready to be pushed through the soil.

2.2.2.2 The PRT Method

Two types of PRT methods are available. The first uses an expendable point holder and expendable point like those used in the standard method. The second uses a retractable point holder that lifts off its point without actually separating from it. Both systems allow for the threading of a PRT adapter and tubing through the drive rod so that the soil gas sample can be taken at the desired depth without being sucked through the drive rod.

To prepare the drive rod and sampler for PRT soil gas sampling, do the following:

1. Select the desired PRT sampler and check to insure that the PRT adapter easily screws onto the threads on the sampler's top. This is necessary to insure that the adapter will fit when trying to affix it from above ground.

2. If using the sampler with an expendable point, attach the point.

3. Screw the sampler to the end of a shortened drive rod so that the total length is nearly 3 feet.

4. Screw the drive cap to the other end of the drive rod.

5. Attach the drive rod and sampler to the hydraulic punch, following the same procedures as that detailed for the standard method (Procedures 4, 5, 6, and 7 above).

2.2.3 GROUNDWATER

The Geoprobe® system offers two methods for collecting groundwater samples, each with a variety of options on how the water is actually removed. The first method involves the use of a mill-slotted well point. The second method uses a specially designed Geoprobe® screen point sampler.

2.2.3.1 **Mill-Slotted Well Point**

The mill-slotted well point is 3-foot length of hollow steel tubing with 15 mill-slotted cuts, each 2-inches long and .020-inches wide. Groundwater enters the tube through these slots. To prepare the mill-slotted well point, do the following:

1. Screw a solid drive point into the female end of the sampler.
2. Screw a drive cap to the other end of the well point.
3. Raise the hydraulic punch as much as needed to place the sampler and rod beneath it. Turn the hydraulic system off.
4. Lifting the hammer latch and place the anvil inside the hydraulic punch until it makes contact with the hammer.
5. Place the mill-slotted well point sampler beneath the anvil with the drive cap facing the anvil and the point aimed at the location where the sample will be taken.

The hydraulic punch and mill-slotted point sampler are now ready to sample.

2.2.3.2 **Geoprobe® Screen Point Sampler**

This sampler has a 19-inch screen encased in a perforated stainless-steel sleeve. The screen remains encased in the sleeve until the sampler reaches the desired depth. The rod is then withdrawn about 19 inches and the screen either drops into the void or is pushed out into the soil. Flexible tubing can be pushed through the drive rod and attached to the sampler using the PRT adapters. This enables the groundwater to be removed without actually touching the drive rod itself, which, in turn, makes decontaminating the rod easier.

To prepare a Geoprobe® screen point sampler, do the following:

1. Close the screen on the sampler.
2. Attach its expendable point.

3. Attach the sampler to a shortened drive rod so that the assembly is nearly 30 inches long.

4. Place the sampler into the hydraulic punch using the methods detailed for mill-slotted well points (Procedures 4, 5, and 6 above).

5. Collect the groundwater sample.

2.3 SAMPLING PROCEDURES

Sampling procedures for the Geoprobe® hydraulic punch are largely the same no matter which sampler is being pushed into the soil which type of sample is being collected. This section presents an overview of operating procedures that apply to all sampler and sample types and then lists sample-specific and sampler-specific operating procedures.

2.3.1 GENERAL OPERATING PROCEDURES

All control panel switches can be run in the slow or fast position. All switches should initially be run in the slow position when positioning the hydraulic punch and the sampling tools. In all cases, the hydraulic system should be shut off when not in operation. It should also be shut off when different adapters or additional drive rods are put into place.

The hydraulic punch has a key safety feature that automatically shuts it off if the controls are released. If at any time, personnel operating the controls sense that something is wrong, they should release the controls, until you are satisfied that all is well. At no time should the foot of the punch be allowed to lift higher than 6 inches from the ground because this may destabilize the hydraulic punch and result in the bending of the drive rod or sampling tube.

At no time should any part of the human body be placed on top of a drive cap while it is near the anvil or under the foot of the hydraulic punch.

When the assembled sampler or drive rod is under the anvil, check to insure that both it and the hydraulic punch are vertical. Positioning this rod is critical in order to drive the rod vertically. Not positioning it vertically will result in problems with later rods should they be needed to reach the proper depth. It can also result in problems during rod retrieval.

To begin probing in soils of normal texture, do the following:

1. Activate the hydraulic system and push down on the probe lever on the control panel so that the probe slowly lowers itself. Always use the slow position on the first rod or sampler.

2. Continue to press on the probe lever until the rod or sampler is forced into the soil. The point of the rod should then be nearly 3 feet into the soil.

Often the soil and other materials through which the drive rod and sampler must move are too hard for the hydraulic punch's probe mechanism to penetrate. When this occurs, the hammer on the hydraulic punch should be used. In these cases, do the following:

1. Insure that the hammer rotation valve is closed.

2. Use the hydraulic punch to put pressure on the rod, sampler, and soil. When the probe rod refuses to move, the foot of the hydraulic punch will begin lifting off of the ground. Never allow the foot to lift more than 6 inches off the ground, but never use the hammer with the foot resting on the ground surface.

3. If the probe foot lifts off the ground, the hydraulic punch may no longer be perpendicular. If this occurs, use the fold lever located on the control panel to correct its position.

4. **Press the hammer lever on the control panel. The rod should now advance. Never use the hammer unless there is downward pressure on the drive cap. Doing so may damage the equipment.**

5. Stop hammering periodically to check whether the probe rods can be advanced using the probe mechanism only.

In cases where samples are to be taken at depths greater than 3 feet, additional drive rods will need to be added to those already in the ground. For all sampling methods, with the exception of Shelby tube sampling, follow the procedures below to add drive rods. For Shelby tube sampling, see Section 2.3.2.1.

1. Raise the hydraulic punch off of that portion drive rod jutting from the ground using the probe lever.

2. Unscrew the drive cap from the drive rod.

3. If using the standard method of collecting soil gas or other sampling methods that draw the sample through the entire drive rod, wrap the threads of the drive rod with teflon tape or push an O-ring over the threads. This will make the drive rod string air- and watertight.

4. Screw another drive rod onto the part of the first drive rod, which juts from the ground. Tighten the rods together with a pipe wrench.

5. Screw a drive cap onto the top of the new drive rod.

6. Place the hydraulic punch over the new drive rod and begin to push the rod further into the ground.

As the string of drive rods is pushed farther into the ground, they may begin to loosen. It is important that they remain tight so that the threads are not damaged. Stop probing periodically and twist the string of rods with a pipe wrench to insure all joints remain tightly sealed.

2.3.2 SOIL SAMPLING PROCEDURES

These sections detail procedures that may be used to sample soils, using either the Shelby tube sampling method or any of the probedrive systems. In all cases, sampling tools should never be advanced farther than their length when extended. Doing so will overfill the sampler causing it to be damaged.

2.3.2.1 Shelby Tube Sampling Procedures

Because the Shelby tube does not remain closed until it reaches the desired sampling depth and because it is not connected to a drive rod, but to a Shelby drive head, sampling with a Shelby tube differs greatly from soil sampling using other methods. Probing deeper than 30 inches, involves a stairstep progression for obtaining samples. For example, to sample to 90 inches, three Shelby tubes are needed. The first is advanced from 0 to 30 inches, then removed. The second Shelby tube, which is connected to a driverod, is pushed through the hole made by the first and then advanced from 30 to 60 inches and then removed. The third is also pushed through the hole and then advanced from 60 to 90 inches.

Problems often arise when using the stair-step progression Shelby tube method. The need may arise to change methods. For example, if soils are not cohesive, they tend to drop out of the Shelby tube as it is pulled from the ground. Soils which are not cohesive also tend to collapse into the hole left by the initial tube before the second and third can be pushed into place. Rocky soils are also difficult to sample with a Shelby tube sampler. They tend to destroy the sampler while it is being driven into the ground.

For all of these reasons, use of the Shelby tube method is impractical at depths much deeper than 10 feet or in soils that are rocky or not cohesive.

To sample using the Shelby tube method, do the following:

1. Turn on the hydraulic system and slowly press the Shelby tube into the soil using the probe lever on the control panel.
2. Once the tube has reached the desired depth for the sample -- or once it has been punched nearly its full 30 inches -- stop the hydraulic punch and raise it off the drive cap and Shelby tube drive head.
3. Unscrew the drive cap.
4. Screw on a pull cap in its place.
5. Lower the hydraulic punch and lift the hammer latch. Remove the anvil. Place the latch around the pull cap so that the latch will hold the cap to the hydraulic hammer.
6. Using the probe lever, raise the hydraulic punch. This should pull the Shelby tube from the ground.

After a Shelby tube core is retrieved from a sampling point, it must be extruded from the Shelby tube sampler. To do this, do the following:

1. Lower the hydraulic punch using the probe lever so that its mast will not strike the top of the vehicle as it is folded.

2. Lift the foot of the hydraulic punch using the foot lever.

3. Slowly and carefully, fold the hydraulic punch using the fold lever.

4. Once the hydraulic punch is horizontal, the Shelby tube extruder bracket can be placed onto the punch's foot. This bracket will hold the Shelby tube in place and allow the punch to drive an extruder piston, pushing the soil out of the tube.

5. Screw an extruder piston onto a drive rod and a drive cap onto the other end.

6. Place the drive rod under the horizontal drive punch.

7. Place the full Shelby tube into the extruder rack and secure it with the extruder latch.

8. A pan or container should be held at the end of the Shelby tube to collect sample material as it is extruded.

9. The probe lever is used to activate the hydraulic punch and push the soil from the Shelby tube.

The Geoprobe® system has now been used to collect a Shelby tube sample. PRC's SOPs on packaging and documenting samples should be used to prepare the sample for analysis (SOPs 016, 017, 018, and 019).

2.3.2.2 Probedrive Sampling System Procedures

All three types of probedrive samplers work in essentially the same way. The sampler is pushed to just before the proper depth and then the point is released by removing a stop pin using solid extension rods that have been dropped through the hollow drive rod. The point is then pushed back into the body of the sampler as the body is filled with the soil sample.

In addition to the general operating procedures listed in Section 2.3.1, one important factor needs to be kept in mind for all probedrive sampling systems. The probe must stop just before the desired sample depth so that the stop pin can be removed. Pushing the probe too far will demand starting over.

To use probedrive sampling systems to sample soil, do the following:

1. Attach additional drive rods as discussed in the general procedures in Section ______.

2. Stop the hydraulic probe just before the desired sampling depth.

3. Raise the hydraulic punch, turn off the hydraulic system, and remove the drive cap.

4. Insert an extension rod into the drive rod, and add others as needed until they reach the top of the sampler.

5. Attach a small extension rod handle to the top of the extension rod.

6. Rotate the handle clockwise until the leading extension rod has turned the stop pin and disengaged it.

7. Pull the extension rod from the hollow drive rod. The stop pin should be attached to the bottom. If not, try again.

8. You are now ready to sample. Mark the drive rod with tape or chalk about 10 inches above the ground if a 10-inch sampler was used or 24 inches from the ground if a 24-inch sampler was used.

9. Replace the drive cap and start the hydraulic system.

10. Drive the rod until the tape or chalk mark touches the ground. Be careful not to overdrive the sampler. Doing so could compact the soil in the sampler or even cause it the balloon outward. This will cause a great deal of trouble when removal and extrusion are necessary.

11. Raise the hydraulic punch and replace the drive cap with the pull cap. Remove the anvil.

12. Latch the pull cap underneath the hydraulic hammer latch and pull the rods out of the ground, disassembling the rod as needed.

13. Check to insure that a soil sample is now in the sampler.

Once a soil sample has been taken and removed from the ground, the soil sample can be extruded using the Geoprobe®. The tools supplied by Geoprobe Systems for extruding soil from probedrive samplers do not require that the Geoprobe® be folded and horizontal like those for the Shelby tube system. If liners are used with large bore samplers, extrusion is usually unnecessary. In cases where extrusion is necessary for probedrive samplers, do the following:

1. Raise the foot of the hydraulic punch off of the ground using the foot lever on the control panel.

2. Attach the extruder rack onto the foot of the punch so that its crossbeam rests on top of it.

3. Completely disassemble the sampler, which includes removing the piston, point, and drive head of the sampler. In the case of the Kansas sampler and large bore sampler, it will mean unscrewing the removable cutting shoe as well.

4. Insert the sample tube into the extruder with its cutting end up.

5. Insert a disposable wooden dowel or the reusable steel piston above the soil and below the hydraulic punch so that pressure on the dowel or piston from the punch will push the soil out the bottom of the sample tube.

6. Position sampling jars or trays under the sample tube, and very slowly use the probe lever to force the soil out of the tube. This must be done slowly and carefully or injury can result.

The soil sample is now ready for packaging or on-site laboratory analysis. In the case of the large bore sampler, acetate liners or brass sleeves within the sampler contain the soil sample. In the case of acetate liners, cut the liner open and remove and prepare the sample for shipment to the laboratory. The brass sleeves are simply capped on both ends and shipped to the laboratory as is. PRC's SOPS on packaging and documenting samples for analysis should be followed.

2.3.3 SOIL GAS SAMPLING PROCEDURES

The two methods of collecting soil gas samples using the Geoprobe® are the standard method and the PRT method. The major difference is that when using the standard method, the drive rods must be sealed together with either O-rings or teflon tape to ensure an airtight seal. This prevents soil gas from other depths from entering the string of drive rods.

The PRT method does not demand these precautions because the soil gas will be drawn through continuous tubing that will be dropped through the drive rod after it has reached the desired level and that will be attached directly to the point holder in the end of the drive-rod string.

Regardless of which of these methods are used, the drive rod should be driven to the desired depth. The drive cap should be replaced by the drive pull cap and the rod should be pulled back out of the hole approximately 6 inches. It is from this 6-inch void that the soil gas sample is drawn. A pipe wrench or vise-grip pliers should be attached to the pipe just above the foot of the hydraulic punch so that the wrench or pliers rest on the foot. This is to stop the drive rod from working its way back down into the hole.

In cases where Tygon® tubing is used between sample collectors and drive rods or PRT systems, that tubing should be replaced between each sample.

In many other ways, however, the two soil gas methods vary on what preparation is needed to collect the sample and on what procedures are used to draw the soil gas into the sample container. The five sections below detail both the sampling preparations and the methods of collecting the soil gas samples.

2.3.3.1 The Standard Method

To collect ____ samples, raise the hydraulic punch, and replace the pull cap with a gas sampling cap. This cap is specially made to fit the drive rods and is used to connect them to a vacuum supply by tubing. Once in place, remove the volumes of air necessary to insure none of the gas being drawn was in the rod during probing, and then collect the sample using the steps presented in Sections 2.3.3.3 or 2.3.3.4.

2.3.3.2 The PRT Method

To collect soil gas samples, regardless of whether you are using a sampler with an expendable point or one with a retractable point, do the following:

1. Secure the PRT adapter to the end of a piece of polyethylene tubing, which that is 1- to 2-feet longer than the total length of the drive rod sting. The adapter must fit tightly within the tubing. If it does not, tape it into place. Insure that the O-ring is in place on the threaded end of the adapter.

2. Remove the drive cap from the probing rod and lower the adapter into the rod while holding the tubing in place.

3. Grasp the excess tubing and apply downward pressure. Turn it in a counterclockwise to engage the adapter threads on the sampler holder.

4. Pull up lightly on the tubing to test engagement of threads. If the adapter has not engaged, try again. If it repeatedly does not engage, the reason may be that soil has intruded into the drive rod either during probing, or in the case of the retractable point, when the rod was pulled back to leave the point opening. If this has occurred, use the threaded extrusion rods to clean out the threads.

5. In most cases, the adapter will easily screw into place, and the sampler will be ready to collect the sample using the methods presented in Sections 2.3.3.3 and 2.3.3.4. After the sample is collected and the sampler and tube have been extracted from the ground, it is important that the O-ring is checked to insure that a good seal was made between the sampler and adapter. If the O-ring is tightly sandwiched between the adapter and the PRT point holder, the seal should be airtight.

6. New polyethylene tubing must be used for each sample.

2.3.3.3 Tedlar® Bag Method

Using this method, the soil gas is collected for chemical analysis in a 500-cc Tedlar® gas sampling bag by inducing a vacuum on the exterior of the bag. The following procedure should be followed:

1. Connect a short piece of Tygon® tubing (6- to 12-inches in length) to the free end of the polyethylene tubing sticking out of the drive rod. If using the traditional method, connect the Tygon® tubing to the soil gas sampling cap.

2. Attach the other end of the Tygon® tubing to one end of the tedlar bag chamber. PRC uses modified, plastic, airtight kitchen containers for these chambers. They are inexpensive and work well.

3. Connect another piece of Tygon® tubing (2- to 3-feet in length) to the other end of the tedlar bag chamber, and to the nipple on the bottom of the vacuum system panel.

4. Place the top on the Tedlar® bag chamber.

5. Turn the vac/vol pump switch on and allow pressure to build in the vacuum tank. Make sure that the line valve is closed before turning on the pump switch.

6. Open the line valve and purge three times the volume of ambient air out of the Tedlar® bag chamber and PRT tubing or probe rods. The equations for figuring out the system's volume are as follows: $V = \pi r^2 H$ for tubing or probe rod, and $V = L \times W \times H$ for the vacuum chamber.

7. Close the line valve.

8. With hemostats, clamp shut the Tygon® tubing, which is connected to the PRT.

9. Remove the top from the Tedlar® bag chamber.

10. Connect a Tedlar® gas sampling bag to the fitting inside the Tedlar® bag chamber and open the valve on the gas sampling bag.

11. Place the top back on the Tedlar® bag chamber, seal it tightly, and remove the hemostats.

12. Turn the vac/vol pump switch on and open the line valve. This should create a vacuum in the chamber and the Tedlar® bag should fill. The rate at which the Tedlar® gas sampling bag fills depends on the permeability of the soil. The minimum amount of soil gas needed for analysis is approximately 0.5 liters. If less than 0.5 liters is collected after four minutes of sampling, raise the soil gas probe a half foot, and continue to apply a vacuum for another minute. If the minimum required soil gas is not collected, repeat the procedure again. If the minimum required volume of soil gas is still not collected, abandon the collection process at this location. All steps conducted should be accurately recorded in the logbook.

13. After the soil gas sample is collected in the Tedlar® bag, clamp shut the Tygon® tubing extending from the probe rod with hemostats.

14. Turn off the pump.

15. Remove the top from the vacuum chamber.

16. Close the valve on the Tedlar® gas sampling bag and remove it from the chamber. Label the Tedlar® bag with the appropriate information.

2.3.3.4 Glass Bulb Method

The following procedure should be followed when collecting soil gas in glass bulbs:

1. Turn the vac/vol pump switch on and allow pressure to build in the vacuum tank. Make sure that the line valve is closed before starting the pump. The inside scale of the vacuum tank gauge is calibrated in inches Hg. The outside scale is calibrated for volume in liters (at standard temperature and pressure). Build the pressure to the desired level and turn the switch off.

2. Connect a short piece of Tygon® tubing (6- to 12-inches in length) to the sample cap or PRT extending from the drive rod.

3. Connect one end of the labeled glass bulb to the Tygon® tubing.

4. Connect another piece of Tygon® tubing (3- to 5-feet long) to the other end of the glass bulb and to the nipple on the bottom of the vacuum system panel.

5. Open the two valves on the glass bulb.

6. Turn off the vacuum pump.

7. Turn the line valve to its open position.

8. Purge three times the volume of ambient air within the rods, bulb, and tubing. Equations for figuring out volumes are described in Section 2.3.3.3.

9. Turn the line valve to its closed position. Allow the pressure in the sample train to equalize (the sample line gauge should read zero).

10. Close the valves on the glass bulb.

11. Remove the glass bulb.

2.3.3.5 Adsorption Tube Method

The following procedure should be used when collecting soil gas in adsorption tubes:

1. Connect a short piece of Tygon® tubing (6- to 12-inches in length) to the sample cap or PRT extending from the drive rod.
2. Connect this piece of tubing to the nipple on the bottom of the vacuum system panel and purge three volumes of air from the drive rod or PRT system as described in Section 2.3.3.3.
3. Use hemostats to close off the Tygon® tubing attached to the drive rod or PRT.
4. Insert the adsorption tube between the Tygon® tubing coming from the drive rod or PRT and the Tygon® tubing attached to the vacuum system panel.
5. Remove the hemostats and draw the required volume of air through the adsorption tube.
6. Remove the adsorption tube and place the appropriate caps on the ends.
7. Package and ship samples following appropriate SOPs.

2.3.3.6 Soil Gas Sampling Pointers

If the needle on the line valve does not move, it may indicate that the soil at the sampling depth is saturated or that the pore space is too tight to yield a sample. It may also indicate that the sampling train is plugged. If the needle moves back to zero very quickly, it may indicate that the soil at the sampling depth is very permeable or that there is a leak in the sampling train.

In some soils, the needle may return to zero very slowly. The time it takes for the needle to return to zero is called the recovery time. This time should be recorded for each sample taken in a field log book. This information will allow relative comparison of soil permeability. Recovery times greater than 10 minutes should be considered suspect. The effect of any leakage in the sampling system is increased with longer recovery times. After 10 minutes, the operator should consider either changing the sampling depth, location, length of pullback from the sampling tip, or switching entirely from soil gas sampling to grab sampling and analysis of soil.

2.3.4 GROUNDWATER SAMPLING PROCEDURES

The two options for sampling groundwater using the Geoprobe® system follow procedures similar to those presented in Sections 2.3.2 and 2.3.3. The principal difference is how the water sample is collected. The sections below detail procedures for using mill-slotted well points and Geoprobe® screen point samplers to sample groundwater.

2.3.4.1 Mill-slotted Point System Procedures

Once the mill-slotted point reaches groundwater, the water will begin to flow through the slots. When analyzing for VOCs do not use a vacuum to remove the groundwater sample from the drive rod. If the sample is to be analyzed for metals, semivolatiles, pesticides, or explosives using a vacuum on the drive rod is acceptable. In all cases, polyethylene tubing may be used as a thieving rod by lowering its end into the drive rod, capping or sealing the tube's top, and then removing it. The preferred method for collecting a sample for VOC analysis is a well minibailer. To use the bailer, do the following:

1. Raise the hydraulic punch, turn off the hydraulic system, and remove the drive cap.

2. Lower a minibailer into the drive rod until it reaches the bottom of the well. As it reaches the bottom, the ball on the bailer's end will float to the top of the bailer before slowly sinking back to the bottom.

3. Allow a couple of seconds for the ball to sink and set.

4. Pull the minibailer out of the drive rod. It should contain about 20 mL of groundwater.

5. Package and document the samples following PRC SOPs 16, 17, 18, and 19 or a similar EPA-approved procedure.

If a bailer is not required and VOCs are not being collected, a foot valve sampler, vacuum trap, or peristaltic pump can be used to collect samples. Once the sample has been removed and packaged, the mill-slotted point can be removed and decontaminated.

2.3.4.2 Geoprobe® Screen Point Sampler Procedure

The screen point sampler contains a screen and screen plug, which allow water to enter the rod. To use the screen point sampler, do the following:

1. Push the sampler below the depth necessary to reach groundwater.
2. Raise the hydraulic punch and replace the drive cap with a pull cap. Also, remove the anvil.
3. Latch the pull cap under the hammer latch and use the probe lever to lift the drive rod about 18 inches. Because the sampler has an expendable point, the point should have stayed at the deepest depth and the screen and screen connector should have fallen out from the bottom of the sampler. Sometimes, however, the screen stays within the sampler and is lifted the 18 inches with the drive rod.
4. To insure the screen is exposed, attach a vice grip or pipe wrench to the rod above the foot of the hydraulic punch and raise the hydraulic punch. Then remove the pull cap and stick an extension rod ram through the tubing to push the screen into place. Additional extension rods can be attached to reach the desired depth.

To remove the groundwater sample, a minibailer can be used by following the procedures detailed in Section 2.3.4.1. Tubing can be used as a thieving rod. If the sampler was supplied with the optional PRT expendable point holder, then a PRT adapter can be pushed through the drive rod and threaded into place by following the PRT method procedures listed in Section 2.3.3.2. Then a vacuum trap system or peristaltic pump can be used to withdraw the sample. The PRT method, however, should never be used when the sample is to be analyzed for VOCs because it involves using a vacuum to remove the sample.

3.0 PIEZOMETER AND VAPOR SAMPLING IMPLANT INSTALLATION

The Geoprobe® system's ability to quickly probe into soil allows for easy installation of both piezometers and vapor sampling implants. Each demands a slightly different procedure. The two procedures are detailed below.

3.1 INSTALLING PIEZOMETERS

Piezometers are permanent tubes that reach into groundwater and enable easy sampling of groundwater on a routine basis (Figure 10). In addition to installing the tubing, piezometers must be protected from the weather and from contamination. To do this, a well-head protector must be installed around them. In some soil types, preparing for the well-head protector may be the first step to installing a piezometer. For this reason, the directions below should be read completely before beginning. If a post-hole digger is used to install the well-head protector, step five below should be done first. Then the pipe should be advanced through this hole.

To install temporary or permanent piezometers, do the following:

1. Use the hydraulic punch to drive the temporary casing to the desired piezometer installation depth. See Section 2.3.1 for details on how to do this. The different temporary casings which can be used are mentioned below. Geoprobe® Systems also manufactures special drive caps, expendable points, and pull caps fit the many types and sizes of pipe.

   (a) 1-7/16-inch outer diameter (OD) x 1-3/16-inch inner diameter (ID), RW-flush threaded pipe can be used as a temporary casing. This casing can be driven approximately 25- to-30-feet in depth. Two sizes of piezometer wells can be installed inside of the temporary casing: (1) 3/4-inch OD x 1/2-inch ID, polyvinyl chloride (PVC) pipe, or (2) 1-inch OD x 3/4-inch ID, PVC pipe.

   (b) 1-13/16-inch OD x 1-1/2-inch ID, EW-flush threaded pipe can be used as a temporary casing. This casing can be driven approximately 15- to-20-feet in depth. Three sizes of piezometer wells can be installed inside of the temporary casing: (1) 3/4-inch OD x 1/2-inch ID, PVC pipe, or (2) 1-inch OD x 3/4-inch ID, PVC pipe, or (3) 1-1/2-inch OD x 1-inch ID, PVC pipe.

   (c) 1-1/4-inch OD x 1-inch ID, NPT threaded pipe can be used as a temporary casing. This casing can be driven approximately 25- to 30-feet in depth. Only one size piezometer well can be installed inside of the temporary casing: 3/4-inch OD x 1/2-inch ID, PVC pipe. If using NPT threaded pipe, couplers are needed to attach each section of pipe.

2. Once at the proper depth, remove the drive cap and install the selected size piezometer pipe inside of the temporary casing.

FIGURE IN PREPARATION

SOP 54: USING THE GEOPROBE SYSTEM

FIGURE 10

PIEZOMETER WELLS

PRC Environmental Management, Inc.

3. Using a pull plate, remove the temporary casing.

4. If the hole stays open, attempt to install a sand pack around the slotted portion of the piezometer, and then place dry bentonite powder on top of the sand pack as a seal. Using 1 foot of bentonite is preferable.

5. Dig an 8-inch, nominal-diameter hole around the piezometer pipe. This hole should extend to a depth of 1.5 to 2 feet. A post-hole digger can be used for this if the hole is dug prior to driving the temporary casing. The bottom 6 inches of this hole should be filled with dry granular or slurry bentonite. The remainder of the hole should be filled with concrete. A steel, locking, above ground or flush-mounted well protector should be inserted into the wet concrete to provide well-head security. A concrete pad can also be constructed around the steel well-head protector.

3.2 INSTALLING VAPOR SAMPLING IMPLANTS

To install vapor sampling implants (Figure 11), it is first important to punch a drive rod to the desired depth using an expendable point holder and expendable point. Once at the desired depth, do the following:

1. Disengage the expendable point and retract the probe rod about 1 foot. This is done by raising the hydraulic punch, replacing the drive cap with a pull cap, removing the anvil, latching the pull cap onto the hydraulic hammer using its latch, and raising the hydraulic punch again using the probe lever.

2. Lock the rod into place so it does not sink back into the hole by using vice-grip pliers or a pipe wrench.

3. Unlatch the pull cap and raise the hydraulic punch again to allow enough room to work.

4. Remove the pull cap.

5. Attach appropriate stainless-steel tubing to the vapor implant. If tubing is precut, allow 48 inches more than the required depth of the implant.

6. Insert the implant and tubing down the inside diameter of the probe rods until it stops. Note the length of the tubing inserted to insure that the desired depth has been reached. Allow the excess tubing to extend out of the drive rod's top.

FIGURE IN PREPARATION

SOP 54: USING THE GEOPROBE SYSTEM

FIGURE 11

VAPOR SAMPLING IMPLANTS

PRC Environmental Management, Inc.

7. Pour glass beads down the inside diameter of the probe rod using a funnel. This will create a permeable layer around the implant.

8. Use the tubing that extends from the drive rod to stir the beads into place. Do not lift up on the tubing while doing so.

9. Position the remaining tubing through the hole on a rod pull plate and then put the drive rod itself through that hole.

10. Attach the plate to the hydraulic punch using its chain and slowly pull the rod up another 18 to 24 inches. While the punch pulls the rod, push down on the tubing so that it stays in place.

11. Pour bentonite seal mixture down the inside diameter of the probe rod. Stir the mixture using the tubing as before. It may also be permissible to chase the initial mixture with distilled water to initiate the seal, but this will depend on the site and on the role the vapor implant is to play.

12. Pull the drive rod from the hole using the probe rod pull plate already attached, and then plug the hole.

The vapor sampling implant should now be in place and the stainless-steel tubing connected to it should be protruding from the ground. The vapor implant tubing should be protected in the same manner as described in Section 3.1, Step 5 for the piezometer.

4.0 REMOVING RODS

Throughout the many procedures discussed earlier, it will occasionally be necessary to remove drive rods and samplers. The standard way of doing this is to raise the hydraulic punch, turn off the hydraulic system, replace the drive cap with a pull cap, remove the anvil, and then latch the pull cap under the hammer latch. The hydraulic punch can then be used to pull the rod from the ground.

Two deviations to this procedure sometimes occur. The first is necessary when sampling tubes are to be left inside the hole as the drive rod is removed. This is especially the case when soil gas implants or piezometers have been implanted. Because of the presence of these sampling tubes, a pull cap can not be screwed onto the top of the drive rod. Instead, a rod pull plate is used.

This plate is a piece of steel with a hole in it large enough for a drive rod to fit through and it has a hook on one end. The tubing and rod are pushed through the plate and it is attached to the latch on the hydraulic punch by a chain. As the punch pulls up, the plate shifts, and the inside of the hole binds onto the rod. This binding is usually enough to hold the rod to the plate and results in the rod being pulled up as the punch is raised.

The second deviation occurs when the rods have not been pushed perpendicular to the ground. In these cases, a specially designed chain-assisted pull cap is used. This cap looks like a pull cap, but has a chain on it that fits under the latch of the hammer. Once screwed to the drive rod and latched to the probe, raising the probe raises the rod.

In a few cases, drive rods may break while in the ground. To retrieve these rods a rod extractor is used. This extractor, which looks something like a drill bit, is screwed to the end of a probe rod. A hammer is used to pound the extractor into the top of the broken rod. The extractor joins the broken rod to the second drive rod so they can be pulled out together.

5.0 BACKFILLING GEOPROBE® HOLES

Sampling holes made using Geoprobe® system tools should be backfilled with dry, fine, granular bentonite unless otherwise specified in a site-specific sampling plan.

6.0 DECONTAMINATION

Between sampling holes, the hydraulic punch, driverods, and sampling equipment must be decontaminated. Since there are no provisions for this included in the Geoprobe® system itself, a separate decontamination station must be made available. A wire brush, shotgun cleaner (for reaming out the rod), and soft brushes will help clean sticky soil from the probe and rods. Follow PRC SOP 002 for decontamination procedures when sampling for soil or groundwater.

When sampling for soil gas, driverods and samplers are heated by a 100,000 BTU heater until too hot to touch with the bare hand (approximately 15 to 20 minutes). They are then allowed to cool before being used again. Be careful not to heat the rods too hot. Doing so will fatigue the metal.

Sampling plans may have different requirements. Most plans also have requirements for rinsate samples as part of the QA/QC process.

APPENDIX B

FIELD SAMPLE DOCUMENTATION FORMS

PRC ENVIRONMENTAL MANAGEMENT, INC. **DAILY QUALITY CONTROL REPORT**

NAVAL AIR STATION MOFFETT FIELD	DATE:	TEMPERATURE:
	DAY:	WIND:
	WEATHER:	HUMIDITY:

PROJECT:	CONTRACT NUMBER:
PRC PROJECT NUMBER:	

SUBCONTRACTORS ON SITE

PERSONNEL ON SITE

FIELD TEAM LEADER:

EQUIPMENT ON SITE:

WORK PERFORMED (INCLUDING SAMPLING)

QUALITY CONTROL ACTIVITIES:

HEALTH AND SAFETY LEVELS AND ACTIVITIES:

PROBLEMS ENCOUNTERED/CORRECTIVE ACTION TAKEN:

PRC ENVIRONMENTAL MANAGEMENT, INC.	DAILY QUALITY CONTROL REPORT
DEVIATIONS FROM FIELD WORK PLAN:	
SPECIAL NOTES:	
TOMORROW'S EXPECTATIONS:	
DISTRIBUTION:	**SUBMITTED BY:**

PRC ENVIRONMENTAL MANAGEMENT INC.
1099 18th ST
Suite 1960
Denver, CO 80202
(303) 295-1101

D...

CHAIN-OF-CUSTODY RECORD

DESTINATION ____________

PROJECT NAME	PROJECT JOB #
SAMPLER(S): PRINTED NAME AND SIGNATURE	SAMPLING TEAM #

SAMPLE I.D.	DATE OF COLLECTION	TIME OF COLLECTION	SAMPLE MEDIUM (MATRIX)	GRAB	COMP.	SAMPLE LOCATION	NUMBER/SIZE OF CONTAINERS	ANALYSES REQUIRED — FIELD SAMPLE PREPARATION										REMARKS

Larboratory, Please distinguish. Call if you are uncertain. The number zero is "0" and the letters O are "O" or "o".

SIGNATURE	NAME (print)	COMPANY/TITLE	DATE	TIME
RELINQUISHED BY:				
RECEIVED BY:				
RELINQUISHED BY:				
RECEIVED BY:				
RELINQUISHED BY:				
RECEIVED BY:				

REMARKS:	REQ. TURN AROUND

INSTRUCTIONS: Enter only one of the following four codes for each analysis required & for each sample listed. The codes should be entered under the columns labeled "ANALYSES REQUIRED".

U = UNPRESERVED AND UNFILTERED SAMPLE P = PRESERVED SAMPLE F = FILTERED SAMPLE B = BOTH PRESERVED & FILTERED SAMPLE

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FIELD BOREHOLE LOG

PRC ENVIRONMENTAL MANAGEMENT, INC.

SHEET ____ OF ____

LOCATION OF BOREHOLE	JOB NO.:	BOREHOLE DESIGNATION:
	CLIENT:	SURFACE ELEVATION:
	SITE:	DEPTH TO WATER:
	BORING DIAM.:	LOGGED BY:
	DRILLING CO.:	DRILLING DATE(S):
	DRILLING PERSONNEL/METHOD:	

SAMPLER TYPE	SAMPLE DEPTH TOP BOT	BLOWS/ 6 IN. SAMPLE	RECOVERED / DRIVEN	TIME	FIELD SCREENING	ANLYS PHYS CHEM	WELL INFO.	DEPTH (FEET)	USCS SOIL TYPE GRAPHIC LOG	SOIL DESCRIPTION
								1		
								2		
								3		
								4		
								5		
								6		
								7		
								8		
								9		
								0		
								1		
								2		
								3		
								4		
								5		
								6		
								7		
								8		
								9		
								0		

Date: ____________

Data for week ending: ____________

Field team leader: ____________

Page: ______ of ______

Batch No. ____________
To be assigned by Document Control

PRC FIELD FORMS TRANSFER LIST

CHAIN OF CUSTODY RECORD (enter the 1st sample Id. listed on ea. COC)	SOIL or GROUNDWATER FIELD SAMPLING FORM (enter the 1st sample Id. listed on ea. form)	GROUNDWATER SAMPLING DATA SHEET or GRAB SAMPLE FORM (enter point (location) name from the top of ea. sheet)	GEOPROBE, HYDRO PUNCH or OTHER FIELD ______ SAMPLE FORM (enter point (location) name from the top of ec. sheet)
TOTAL PAGES: ______	TOTAL PAGES: ______	TOTAL PAGES: ______	TOTAL PAGES: ______

Originated by: ____________ Date: ____________

Received in full by: ____________ Date: ____________

Received in full by: ____________ Date: ____________

Entered to database by: ____________ Date: ____________

NOTE: Please return this form signed and dated to: PRC Denver, attn: Moffett Field Document Control, after the data has been entered into the Moffett database.

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Date: ______________

Data for week ending: ____________

Field team leader: ______________________

Page: ______ of ______

Batch No. ______________ To be assigned by Document Control

PRC FIELD FORMS TRANSFER LIST

WELL INSTALLATION RECORD or WELL COMPLETION DIAGRAM (enter well name listed on ea. well record or diagram)	BORE HOLE LOG (enter the boring id listed on each bore hole log)	SURVEY REPORTS / MAPS (enter the 1st point name listed on ea. survey report or the title or plate number of each map)	WELL DEVELOPMENT RECORD (enter the well name listed on ea. well development record)
TOTAL PAGES: ______	TOTAL PAGES: ______	TOTAL PAGES: ______	TOTAL PAGES: ______

Originated by: ______________________________ Date: ____________

Received in full by: ______________________________ Date: ____________

Received in full by: ______________________________ Date: ____________

Entered to database by: ______________________________ Date: ____________

NOTE: Please return this form signed and dated to: PRC Denver, attn: Moffett Field Document Control, after the data has been entered into the Moffett database.

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PRC

GROUND WATER SAMPLING DATA SHEET

PAGE ___ OF ___

WELL NAME ______________

DATE ______________

PROJECT ______________ STATION ELEVATION ______________ GND ___ TOC ___ IMMISCIBLE PHASES PRESENT YES ___ NO ___

PROJECT No. ______________ STATIC WATER LEVEL (from TOC) ______________ TYPE ______________

WELL LOCATION ______________ WELL STICK UP ______________ ______________ MEASURED WITH ______________

SAMPLE DATE ______________ STATIC ELEVATION ______________ PID READINGS (backgrnd) ______________

SAMPLING PERSONNEL ______________ WELL DEPTH ______________ MEAS ___ RPTD ___ PID READINGS (TOC) ______________

FEET OF WATER ______________ WELL INSTALLED BY ______________

SAMPLE ID ______________ GALLONS/FOOT ______________ INSTALLATION DATE ______________

DUPLICATE ID ______________ CASING VOLUME ______________ DEVELOPMENT DATE(S) ______________

FIELD CHEMISTRY CALIBRATIONS

DATE/TIME ______________ SPEC. CONDUCTANCE: STANDARD ______________ UMHOS/CM AT 25C READING ______________ UMHOS/CM AT ___ C

pH: pH 4.00 = ______ AT ______ C pH 7.00 = ______ AT ______ C pH 10.00 = ______ AT ______ C SLOPE ______

DISSOLVED OXYGEN: D.O. METER ______ MG/L AT ___ C PID: CALIBRATION GAS ______________ PPM ______ SPAN ______ READING ______

	TIME	DISCHARGE RATE (GPM)	DISSOLVED OXYGEN (MG/L)	pH	Eh/ORP	TEMP (C)	SPECIFIC CONDUCT. (UMHOS/CM AT C)	TURBID. (NTU)	CUMULATIVE VOL. OF WATER REMOVED (PURGED) GALLONS	CASING VOLS.	PID/OVA READING LOCATION	PID/OVA READING VALUE	COMMENTS
PUMPED													
BAILED													

PUMPED PARAMETERS STABLE (Y/N) ___ PUMPED=BAILED PARAMETERS (Y/N) ___ CONDITION OF WELL: ______________

REMARKS ______________

FIELD EQUIPMENT

pH METER ______________ SERIAL NUMBER ______________

SPEC. COND. METER ______________ SERIAL NUMBER ______________

PUMP ______________ SERIAL NUMBER ______________

BAILER ______________ SIZE ______________

WATER LEVEL METER ______________ SERIAL NUMBER ______________

D. O. METER ______________ SERIAL NUMBER ______________

FILTER APPARATUS ______________ FILTERS ______________

TEMPERATURE MEASURE ______________

INTERFACE PROBE ______________ SERIAL NUMBER ______________

PID/OVA ______________ SERIAL NUMBER ______________

FIELD CHEMISTRY CALIBRATIONS

FRACTIONS ______________

NUMBER OF BOTTLES ______________

SAMPLE DEPTH ______________

FIELD NOTEBOOK ______________

SAMPLE METHOD ______________

DISCHARGE WATER CONTAINERIZED

YES ______ NO ______

PRC GROUND-WATER FIELD SAMPLING FORM

PROJECT NAME	PROJECT JOB #	DATE
SAMPLER(S): PRINTED NAME		SAMPLING TEAM # (req. to properly correlate equip rinsates)

SAMPLE ID	POINT NAME (WELL ID)	SAMPLE DATE	SAMPLE* MEDIUM	INVESTIG.*	QA* TYPE	SAMPLER'S INITIALS	SAMPLER'S* COMPANY	PURGE* METHOD	SAMPLE* METHOD
	Enter "QC SAMPLE" for trip blanks, equip. rinsates & field blanks								

REMARKS: (note: Identify any associated equipment rinsates and trip blanks whether they are listed on this field sampling form or on another field sampling form.)

INSTRUCTIONS: Complete all columns for each row you use. Enter only the codes listed below for columns containing an asterisk (*). Enter the three initials of the field sampler who collected the sample. Draw a vertical arrow down the column if an entry in any row applies to additional rows in the same column (i.e. Sample Date).

SAMPLE MEDIUM

Soil = Soil
Water = Water
Sludge = Sludge
Soil Gas = Soil Gas
Air = Air
Sediment = Sediment
Waste = Waste
Plants = Plant matter
Product = Pure product
Animal = Animal tissue

INVESTIGATION

Q5-6/93 = Quarterly sampling May/June '93
AISI = Additional Inferred Sites Invest
Remed = Remediation monitoring
OU1&5 = OU1,5 Add. Field Investig.
Other = Other Investigation

QA TYPE

TB = Trip blank
ER = Equip. rinsate
FD = Field duplicate
FB = Field Blank
Real = Real sample

SAMPLER'S COMPANY

PRC = Planning Research Corp.
MWA = Montgomery Watson America
Other = Other company

PURGE METHOD

Bail = Purged well with hand bailer
Pump = Purged well with a submersible pump
N/A = Not Applicable. Use for trip blanks, equip. rinsates, soils
Other = Other purge method

SAMPLE METHOD

Bail = Sampled well w/hand bailer
Pump = Sampled well with submersible pump
Comb = Sampled VOCs &TPHG w/ bailer, non-volatiles w/pump
N/A = Not Applicable (i.e trip blanks)
Other = Other sampling method (equip. rinsate)

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PRC GEOPROBE® FIELD SAMPLING

PROJECT NAME	INVESTIGATION *	STATION ID (POINT NAME)	POINT TYPE GP
LOCATION DATA SOURCE (SURVEY OR MAP)	SURVEY COMPANY		

COORDINATES (IF KNOWN; OTHERWISE INCLUDE MAP SHOWING STATION)
X Y STATION ELEVATION

GEOPROBE COMPANY	OVERSIGHT CONTRACTOR (SEE SAMPLER'S COMPANY FOR CODES)
CONE DIAMETER (INCHES)	CALIBRATION METHOD

LAND OWNER *
NAVY ☐ NASA ☐ OTHER ______

SAMPLE (Y/N)	SAMPLE ID	SAMPLE DATE	

SAMPLE MEDIUM (FOR SOIL GAS -- SEE GEOPROBE COMPANY'S DATA SHEET FOR PARAMETERS (VACUUM PRESSURE, FLOW RATE, AND CONCENTRATIONS)
WATER ☐ SOIL ☐ SOIL GAS ☐

SAMPLE DEPTH (IN FEET) (IF ONLY ONE DEPTH, PUT DEPTH VALUE IN UPPER DEPTH FIELD.)
UPPER DEPTH LOWER DEPTH

FIELD QA *	SAMPLER'S NAME	SAMPLER'S COMPANY * (CONSULTANT)

	IF WATER:	IF SOIL:	IF SOIL GAS:
PRESEVATION METHOD			
FIELD NOTEBOOK #			
IMMISCIBLE PHASE PRESENT (Y/N)			
PID/OVA			
SOIL TYPE (SAND, SILT, CLAY)			
SOIL SAMPLER DIAMETER (INCHES)			

DUPLICATE SAMPLE ID
-99

THIS MUST BE FILLED IN IF A DUPLICATE IS TAKEN

COMMENTS

INSTRUCTIONS: Enter only the codes listed for columns containing an asterisk (*).

INVESTIGATION	FIELD QA	SAMPLER'S COMPANY
HC = HORIZONTAL CONDUIT STUDY	TB = Trip blank ER = Equip. rinsate FD = Field duplicate Real = Real sample	PRC = PRC Environmental Mgmt. Inc. MWA = Montgomery Watson Inc. Other = Other company

PRC

HYDROPUNCH SAMPLING FORM FORM

PROJECT NAME & NUMBER	INVESTIGATION *	STATION NAME (POINT NAME)	POINT TYPE *
STATION DESCRIPTION (Narrative, use back side if necessary)	LAND OWNER NAVY ☐ NASA ☐ OTHER ________		
LOCATION DATA SOURCE ☐ SURVEY ☐ MAP	SURVEY COMPANY	SAMPLE ID	
COORDINATES (IF KNOWN; OTHERWISE INCLUDE MAP SHOWING STATION) X Y	STATION ELEVATION	SAMPLE MEDIUM WATER	
SAMPLE DATE	QA TYPE *	SAMPLER'S NAME	SAMPLER'S INITIALS
SAMPLER'S COMPANY * (CONSULTANT)			

DEPTH OF SAMPLE (IN FEET)	pH	Eh (ORP)	SPECIFIC CONDUCTANCE (UMHOS/CM at C°)	TEMPATURE (C°)	DISSOLVED OXYGEN
SAMPLE METHOD *	FIELD NOTEBOOK	IMMISCIBLE PHASE PRESENT (Y/N)	DUPLICATE SAMPLE ID THIS MUST BE FILLED IN IF A DUPLICATE IS TAKEN		
COMMENTS/NOTES					

FIELD CHEMISTRY CALIBRATIONS

DATE/TIME ________ SPEC. CONDUCTANCE: STANDARD ____ UMHOS/CM AT 25C READING ____ UMHOS/CM AT __ C

pH: pH 4.00 = ____ AT ____ C pH 7.00 = ____ AT ____ C pH 10.00 = ____ AT ____ C SLOPE ____

DISSOLVED OXYGEN: D.O. METER ____ MG/L AT __ C PID: CALIBRATION GAS ____ PPM ____ SPAN ____ READING ____

FIELD EQUIPMENT

pH METER ________ SERIAL NUMBER ________ TEMPERATURE MEASURE ________

SPEC. COND. METER ________ SERIAL NUMBER ________ FILTER SIZE ________

D. O. METER ________ SERIAL NUMBER ________

PID/OVA ________ SERIAL NUMBER ________

Eh METER ________ SERIAL NUMBER ________

	INVESTIGATION	QA TYPE	SAMPLER'S COMPANY	POINT TYPE	SAMPLE METHOD
INSTRUCTIONS: Enter only the codes listed for columns containing an asterisk (*).	EC = Ecological Risk Assessment AISI = Additional Inferred Sites Investig	FD = Field duplicate TB = Trip blank ER = Equip. rinsate FB = Field blank Real = Real sample	PRC = PRC Environmental Mgmt. Inc. MWA = Montgomery Watson Inc. Other = Other company	HP = HydroPunch QC = QC SAMPLE	HP = Hydropunch N/A = Not Applicable (i.e trip blanks) Other = Other sampling method (equip. rinsate)

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PRC SOIL FIELD SAMPLING FORM

PROJECT NAME	PROJECT JOB #	DATE
SAMPLER(S): PRINTED NAME		SAMPLING TEAM # (req. to properly correlate equip. rinsates)

SAMPLE ID	POINT NAME (LOCATION ID)	SAMPLE DATE	SAMPLE * MEDIUM	INVESTIG.*	QA* TYPE	SAMPLER'S INITIALS	SAMPLER'S* COMPANY	COLLECTION DEPTH DEPTH 1	DEPTH 2	SAMPLE* METHOD	INSITU* (yes/no)
	Enter "QC SAMPLE" for trip blanks, equip. rinsates & field blanks										

REMARKS: (note: Identify any associated equipment rinsates and trip blanks whether they are listed on this field sampling form or on another field sampling form.)

INSTRUCTIONS: Complete all columns for each row you use. Enter only the codes listed below for columns containing an asterisk (*). Enter the three initials of the field sampler who collected the sample. Draw a vertical arrow down the column if an entry in any row applies to additional rows in the same column (i.e. Sample Date). INSITU* - Write (YES) if the soil sample characterizes the soil remaining in place (insitu) or write (NO) if the sample characterizes the soil removed by an Interim Measure/Interim Remedial Action (i.e. an excavation).

SAMPLE MEDIUM

Soil = Soil
Water = Water
Sludge = Sludge
Soil Gas = Soil Gas
Air = Air
Sediment = Sediment
Waste = Waste
Plants = Plant matter
Product = Pure product
Animal = Animal tissue

INVESTIGATION

Q5-6/93 = Quarterly sampling May-June '93
Remed = Remediation monitoring
EC = Ecological Risk Assessment
AISI = Additional Inferred Sites Investigation
OU1&5 = OU1,5 Add. Field Investig.
Other = Other Investigation

QA TYPE

TB = Trip blank
ER = Equip. rinsate
FD = Field duplicate
FB = Field Blank
Real = Real sample

SAMPLER'S COMPANY

PRC = Planning Research Corp.
MWA = Montgomery Watson America
Other = Other company

SAMPLE METHOD

SS = Split spoon (no sleeve)
BS = Split spoon w/ brass, metal, plastic or other sleeves
HA = Hand auger
OS = Open spoon (hand/grab sampling)
N/A = Not Applicable (i.e trip/field blanks)
Other = Other sampling method (equip. rinsate)