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Final

RCRA Facility Investigation Work Plan
SWMUs 53 and 54

Naval Station Roosevelt Roads

RCRA/HSWA Permit No. PR2170027203

Ceiba, Puerto Rico

Prepared For

Department of the Navy
Atlantic Division
Naval Facilities Engineering Command

Norfolk, Virginia

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CDM
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LIST OF ACRONYMS AND ABBREVIATIONS

Baker	Baker Environmental, Inc.
bgs	below ground surface
CMS	Corrective Measures Study
DDT	dichlorodiphenyltrichloroethane
EPA	Environmental Protection Agency
IDW	Investigation Derived Waste
MCLs	Maximum Contaminant Levels
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NEX	Navy Exchange
NSRR	Naval Station Roosevelt Roads
OU	Operable Unit
PID	Photoionization Detector
ppb	parts per billion
ppm	parts per million
pvc	polyvinyl chloride
QA/QC	Quality Assurance/Quality Control
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SOPs	Standard Operating Procedures
SVOCs	Semivolatile Organic Compounds
SWMU	Solid Waste Management Unit
TCE	Trichloroethene
UST	Underground Storage Tank
VOCs	Volatile Organic Compounds

1.0 INTRODUCTION

This Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Work Plan has been prepared by Baker Environmental, Inc. (Baker) under contract to the Atlantic Division, Naval Facilities Engineering Command (LANTDIV) Contract Number N62470-95-D-6007, Contract Task Order (CTO) 099. This work plan has been prepared to perform field investigation work at Solid Waste Management Unit (SWMU) 53 – Building 64 (Malaria Control Building) and SWMU 54 – Building 1914 (Former Navy Exchange [NEX] Repair/Maintenance Shop) at Naval Station Roosevelt Roads (NSRR), under the Corrective Action provisions of the Station's RCRA Part B Permit No. PR2170027203.

Building 64 (Malaria Control Building) and Building 1914 (Former NEX Repair/Maintenance Shop) were first listed as SWMUs in the May 31, 2000 RCRA Quarterly Progress Report (Baker, 2000a). Attachments two and three to the abovementioned report contained the Phase I Environmental Assessment Report for SWMUs 53 and 54, respectively. A Draft Sampling and Analysis Plan was submitted for SWMUs 53 and 54 on August 4, 2000 (Baker, 2000b), and was approved by the United States Environmental Protection Agency (EPA) on October 10, 2000. The field investigation was conducted in December 2000 in accordance with the EPA approved sampling and analysis plan. The Draft Sampling and Analysis Report for SWMUs 53 and 54 was submitted on April 11, 2001. The EPA commented on this report on July 5, 2001, requesting that a RFI work plan be submitted to further delineate contamination found at SWMUs 53 and 54, as well as the submission of a Final Sampling and Analysis Report. The Final Sampling and Analysis Report was submitted on August 27, 2001.

The SWMUs discussed in the following sections include SWMU 53, located approximately 300 feet northeast of SWMU 13. The other SWMU discussed in this RFI work plan is SWMU 54, located north-northeast of SWMU 26, as presented on Figure 1-1.

The specific element of the SWMU 53 investigation to be performed includes:

- A soil boring program focused in areas around Building 64, to ascertain the extent of lead, arsenic, and DDT contamination in soil presented in the Final Sampling and Analysis Report (Baker, 2001).

The specific element of the SWMU 54 investigation to be performed includes:

- A temporary monitor well installation program focused in areas around Building 1914, to ascertain the extent of Trichloroethene (TCE) in groundwater presented in the Final Sampling and Analysis Report (Baker, 2001).

When this work is completed, the results will be provided in a draft RFI report.

2.0 SIGNIFICANT FINDINGS AND GOALS

The information collected during the sampling and analysis investigation performed at these two SWMUs in December 2000, has provided a great deal of information as to the environmental impact of past operations at this site. However, the results from this investigation have raised additional questions pertaining to site characterization at these two SWMUs.

The goals of this investigation are related to specific findings from the investigation performed in December 2000 (Baker, 2001). The significant findings from the Sampling and Analysis Report are summarized in the following paragraphs.

2.1 Significant Findings

There were a number of findings from the sampling and analysis program at both SWMUs which are discussed in the following subsections.

SWMU 53

1. Organic concentrations of 4,4'-dichlorodiphenyltrichloroethane (DDT) taken from surface soil location 53SS02 exceeded the EPA Region III Residential risk-based concentration (RBC) value. The extent of the contamination has not been established.

2. Metals concentrations of lead and arsenic in surface soil, and arsenic concentrations in subsurface soil, exceeded EPA Region III Industrial RBC values. The extent of the contamination has not been established.

SWMU 54

1. Organic concentrations of TCE were detected in groundwater at this SWMU. The extent of the contamination has not been established.

2. The hydraulic gradient was not realistically inferred because water levels were not taken on the same day.

2.2 Investigation Goals

This work plan proposes an investigation for each SWMU designed to address the concerns of the EPA and to close any data gaps which exist at these SWMUs. The goals of the program, and how they are to be reached, are briefly discussed for each SWMU in the paragraphs which follow.

The goals for SWMU 53:

1. Establish the extent of 4,4'-DDT in soil, if it is found to be laterally extensive from sample location 53SS02 taken in December 2000. This will be accomplished through a boring program during which surface soil and subsurface soil samples will be obtained in the general area of 53SS02.

2. Establish the extent of lead in soil, if it is found to be present areally, in the vicinity of Building 64. This will be accomplished through a boring program during which surface soil and subsurface soil samples will be obtained around the building.

3. Establish the extent of arsenic in soil, if it is found to be present areally, in the vicinity of Building 64. This will be accomplished through a boring program during which surface soil and subsurface soil samples will be obtained around the building.

The goals for SWMU 54:

1. Establish the extent of volatile organic compounds (VOCs) in groundwater, if any is found to be laterally extensive from monitor wells 510MW3, 510MW5, and 510DW2 taken during the December 2000 field investigation. This will be accomplished through a temporary monitor well installation program during which groundwater samples will be obtained.

2. Establish the extent of semivolatile organic compounds (SVOCs) in groundwater, if any is found to be laterally extensive, in the vicinity of Building 1914. This will be accomplished through a temporary monitor well installation program during which groundwater samples will be obtained.

3. Establish groundwater flow directions through the interpretation of groundwater elevation measurements obtained in existing monitor wells and the proposed temporary monitor wells.

Details of all the investigations to be performed are provided in Section 3.0 of this work plan.

3.0 TECHNICAL APPROACH

This section of the work plan describes the technical elements of the investigation necessary to accomplish the goals described in Section 2.0.

The EPA has approved a RFI work plan for the initial work at Roosevelt Roads under the Corrective Action Program (Baker, 1995). This work plan addressed necessary technical elements such as standard operating procedures (SOPs) and resumes of key personnel, as well as provisions of the following separate plans:

- Project Management Plan
- Data Collection Quality Assurance Plan
- Data Management Plan, and
- Health and Safety Plan.

Together, these plans provided all the details regarding field investigatory techniques, laboratory analyses, data validation and data evaluation needed to fulfill the requirements of the RFI program. Since the abovementioned document is in place and approved, it will form the basis of this plan. All the investigatory tasks described in subsequent sections of this plan will be performed in accordance with the techniques and methodologies provided in the original EPA approved work plan unless otherwise noted in this work plan. Therefore, only the work elements themselves are discussed in the sections which follow.

The sections that follow introduce site-specific information obtained from the December 2000 field investigation by Baker and provide a description of the environmental field investigations that will be conducted along with the rationale and expected data usage at SWMUs 53 and 54.

3.1 SWMU 53 – Building 64 (Malaria Control Building)

Site Context

Three contaminants were found to be present after the sampling and analysis investigation fieldwork performed in December 2000. The area in the vicinity of Building 64 contained elevated levels of 4,4'-DDT, lead, and arsenic. These contaminants were documented in the Sampling and Analysis Report (Baker, 2001), however, the areal extent of the contaminants listed above have not been established. EPA expressed concerns in their comment letter (July 5, 2001), requesting additional characterization of surface and subsurface soils for 4,4'-DDT, lead, and arsenic be conducted via a RFI in the vicinity of Building 64.

Investigations Proposed

A total of fourteen surface soil and subsurface soil samples will initially be collected in the SWMU 53 area, as presented on Figure 3-1 and presented in Table 3-1. These samples will be screened in the field for lead and 4,4'-DDT. The field test kits include Lead Check Soil and EnviroGard® DDT in Soil Test Kit (EPA SW-846 Method #4042). More detailed information about these test kits are provided as Appendix A. At the present time there is not a field screening test for arsenic, therefore samples will be submitted to the mainland fixed base analytical laboratory for analysis of arsenic. Following the field analysis of the soil samples additional samples may need to be obtained to characterize the site. A flow chart (Figure 3-2) presents the steps required to characterize the site if the initial fourteen samples positively detect lead or arsenic in the field. If positive detections of lead above 400 parts per million (ppm) or DDT above 1 ppm are detected then additional samples will be obtained another ten feet away from the previous location. This methodology will continue until the site is characterized for lead and DDT in soil.

A minimum of three of the surface soil samples and three of the subsurface soil samples screened in the field will be submitted to the mainland laboratory for confirmatory analysis of 4,4-DDT and Lead. Twenty percent of all additional samples collected and screened in the field, will be submitted to the mainland laboratory for the above-mentioned confirmatory analysis. This will provide verification on the test kits being used in the field along with validated data to be utilized for assessing risks at a later date if required. The mainland fixed base laboratory results will be validated by an independent, third party, data validator.

At each soil boring location, a surface soil sample will be collected from 0-6 inches below ground surface (bgs) and a subsurface soil sample will be collected at the mid depth between the ground surface and top of rock. As presented in the Additional Investigations Report for Operable Unit (OU) 1, 6, and 7 (Baker, May 1998), the suspected water table level for adjacent area SWMU 13 ranges from 4 to 13 feet (bgs). Therefore, it is anticipated that groundwater will be encountered in the 10 to 20 foot bgs range at SWMU 53, due to its increased elevation over SWMU 13.

The surface soil and subsurface soil samples will be acquired following the appropriate Baker SOPs mentioned in the EPA approved 1995 Work Plan (Baker, 1995). The soil borings will be advanced using a Geoprobe® rig with continuous macro core sampling to give us an accurate representation of the geologic stratigraphy located at SWMU 53. These boring logs can than be used as a tool for future work conducted at this site if necessary. Boring logs from the previous work conducted at SWMU 53 are provided for reference as Appendix B.

Investigations Rationale

Several contaminants (4,4'-DDT, arsenic, and lead) were found in the soil at SWMU 53 as mentioned in the Final Sampling and Analysis Report (Baker, 2001). A boring program has been proposed that will utilize Geoprobe® technology coupled with field test kits to provide an immediacy of analytical results. This will allow the investigation to adjust if need be to sampling results while the crew and equipment are still in the field.

The proposed boring locations were established to further delineate the contamination, both horizontally and vertically, that were found during the sampling and analysis investigation performed in December 2000. The distances of the soil boring locations from Building 64 and 53SB01 were set to accurately establish a perimeter of a contamination plume if one was to be present. Should contamination be found at the outermost soil boring locations, additional borings will be installed at further distances of 10 feet until lead and DDT is detected below 400 ppm or 1 ppm respectively. This process will more accurately delineate the contamination present at the site.

Analysis of the soil will be for DDT, lead, and arsenic as requested by the EPA in their July 5, 2001 comment letter. Field test kits will be utilized for immediate analytical results for lead and DDT, while twenty percent of the samples collected will be sent to a mainland laboratory for confirmation purposes. Because 4,4'-DDT absorbs very strongly to soil and is subject to evaporation and

photodegradation at the surface of soils (Spectrum Laboratories, 2001), as well as its limited presence in the subsurface soils, no investigation of groundwater will be conducted at this site. Section 3.3.3 describes the geology present at SWMU 53. Bedrock underlies the entire site at depths ranging from 4.5 to 10 feet below ground surface with groundwater below the subsurface soils. Groundwater was not encountered during the investigation due to split-spoon refusal at the subsurface soil bedrock interface. As such groundwater underlying SWMU 53 is not in contact with the soils at the site, therefore no investigation of groundwater will be conducted.

Data Usage

The data obtained from this investigation will be utilized to delineate the vertical and horizontal migration, if present, of contamination (4,4'-DDT, lead, and arsenic) presented in the Final Sampling and Analysis Report (Baker, August 2001). The data will be thoroughly evaluated as described in Section 4.0 of this work plan.

3.2 SWMU 54 – Building 1914 (Former NEX Repair/Maintenance Shop)

Site Context

Several contaminants were found to be present after the sampling and analysis investigation fieldwork performed in December 2000. Of the contaminants detected, the result of TCE in groundwater is above the Federal Maximum Contaminant Level (MCL). The other groundwater contaminants observed during the investigation are believed to be related to the former underground storage tank (UST) associated with Building 510. Although the results of TCE were documented in the Final Sampling and Analysis Report for SWMUs 53 and 54 (Baker, 2001), the source and the areal extent of the TCE contamination in unclear at this time. EPA expressed a concern in their comment letter (July 5, 2001), that the groundwater flow patterns have not been adequately defined across the SWMU 54 and Building 510 area. The EPA requested that further groundwater characterization be performed of the entire SWMU 54 and Building 510 area.

Investigations Proposed

A total of eight temporary monitor wells will initially be installed in the SWMU 54 area as presented on Figure 3-3. These eight wells include four wells spaced 25 feet radially away from existing

monitor well 510MW5 to the north, east, south, and west, and four wells spaced 25 feet radially away from existing monitor well 510MW3 to the north, east, south, and west. Groundwater samples will be collected from each of the temporary monitor wells, and analyzed for TCE at a mainland laboratory utilizing quick turn analysis as presented in Table 3-2. Pending the quick turn analytical results additional temporary monitor wells may need to be installed to delineate the TCE contamination. Figure 3-4 presents the process in determining which additional wells would need to be installed. If positive detections of TCE above 5 parts per billion (ppb) are detected then additional samples will be obtained another 25 feet away from the previous location. This methodology will continue until the site is characterized for TCE in groundwater. It should be noted that 5 ppb of TCE is the Federal MCL for this constituent. The laboratory results will be validated by an independent, third party, data validation firm.

The temporary monitor wells will be installed via a truck mounted drill rig. The soil borings will be advanced using 4-1/4 inch inside diameter hollow-stem augers. Soil samples will be collected continuously (at 2-foot intervals) using 2-inch outside diameter split-spoons. The soil samples will be for descriptive purposes only. Each soil boring well be advanced to a depth that will enable the temporary monitor well to be screened across the water table (i.e., a portion of the monitor well screen is above the level of the groundwater surface). Temporary monitor wells will be constructed of 2-inch nominal inside diameter, schedule 40, flush-joint and threaded polyvinyl chloride (pvc) casing, screen (10 feet long with 0.010-inch slots), and a threaded bottom cap inside the open borehole. The open borehole will be protected to prevent foreign material from falling into the borehole.

The temporary monitor wells will sit a minimum of 24 hours prior to groundwater sampling to let the monitor well equilibrate with the surrounding aquifer. The groundwater samples will be obtained via low stress (low flow) sampling and analyzed for VOCs and SVOCs via quick turn analysis at the mainland fixed-base analytical laboratory. Appendix C provides the groundwater sampling procedure for low stress (low flow) purging and sampling. The temporary monitor wells will not be developed prior to sampling since they are temporary monitor wells.

Three temporary piezometers will also be installed during this investigation as indicated on Figure 3-3 to assist in determining the groundwater flow characteristics of the site. The piezometers will be installed in the same manner as the temporary monitor wells as discussed above.

As presented in the Final Sampling and Analysis Report for SWMU 54 (Baker, 2001), the suspected water table level for the two areas of contamination mentioned above, ranges from approximately 11 to 13 feet below ground surface. The boring logs from the existing monitoring wells located at the site are provided for reference as Appendix B.

Following the completion of the temporary monitor well installation and groundwater sampling, one round of water levels will be obtained from all permanent and temporary monitor wells and temporary piezometers throughout the site. The water levels will be obtained on the same day continuously until all wells are measured. A round of water levels will also be collected from the permanent monitor wells at the site prior to the installation of the temporary monitor wells and temporary piezometers. This will provide additional data to assist in determining the groundwater flow characteristics associated with the site.

Investigations Rationale

TCE appears to be the only contaminant identified in the Final Sampling and Analysis Report (Baker, August 2001) with the source of contamination unclear at this time. A temporary monitor well installation program has been proposed that will utilize a drill rig coupled with a quick turn analytical program for expedient results. This will allow the investigation to adjust if need be to sampling results while the crew and equipment are still in the field.

The proposed temporary monitor well locations were established to further delineate the horizontal migration of the TCE contamination that was found during the sampling and analysis investigation performed in December 2000. The temporary monitor well locations are also set to intercept any down-gradient migration of TCE contaminants if any were to occur. The distances of the temporary monitor well locations were set to accurately establish a perimeter of a contamination plume if one was to be present.

Analysis of the groundwater will be for VOCs and SVOCs as requested by the EPA in their July 5, 2001 comment letter. A quick turn analytical program will be utilized at a mainland laboratory for expedient analytical results.

The groundwater samples will be acquired following the ap7propriate Baker SOPs mentioned in the EPA approved 1995 Work Plan (Baker, 1995) and Appendix C of this document. The temporary

monitor wells will be installed using a drill rig, instead of direct push technology. The reason for this rationale is that the soils in this area contain some granite fill material as indicated in the test boring and well construction records referenced in the Appendix B portion of this document. Direct push technology would not be an efficient method in an area of this nature. The reason for continuous split-spoon sampling is that boring logs will give us an accurate representation of the geologic stratigraphy located at SWMU 54. These borings can then be used in conjunction with boring logs from the Site Characterization Report for Site 510, as a tool for future work conducted at this SWMU.

Data Usage

The data obtained from this investigation will be utilized to delineate the horizontal migration, if present, of contamination (TCE) presented in the Final Sampling and Analysis Report (Baker, August 2001). The data will be thoroughly evaluated as described in Section 4.0 of this work plan.

The groundwater elevation data collected will be utilized to determine the groundwater flow characteristics at the site as requested by the EPA.

3.3 Miscellaneous Tasks

This section contains some miscellaneous tasks required as part of the investigation required for the work proposed in the previous sections for both SWMUs 53 and 54.

3.3.1 Surveying

All sampling locations will be flagged in the field and will be surveyed for vertical (± 0.01 feet) and horizontal (± 0.1 feet) location using established control. All temporary monitor wells and temporary piezometers top of casing will also be surveyed. The survey will be performed by the same firm which has performed previous work for Baker at other SWMUs at NSRR. This will then ensure that the same level of survey quality and detail is attained.

3.3.2 Laboratory Analyses

All analyses done in the mainland laboratory will be performed using current full Appendix IX Methodologies, as presented in Table 3-4. Tables 3-1 through 3-3 summarize the environmental

samples to be obtained and the analyses to be performed. STL Savannah Laboratories will perform the analysis at SWMUs 53 and 54 since they performed the analysis during the previous investigation. This will ensure that the same accuracy and consistency is obtained for the samples.

3.3.3 Data Validation

All mainland laboratory data generated by these investigations will be subjected to independent, third party, validation. The EPA Region II Data Validation Standard Operating Procedures will be followed. Heartland Environmental Services, Inc. will perform the validation. Heartland Environmental Services, Inc. performed the data validation during the previous investigation at SWMUs 53 and 54. This will ensure that the same techniques are followed and that an equivalent review of the data is performed.

3.3.4 Field QA/QC

The collection of QA/QC samples will be obtained during these investigations. These will include the collection of equipment rinsates, field blanks, field duplicates, and matrix spike/matrix spike duplicates (MS/MSD).

3.3.4.1 Equipment Rinsates

Equipment rinsates are the final analyte-free water rinse from equipment decontamination procedures. Equipment rinsate blanks will be collected daily during each sampling event. Initially, samples from every other day should be analyzed. If analytes pertinent to the project are detected in the rinsate, the remaining samples (equipment rinsates) must be analyzed. The results from the blanks will be used to evaluate the decontamination methods. This comparison is made during data validation and the rinsates are analyzed for the same parameters as the related samples. One equipment rinsate will be collected per day of field sampling.

3.3.4.2 Field Blanks

Field blanks consist of the source water used in equipment decontamination procedures. At a minimum, one field blank for each event and each source of water must be collected and analyzed for the same parameters as the related samples. One field blank per source per event will be collected.

It is anticipated that three different sources of water will be utilized for this investigation as shown in Table 3-3.

3.3.4.3 Field Duplicates/Split Samples

Field duplicates (or split samples) for surface soil, and subsurface soil samples are collected, homogenized, and split. The duplicates for water samples should be collected simultaneously. The water samples will not be composited. Field duplicates will be collected at a frequency of ten percent.

3.3.4.4 Matrix Spike/Matrix Spike Duplicates (MS/MSD)

MS/MSDs are not field sampling activities, they are laboratory derived, and are collected to evaluate the matrix effect of the sample upon the analytical methodology. An MS and MSD must be performed for each group of samples of a similar matrix. MS/MSD samples will be collected at a frequency of five percent.

3.3.4.5 Investigation Derived Waste (IDW)

Only two sources of minimal IDW are expected during these investigations:

- Cuttings from the advancement of soil boring locations
- Soil boring tool decontamination water

All waters will be containerized in 55 gallon drums located onsite. The removal of these drums will be handled according to the specific SOP for this procedure as listed in the 1995 EPA approved work plan.

Cuttings from the advancement of the soil borings will be placed back in the hole from which they came, unless contamination is present. As much as possible, soils last out of the hole will be returned first, thereby, approximating original stratigraphy.

3.3.4.6 Standard Operating Procedures

All the SOPs applicable to the work are included in the original RFI work plans or subsequent addenda. These SOPs can be viewed in their entirety in the EPA approved 1995 RFI Work Plan.

The following SOPs are incorporated into this work plan by reference:

- SOP F101 – Borehole and Sample Logging
- SOP F102 – Soil and Rock Sample Acquisition
- SOP F103 – Monitor Well Installation
- SOP F104 – Groundwater Sample Acquisition
- SOP F202 – Water Level, Water-Product Level Measurements, and Well Depth Measurements
- SOP F203 – Photoionization Detector (PID), Hnu Models PI 101 and DL 101
- SOP F303 – Field Logbook
- SOP F501 – Decontaminating of Drilling Rigs and Monitoring Well Materials
- SOP F502 – Decontaminating of Sampling and Monitoring Equipment
- SOP F504 – Handling of Site Investigation Wastes

4.0 DATA EVALUATION

The data obtained from these investigations will be evaluated as follows:

SWMU 53

The sample results obtained during this investigation will be compared to several criteria. The sample results will be compared to their respective RBCs for both industrial and residential conditions as determined by USEPA Region III. The inorganic compounds will be compared against the RBCs, as well as the base background analytical data to determine if the constituents detected are naturally occurring. The background screening criteria will be developed by taking twice the average of each constituent detected in the background samples. One-half the detection limit will be used for non-detects. This background value will be determined in accordance with EPA guidance (EPA, 1999). Based on the results from this investigation, it will be determined if the site has been adequately characterized and whether or not this site should proceed to the Corrective Measures Study (CMS) stage.

SWMU 54

The sample results obtained during this investigation will be compared to several criteria. The groundwater sample results will be compared to Federal Maximum Contaminant Level (MCLs), as well as the EPA Region III Tap Water RBC. Based on the results from this investigation, it will be determined if the site has been adequately characterized and whether or not this site should proceed to the CMS stage.

A full round of water levels of the proposed temporary monitor wells as well as the seven existing monitor wells will be ascertained to more accurately define the groundwater flow patterns across the SWMU 54 and Site 510 area.

5.0 REPORTING

The reports generated for these investigations will be submitted 60 days upon receipt of validated data following completion of the field investigation. The report will be labeled Draft RFI Report for SWMUs 53 and 54, and contain the following information:

- An introduction presenting the investigative history of SWMUs 53 and 54, the scope and objectives, as well as the report organization.
- A facility background presenting the description of the entire base, as well as individual descriptions of SWMUs 53 and 54. This section will also contain a summary of the previous investigation which took place at each of these SWMUs.
- A facility investigation section will be included to present a description of the environmental field investigation activities conducted at these two SWMUs.
- A physical characteristics section for SWMUs 53 and 54 which will present the climatology, topography, regional and site geology, and hydrology for SWMU 54
- A nature and extent of contamination section will present the analytical results for the data collected during this field investigation and the previous investigation. The data shall be analyzed to verify the field delineation of the contaminants from each SWMU.
- A conclusions and recommendations section as determined from the findings of the investigation.
- A reference section presenting the references utilized in the text.

6.0 SCHEDULE

A schedule for the implementation of this work plan is provided as Figure 6-1. It should be noted that this schedule is dependent upon EPA review time. Many other factors can also extend the schedule such as resampling if further re-characterization is required, weather delays in the field, funding is delayed by the Navy, or consensus cannot be reached on how the EPA's comments are to be incorporated.

7.0 REFERENCES

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TABLES

TABLE 3-1

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM
RFI WORK PLAN
SWMU 53 - BUILDING 64 (MALARIA CONTROL BUILDING)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

			Analytical Parameters					
			Field - Screening Kit		Mainland Laboratory			
Sample Media	Sample Designation	Sample Depth (ft bgs)	DDT	Lead	DDT (2)	Arsenic	Lead (2)	Comments
Surface Soil	53SB07-00	0.0-1.0	X	X		X		
	53SB08-00	0.0-1.0	X	X		X		
	53SB09-00	0.0-1.0	X	X		X		
	53SB10-00	0.0-1.0	X	X		X		
	53SB11-00	0.0-1.0	X	X		X		
	53SB12-00	0.0-1.0	X	X		X		
	53SB13-00	0.0-1.0	X	X		X		
	53SB14-00	0.0-1.0	X	X		X		
	53SB15-00	0.0-1.0	X	X		X		
	53SB16-00	0.0-1.0	X	X		X		
	53SB17-00	0.0-1.0	X	X		X		
	53SB18-00	0.0-1.0	X	X		X		
	53SB19-00	0.0-1.0	X	X		X		
	53SB20-00	0.0-1.0	X	X		X		
	53SB21-00*	0.0-1.0	X	X		X		
	53SB22-00*	0.0-1.0	X	X		X		
	53SB23-00*	0.0-1.0	X	X		X		
	53SB24-00*	0.0-1.0	X	X		X		
	53SB25-00*	0.0-1.0	X	X		X		
	53SB26-00*	0.0-1.0	X	X		X		
Subsurface Soil	53SB07-XX	(1)	X	X		X		
	53SB08-XX	(1)	X	X		X		
	53SB09-XX	(1)	X	X		X		
	53SB10-XX	(1)	X	X		X		
	53SB11-XX	(1)	X	X		X		
	53SB12-XX	(1)	X	X		X		
	53SB13-XX	(1)	X	X		X		
	53SB14-XX	(1)	X	X		X		
	53SB15-XX	(1)	X	X		X		
	53SB16-XX	(1)	X	X		X		
	53SB17-XX	(1)	X	X		X		
	53SB18-XX	(1)	X	X		X		
	53SB19-XX	(1)	X	X		X		

TABLE 3-1

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM
RFI WORK PLAN
SWMU 53 - BUILDING 64 (MALARIA CONTROL BUILDING)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

			Analytical Parameters					
			Field - Screening Kit		Mainland Laboratory			
Sample Media	Sample Designation	Sample Depth (ft bgs)	DDT	Lead	DDT [2]	Arsenic	Lead [2]	Comments
Subsurface Soil (Cont.)	53SB20-XX	(1)	X	X		X		
	53SB21-XX*	(1)	X	X		X		
	53SB22-XX*	(1)	X	X		X		
	53SB23-XX*	(1)	X	X		X		
	53SB24-XX*	(1)	X	X		X		
	53SB25-XX*	(1)	X	X		X		
	53SB26-XX*	(1)	X	X		X		

Notes:

(1) - Sample will be collected at the mid depth between the ground surface and top of competent bedrock.
XX - The sample depth designator in which the sample was collected (i.e. 01 = 1-3 ft bgs, 02 = 3-5 ft bgs, etc.) will be established in the field.
ft bgs - feet below ground surface.
* - Samples may or may not be collected depending on field analysis results.
[2] - Samples to be sent to the mainland fixed base laboratory are dependent on the results of the field test kits.

TABLE 3-2

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM
RFI WORK PLAN
SWMU 54 - BUILDING 1914 (NEX REPAIR/MAINTENANCE SHOP)
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

		Analytical Parameters		
Sample Media	Sample Designation	VOCs[1]	SVOCs[1]	Comments
Groundwater	54TW03	X	X	
	54TW04	X	X	
	54TW05	X	X	
	54TW06	X	X	
	54TW07	X	X	
	54TW08	X	X	
	54TW09	X	X	
	54TW09D	X	X	Duplicate
	54TW09MS	X	X	Matrix Spike
	54TW09MSD	X	X	Matrix Spike Duplicate
	54TW10	X	X	
	54TW11*	X	X	
	54TW11D*	X	X	Duplicate
	54TW12*	X	X	
	54TW13*	X	X	
	54TW14*	X	X	
	54TW15*	X	X	
	54TW16*	X	X	
	54TW17*	X	X	
	54TW18*	X	X	
	54TW19*	X	X	
	54TW20*	X	X	
	54TW21*	X	X	
	54TW22*	X	X	

Notes:
D - Duplicate.
MS - Matrix Spike.
MSD - Matrix Spike Duplicate.
[1] - Quick Turn Mainland Laboratory Analysis.
* - Samples may or may not be collected depending on quick turn mainland laboratory analytical results.

TABLE 3-3

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM
RFI WORK PLAN
QA/QC SAMPLE MATRIX - SWMUs 53 AND 54
NAVAL STATION ROOSEVELT ROADS, CEIBA, PUERTO RICO

	Analysis Requested Aqueous Samples					
Sample ID	Lead	Arsenic	DDT	VOCs	SVOCs	Comments
SWMU 53 - Equipment Rinsates						
53ER01	X	X	X			(1)
53ER02	X	X	X			(2)
SWMU 54 - Trip Blanks/Equipment Rinsates						
54TB01				X		Trip Blank
54TB02				X		Trip Blank
54ER01				X	X	(3)
SWMUs 53 and 54 - Field Blanks						
2001FB01	X	X	X	X	X	(A)
2001FB02	X	X	X	X	X	(B)
2001FB03	X	X	X	X	X	(C)

Notes:

(1) - Acetate sleeve.
(2) - Stainless Steel Spoon.
(3) - Silicon Tubing.
(A) - Lab Grade Deionized H_2O.
(B) - Store Bought Distilled H_2O.
(C) - NSRR Base Potable Water Supply.

TABLE 3-4

METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)

Volatiles	Quantitation Limits*		Method Number
	Water (mg/L)	Low Soil (mg/kg)	
Acetone	50	50	8260
Acetonitrile	200	200	8260
Acrolein	100	100	8260
Acrylonitrile	100	100	8260
Benzene	5.0	5.0	8260
Bromodichloromethane	5.0	5.0	8260
Bromoform	5.0	5.0	8260
Bromomethane	10	10	8260
Carbon Disulfide	5.0	5.0	8260
Carbon Tetrachloride	5.0	5.0	8260
Chlorobenzene	5.0	5.0	8260
Chloroethane	10	10	8260
Chloroform	5.0	5.0	8260
Chloromethane	10	10	8260
Chloroprene	5.0	3.0	8260
3-Chloro-1-propene	5.0	5.0	8260
1,2-Dibromo-3-chloropropane	5.0	10	8260
Dibromochloromethane	5.0	5.0	8260
1,2-Dibromoethane	5.0	5.0	8260
Dibromomethane	5.0	5.0	8260
trans-1,4-Dichloro-2-butene	10	10	8260
Dichlorodifluoromethane	10	5.0	8260
Dibromomethane	5.0	5.0	8260
1,1-Dichloroethane	5.0	5.0	8260
1,2-Dichloroethane	5.0	5.0	8260
trans-1,2-dichloroethene	5.0	5.0	8260
1,1-Dichloroethene	5.0	5.0	8260
Methylene Chloride	5.0	5.0	8260
1,2-Dichloropropane	5.0	5.0	8260
cis-1,3-Dichloropropene	5.0	5.0	8260
trans-1,3-Dichloropropene	5.0	5.0	8260
Ethyl benzene	5.0	5.0	8260
Ethyl methacrylate	5.0	5.0	8260
2-Hexanone	25	25	8260
Iodomethane	5.0	5.0	8260
Isobutanol	200	200	8260
Methacrylonitrile	100	100	8260
2-Butanone	25	25	8260
Methyl methacrylate	5.0	5.0	8260
4-Methyl-2-pentanone	25	25	8260

TABLE 3-4

METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)

Volatiles	Quantitation Limits*		Method Number
	Water (mg/L)	Low Soil (mg/kg)	
Pentachloroethane	25	25	8260
Propionitrile	100	100	8260
Stryene	5.0	5.0	8260
1,1,1,2-Tetrachloroethane	5.0	5.0	8260
1,1,2,2-Tetrachloroethane	5.0	5.0	8260
Tetrachloroethene	5.0	5.0	8260
Toluene	5.0	5.0	8260
1,1,1-Trichloroethane	5.0	5.0	8260
1,1,2-Trichloroethane	5.0	5.0	8260
Trichloroethene	5.0	5.0	8260
Trichlorofluoromethane	5.0	5.0	8260
1,2,3-Trichloropropane	5.0	5.0	8260
Vinyl Acetate	10	10	8260
Vinyl Chloride	10	10	8260
Xylene	10	10	8260

* Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis, will be higher.

TABLE 3-4

METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)

Semivolatiles	Quantitation Limits*		Method Number
	Water (mg/L)	Low Soil (mg/kg)	
Acenaphthene	10	330	8270
Acenaphthylene	10	330	8270
Acetophenone	10	330	8270
2-Acetylaminofluorene	10	330	8270
4-Aminobiphenyl	20	330	8270
Aniline	20	330	8270
Anthracene	10	330	8270
Aramite	10	330	8270
Benzo(a)anthracene	10	330	8270
Benzo(b)fluoranthene	10	330	8270
Benzo(k)fluoranthene	10	330	8270
Benzo(g,h,i)perylene	10	330	8270
Benzo(a)pyrene	10	330	8270
Benzyl alcohol	10	330	8270
Bis(2-chloroethoxyl)methane	10	330	8270
Bis(2-chloroethyl)ether	10	330	8270
Bis(2-ethylhexyl)phthalate	10	330	8270
4-Bromophenyl phenyl ether	10	330	8270
Butylbenzylphthalate	10	330	8270
4-Chloroaniline	20	660	8270
4-Chloro-3-methylphenol	10	330	8270
2-Chloronaphthalene	10	330	8270
2-Chlorophenol	10	330	8270
4-Chlorophenyl phenyl ether	10	330	8270
Chrysene	10	330	8270
3&4 Methylphenol	10	330	8270
2-Methylphenol	10	330	8270
Diallate	10	330	8270
Dibenzofuran	10	330	8270
Di-n-butyl phthalate	10	330	8270
Dibenzo(a,h)anthracene	10	330	8270
o-Dichlorobenzene	10	330	8270
m-Dichlorobenzene	10	330	8270
p-Dichlorobenzene	10	330	8270
3,3'-Dichlorobenzidine	20	660	8270
2,4-Dichlorophenol	10	330	8270
2,6-Dichlorophenol	10	330	8270
Diethylphthalate	10	330	8270
p-(Dimethylamino)azobenzene	10	330	8270
7,12-Dimethyl benz(a)anthracene	10	330	8270

TABLE 3-4

METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)

Semivolatiles	Quantitation Limits*		Method Number
	Water (mg/L)	Low Soil (mg/kg)	
3,3-Dimethyl benzidine	20	1,700	8270
2,4-Dimethylphenol	10	330	8270
alpha, alpha-Dimethylphenethylamine	2,000	67,000	8270
Dimethyl phthalate	10	330	8270
m-Dinitrobenzene	10	330	8270
4,6-Dinitro-2-methylphenol	50	1,700	8270
2,4-Dinitrophenol	50	1,700	8270
2,4-Dinitrotoluene	10	330	8270
2,6-Dinitrotoluene	10	330	8270
Di-n-octylphthalate	10	330	8270
1,4-Dioxane	10	330	8270
Dinoseb	10	330	8270
Ethylmethanesulfonate	10	330	8270
Fluoranthene	10	330	8270
Fluorene	10	330	8270
Hexachlorobenzene	10	330	8270
Hexachlorobutadiene	10	330	8270
Hexachlorocyclopentadiene	10	330	8270
Hexachloroethane	10	330	8270
Hexachlorophene	5,000	170,000	8270
Hexachloropropene	10	330	8270
Indeno(1,2,3-cd)pyrene	10	330	8270
Isophorone	10	330	8270
Isosafrole	10	330	8270
Methapyrilene	2,000	67,000	8270
3-Methylcholanthrene	10	330	8270
Methyl methanesulfonate	10	330	8270
2-Methylnaphthalene	10	330	8270
Naphthalene	10	330	8270
1,4-Naphthoquinone	10	330	8270
1-Naphthylamine	10	330	8270
2-Naphthylamine	10	330	8270
2-Nitroaniline	50	1,700	8270
3-Nitroaniline	50	1,700	8270
4-Nitroaniline	50	1,700	8270
Nitrobenzene	10	330	8270
2-Nitrophenol	10	330	8270
4-Nitrophenol	50	1,700	8270
4-Nitroquinoline-1-oxide	20	3,300	8270
n-Nitrosodi-n-butylamine	10	330	8270

TABLE 3-4

METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)

Semivolatiles	Quantitation Limits*		Method Number
	Water (mg/L)	Low Soil (mg/kg)	
n-Nitrosodiethylamine	10	330	8270
n-Nitrosodimethylamine	10	330	8270
n-Nitrosodiphenylamine	NA	330	8270
n-Nitrosodi-n-propylamine	10	330	8270
n-Nitrosomethylethylamine	10	330	8270
n-Nitrosomorpholine	10	330	8270
n-Nitrosopiperidine	10	330	8270
n-Nitrosopyrrolidine	10	330	8270
5-Nitro-o-toluidine	10	330	8270
bis-(2-chloroisopropyl)ether	10	330	8270
Pentachlorobenzene	10	330	8270
Pentachloronitrobenzene	10	330	8270
Pentachlorophenol	50	1,700	8270
Phenacetin	10	330	8270
Phenanthrene	10	330	8270
Phenol	10	330	8270
1,4-Phenylenediamine	2,000	1,700	8270
2-Picolin	10	330	8270
Pronamide	10	330	8270
Pyrene	10	330	8270
Pyridine	50	330	8270
Safrole	10	330	8270
1,2,4,5-Tetrachlorobenzene	10	330	8270
2,3,4,6-Tetrachlorophenol	10	330	8270
o-Toluidine	10	330	8270
1,2,4-Trichlorobenzene	10	330	8270
2,4,5-Trichlorophenol	10	330	8270
2,4,6-Trichlorophenol	10	330	8270
1,3,5-Trinitrobenzene	10	330	8270

* Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis, will be higher.

NA = Not Available

TABLE 3-4

METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)

Pesticides	Quantitation Limits*		Method Number
	Water (mg/L)	Low Soil (mg/kg)	
Aldrin	0.05	1.7	8081
Alpha-BHC	0.05	1.7	8081
beta-BHC	0.05	1.7	8081
delta-BHC	0.05	1.7	8081
gamma-BHC	0.05	1.7	8081
Chlordane	0.5	17	8081
Chlorobenzilate	0.5	17	8081
4,4'-DDT	0.1	3.3	8081
4,4'-DDE	0.1	3.3	8081
4,4'-DDD	0.1	3.3	8081
Dieldrin	0.1	3.3	8081
Endosulfan I	0.05	1.7	8081
Endosulfan II	0.1	3.3	8081
Endosulfan sulfate	0.1	3.3	8081
Endrin	0.1	3.3	8081
Isodrin	0.05	3.3	8081
Kepone	1.0	170	8081
Toxaphene	5.0	170	8081
Endrin Aldehyde	0.1	3.3	8081
Heptachlor	0.05	1.7	8081
Heptachlor epoxide	0.05	1.7	8081
Methyoxychlor	0.5	17	8081

* Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis, will be higher.

TABLE 3-4

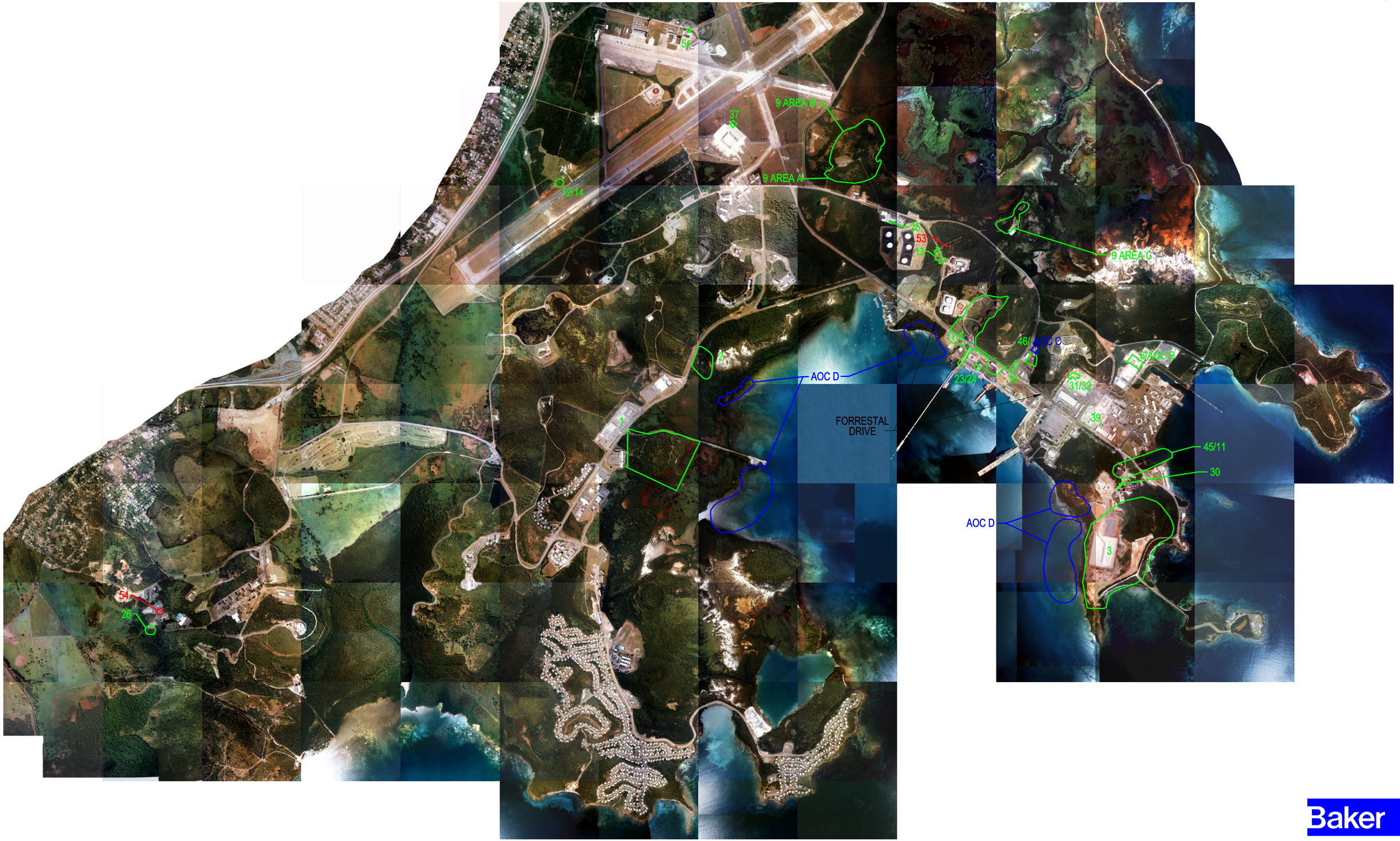
METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)

Inorganics	Method Number	Quantitation Limits*		Method Description
		Water (mg/L)	Low Soil (mg/kg)	
Arsenic	6010	10	1.0	Inductively Coupled Plasma
Lead	6010	5.0	0.5	Inductively Coupled Plasma

* Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis, will be higher.

FIGURES

NSRR_BASEMAP



Baker

LEGEND

1 – SWMUs

53 – AREA OF WHICH THIS INVESTIGATION PERTAINS TO

AOC D – AOCs

SOURCE: GEO-MARINE, INC., SEPTEMBER 6, 2000.

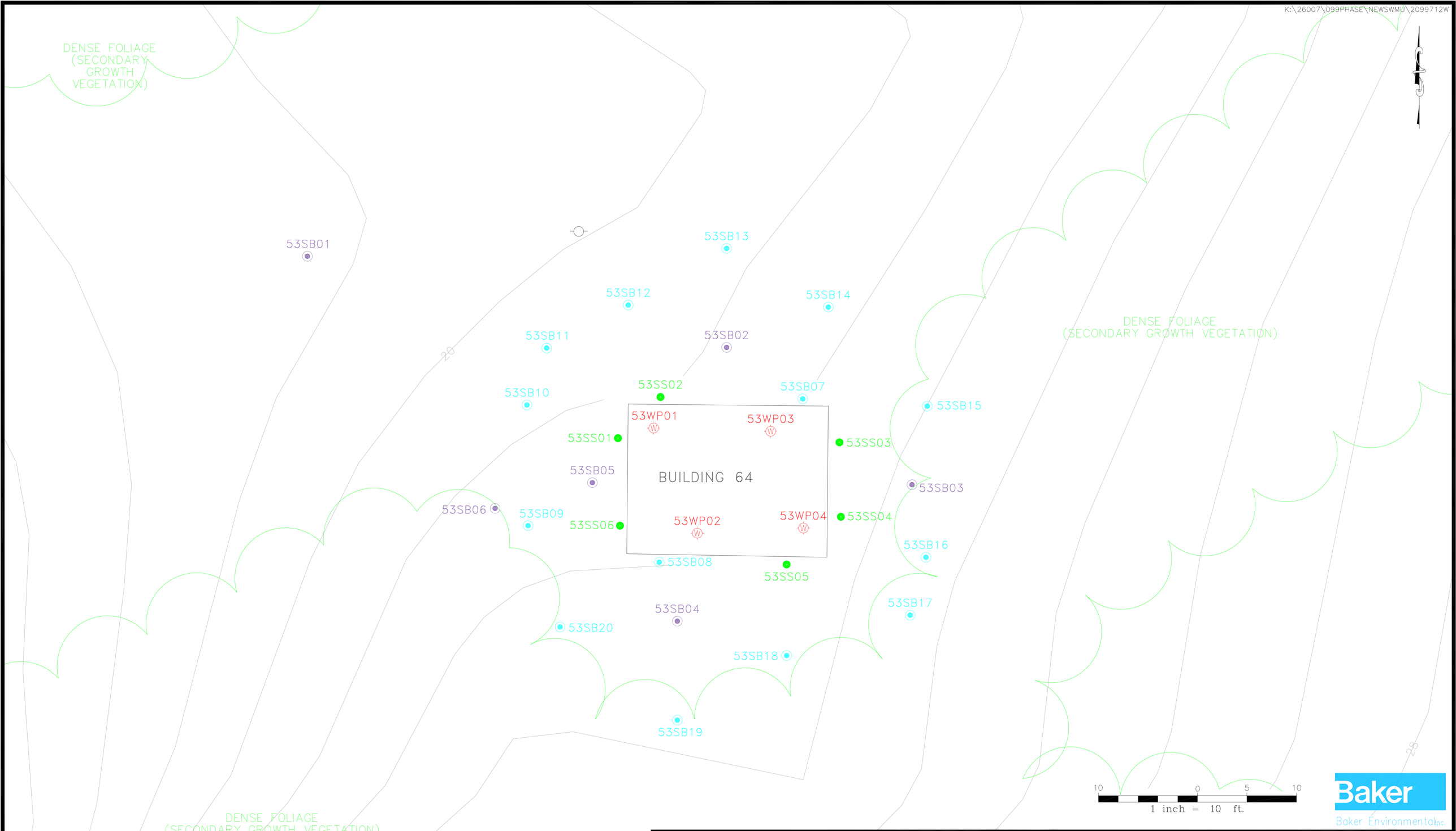
2500 0 1250 2500

1 inch = 2500 ft.

FIGURE 1-1
SWMU/AOC LOCATION MAP

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

K:\26007\099PHASE\NEWSWMU\2099712W



Baker
Baker Environmental Inc.

LEGEND

- (W) – WIPE SAMPLE LOCATION (DECEMBER 2000)
- ● – SURFACE SOIL SAMPLE LOCATION (DECEMBER 2000)
- ◉ – SURFACE AND SUBSURFACE SOIL SAMPLE LOCATION (DECEMBER 2000)
- ◉ – PROPOSED SURFACE AND SUBSURFACE SOIL SAMPLE LOCATION
- – OVERHEAD ELECTRIC UTILITY POLE
- – BUILDING
- – GROUND SURFACE CONTOUR LINE
- – TREE LINE

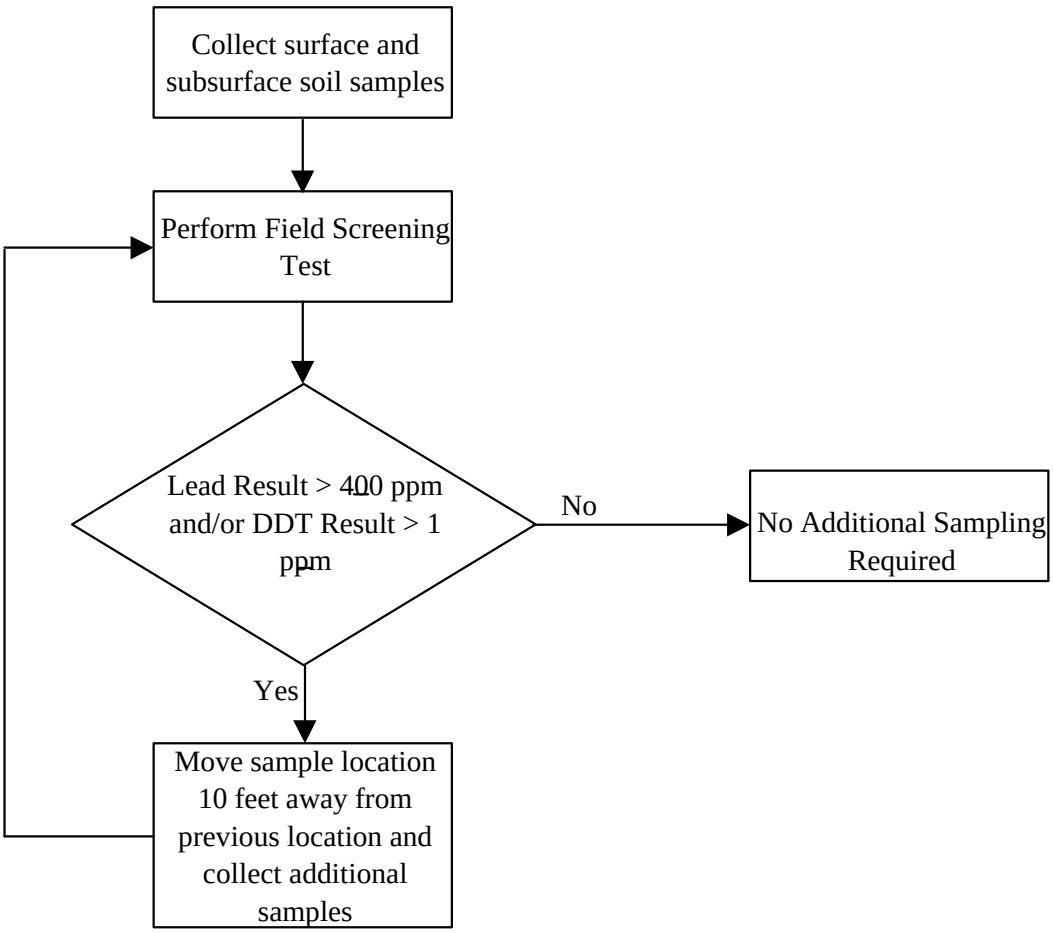
SOURCE: DEPT. OF THE NAVY, SEPEMBER 1999.

FIGURE 3–1
SAMPLE LOCATIONS
SWMU 53, BUILDING 64
(MALARIA CONTROL BUILDING)

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

FIGURE 3-2

FIELD SCREENING DECISION TREE
SWMU 53 - BUILDING 64 (MALARIA CONTROL BUILDING)
NAVAL STATION ROOSVELT ROADS, PUERTO RICO



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SWMU 54

DENSE FOLIAGE
(SECONDARY GROWTH VEGETATION)

54SS14
54PZ03
54PZ02
54SS13
AST
CONTAINMENT
PAD
54SS12
54SS15
54SS02
54SS03
54SS11
TRANSFORMER STORAGE AREA
54SS01
CANOPY
BLDG.
1914
CANOPY
54TW01
OIL/WATER SEPARATOR
54SS10
OPEN STORAGE
SHED
CANOPY POSTS
54SS04
54SS05
54SS09
54SS06
54TW02
54SW02
54SW01
54SS08
510MW4
OPEN EXCAVATIONS
54SS07
54TW03
BLDG.
1686
BAIROKO STREET
54TW07
54TW06
510MW5
54TW04
54TW10
510MW3
54TW08
54TW05
510MW1
510DW1
510DW2
FORMER PUMP
ISLAND LOCATION
54TW09
54PZ01
~4,000 GALLON
UST (REMOVED)
FORMER LOCATION
OF BUILDING 510
510MW2

60 0 30 60
1 inch = 60 ft.

Baker
Baker Environmental Inc.

DENSE FOLIAGE
(SECONDARY GROWTH VEGETATION)

SWMU 26

LEGEND

- SURFACE SOIL SAMPLE LOCATION (DECEMBER 2000)
- EXISTING MONITORING WELL LOCATION (DECEMBER 2000)
- SURFACE WATER SAMPLE LOCATION (DECEMBER 2000)
- TEMPORARY SHALLOW WELL LOCATION/ SUBSURFACE SOIL LOCATION (DECEMBER 2000)
- PROPOSED TEMPORARY SHALLOW MONITOR WELL LOCATION
- PROPOSED TEMPORARY PIEZOMETER LOCATION
- TRANSFORMER STORAGE PALLETS
- GROUND SURFACE CONTOUR LINE
- FENCE LINE
- BUILDING
- TREE LINE
- EDGE OF GRAVEL

FIGURE 3-3
SAMPLE LOCATIONS
SWMU 54, BUILDING 1914
(NEX REPAIR/MAINTENANCE SHOP)
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

SOURCE: DEPT. OF THE NAVY, SEPTEMBER 1999.

FIGURE 3-4

FIELD SCREENING DECISION TREE
SWMU 54 - BUILDING 1914 (FORMER NEX REPAIR/MAINTENANCE SHOP)
NAVAL STATION ROOSVELT ROADS, PUERTO RICO

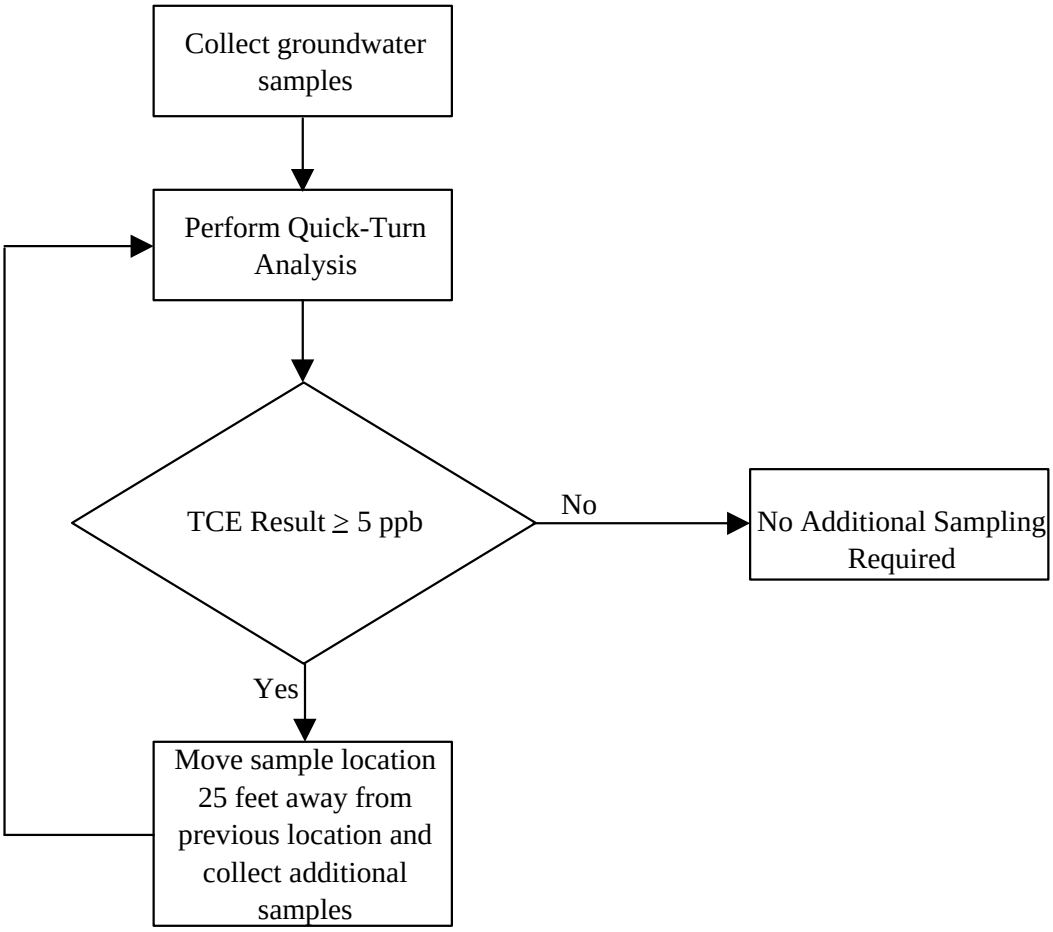
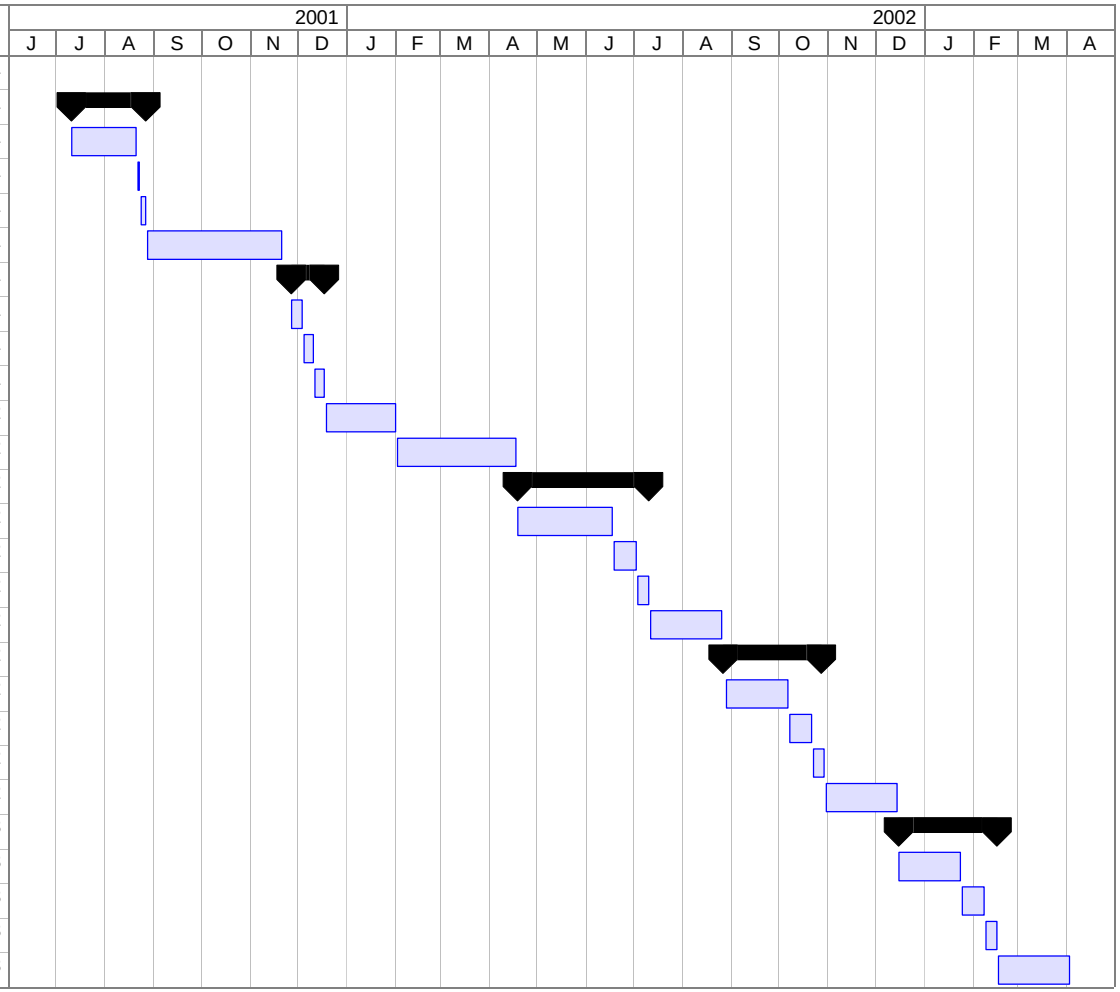


Figure 6-1
SWMUs 53 and 54 RFI Schedule
Naval Station Roosevelt Roads, Ceiba, Puerto Rico

Revised 12/06/01

ID	Task Name	Duration	Start	Finish
1	***SWMUs 53 and 54 RFI***	0 edays	7/11/01	7/11/01
2	**Draft RFI Work Plan**	47 edays	7/11/01	8/27/01
3	Develop Work Plan	41 edays	7/11/01	8/21/01
4	Navy Review	1 eday	8/22/01	8/23/01
5	Address Navy Comments	3 edays	8/24/01	8/27/01
6	EPA Review	85 edays	8/28/01	11/21/01
7	**Final RFI Work Plan**	21 edays	11/27/01	12/18/01
8	Revise Draft RFI Work Plan	7 edays	11/27/01	12/4/01
9	Navy Review	6 edays	12/5/01	12/11/01
10	Address Navy Comments	6 edays	12/12/01	12/18/01
11	EPA Review	44 edays	12/19/01	2/1/02
12	Fieldwork	75 edays	2/2/02	4/18/02
13	**Draft RFI Report**	83 edays	4/19/02	7/11/02
14	Develop Draft RFI Report	60 edays	4/19/02	6/18/02
15	Navy Review	14 edays	6/19/02	7/3/02
16	Address Navy Comments	7 edays	7/4/02	7/11/02
17	EPA Review	45 edays	7/12/02	8/26/02
18	**Draft Final RFI Report**	62 edays	8/27/02	10/28/02
19	Revise Draft RFI Report	39 edays	8/29/02	10/7/02
20	Navy Review	14 edays	10/8/02	10/22/02
21	Address Navy Comments	7 edays	10/23/02	10/30/02
22	EPA Review	45 edays	10/31/02	12/15/02
23	**Final RFI Report**	62 edays	12/16/02	2/16/03
24	Revise Draft Final RFI Report	39 edays	12/16/02	1/24/03
25	Navy Review	14 edays	1/25/03	2/8/03
26	Address Navy Comments	7 edays	2/9/03	2/16/03
27	EPA Review	45 edays	2/17/03	4/3/03



Project: revSWMU53-54chg

Submittal dates are dependent upon Government review calendar days.

APPENDIX A
FIELD TEST KIT INFORMATION

APPENDIX A.1
ENVIROGARD DDT IN SOIL TEST KIT

Remediation, Assessment & Industrial Testing

EnviroGard®

EnviroGard DDT in Soil Test Kit

Features

- rapid and simple field testing procedures
- semi-quantitative results at set calibrator (action) levels
- test up to 17 samples at one time
- results in less than 30 minutes
- training recommended
- coated tube immunoassay
- EPA SW-846 Method # 4042

Test Result Type

- Semi-quantitative or qualitative

Samples per Kit

- Up to 17 soil sample test results can be obtained per kit, depending upon the number of runs and action levels used. (Kit includes 20 antibody coated tubes)
- Typical applications use two or three calibrators and one negative control.

Assay Range

- Semi-quantitative results (greater or less than) at calibrator (action) levels of 0.2, 1.0 and 10.0 ppm DDT.
- Minimum detection level (MDL) is 0.2 ppm DDT.
- No maximum screening level as extracts can be diluted into test range.

Sample Preparation

- Soil samples require prior extraction using the SDI Sample Extraction Kit (sold separately).
- The Sample Extraction Kit provides material for 12 soil sample extractions with methanol.

Sampling Time

- Soil extraction time is typically 2 minutes per sample plus assay run time of approximately 30 minutes.

Remediation, Assessment & Industrial Testing

EnviroGard®

Strategic Diagnostics Inc.

111 Pencader Drive
Newark, DE USA 19702

302.456.6789 *tele*
800.544.8881 *tele*
302.456.6782 *fax*

www.sdix.com

Basic Test Procedures

- Extract the soil sample using the SDI Sample Extraction Kit.
- Pipet DDT assay diluent into the antibody coated tubes, then add either DDT calibrator or sample extract to the tubes along with DDT enzyme conjugate.
- Wait for 15 minutes, then decant and wash the tubes.
- Add subatrate.
- Wait for 10 minutes, add stop solution.
- Read the absorbance using a photometer, and interpret the results. (Refer to DDT Soil Test Kit Instruction Guide procedures.)

Specificity

The EnviroGard DDT immunoassay test does not differentiate between DDT and other organochlorines. The table below shows compounds at the minimum detection limit (MDL) - an approximate concentration required to yield a positive result at the lowest standard. The IC50 is the concentration required to inhibit one-half of the color produced by the negative control. It is also used to calculate cross-reactivity values to similar compounds.

DDT in Soil (ppm)

Contaminant	MDL	IC50
p,p'-DDT (kit calibrator)	0.2	1.25
p,p'-DDD	0.05	0.3
p,p'-DDE	0.6	3.6
o,p'-DDT	14.9	93
o,p'-DDD	1.76	11
o,p'-DDE	14.9	93
DDA	0.01	0.04
Chloropropylate	0.01	0.08
Chlorobenzilate	0.06	0.35
Dicofol	0.3	2
Tetradifon	2.2	14

Test Kit Components

- 20 antibody coated tubes.
- Enzyme conjugate, color developing and color stop solution reagents.
- Calibrators for 0.2, 1.0 and 10.0 ppm DDT.
- Negative control calibrator.
- Test tube rack, reagent and calibrator holders, and pipet tips.
- Test kit instructions.

Storage & Precautions

- Shelf life typically one year from date of manufacture, with specific kit expiration date information provided on product packaging.
- Components must be stored at 39° to 46°F (4° to 8°C) when not in use.
- Storage at ambient temperature 64° to 81°F (18° to 27°C) is acceptable for day of use.
- Kits must be brought to 64° to 81°F (18° to 27°C) before use.
- Do not expose substrate to direct sunlight.
- Portable spectrophotometer battery should be charged prior to use.

Required Test Materials

	SDI Part #
° EnviroGard DDT Soil Kit	7310000
° Sample Extraction Kit (Soil)	73100EB
or	73100EA

Required Test Equipment

- Field Soil Lab (Accessory Kit) 6050400
  which includes:
  Repeating pipette*
  Adjustable pipette*
  Balance*
  Repeating Pipette tips*
  Timer*

- Differential Spectrophotometer*,
  110V 6000001
  220V 6000002

OR

- Field Lab System Rental 6997020
  (includes items marked "*" above)

Other Recommended Materials

- Latex gloves
- Absorbent paper for blotting test tubes
- Liquid and solid waste containers
- Calculator

STRATEGIC DIAGNOSTICS INC.
EnviroGard® DDT in Soil Test Kit
73100

Intended Use
The EnviroGard DDT in Soil Test Kit is a qualitative or semi-quantitative field test for the detection of DDT and its metabolites DDD and DDE in soil. The EnviroGard DDT in Soil Test Kit allows rapid semi-quantitative screening for DDT at 0.2, 1.0, and 10.0 parts per million (ppm) in soils.

Test Principles
The EnviroGard DDT in Soil Test Kit is based on the use of polyclonal antibodies that bind either DDT or DDT-Enzyme Conjugate. These antibodies are immobilized to the walls of the test tubes. When DDT is present in the sample, it competes with the DDT-Enzyme Conjugate for a limited number of antibody binding sites.

Since there are the same number of antibody binding sites on every test tube and each test tube receives the same number of DDT-Enzyme Conjugate molecules, a sample that contains a low concentration of DDT allows the antibody to bind many DDT-Enzyme Conjugate molecules.

Therefore, a low concentration of DDT produces a dark blue solution. Conversely, a high concentration of DDT allows fewer DDT-Enzyme Conjugate molecules to be bound by the antibodies, resulting in a lighter blue solution.

NOTE: Color is inversely proportional to DDT concentration.

Darker color = Lower concentration
Lighter color = Higher concentration

Performance Characteristics
The EnviroGard DDT in Soil Test Kit will not differentiate between DDT, its metabolites, and other structurally similar compounds, but will detect their presence to differing degrees. The following table shows a number of compounds and the approximate concentration of each required to yield a positive result (Lower Limit of Detection or LLD), and the concentration required to inhibit one-half of the color developed by the Negative Control (IC50). Concentration is in parts per million (ppm) in soil.

Compound	LLD	IC50
p,p'-DDT (kit calibrator)	0.04	1.25
p,p'-DDD	0.01	0.3
p,p'-DDE	0.18	3.6
o,p'-DDT	4	93
o,p'-DDD	0.4	11
o,p'-DDE	3	93
DDA	0.002	0.04
Chloropropylate	0.007	0.08
Chlorobenzilate	0.03	0.35
Dicofol	0.14	2
Tetradifon	1.2	14
Thiobencarb	5	52
Tebuconazole	7	95
Neburon	17	284
Chloroxuron	24	216
Monolinuron	25	714
Diclofop	70	>1000

The following compounds have lower limits of detection > 100 ppm:

2,4-D	4-chlorophenoxyacetic acid
Chlorbromuron	Chlordane
Chlortoluron	Dicamba
Diflubenzuron	Diuron
Lindane	Linuron
MCPA acid	MCPB
Mecoprop	

Precautions
• Treat DDT, solutions that contain DDT and potentially contaminated soil samples as hazardous materials.
• Where appropriate, use gloves, proper protective clothing, and methods to contain and handle hazardous material.
• Store all test kit components at 4°C to 8°C (39°F to 46°F) when not in use.
• Do not freeze test kit components or expose them to temperatures greater than 37°C (99°F).
• Allow all reagents to reach ambient temperature (18°C to 27°C or 64°F to 81°F) before beginning the test.
• Do not use test kit components after the expiration date.
• Do not use reagents or test tubes from one test kit with reagents or test tubes from a different test kit.
• Use approved methodologies to confirm any positive results.
• Do not dilute or adulterate test reagents or use samples not called for in the test procedure; this may give inaccurate results.
• Tightly recap the DDT calibrator vials to prevent evaporative loss.
• Distribution of DDT in soils may be highly variable. The use of a composite sampling technique may be appropriate. Development of a sampling plan that assures adequate sample number and distribution is the responsibility of the analyst.
• DDT is light sensitive. Store soil extracts at 2°C to 7°C, shielded from direct light.

Materials Provided
EnviroGard DDT in Soil Test Kit
This test kit contains the following items:
20 Antibody-Coated Test Tubes
1 vial of Assay Diluent
1 vial of Negative Control (methanol)
1 vial of 0.2 ppm DDT Calibrator in methanol
1 vial of 1.0 ppm DDT Calibrator in methanol
1 vial of 10.0 ppm DDT Calibrator in methanol
1 vial of DDT-Enzyme Conjugate
1 vial of Substrate
1 vial of Stop Solution
1 20-place Test Tube Rack

22 Pipette Tips, yellow (for the Gilson M-25 Microman® Positive Displacement Pipettor)

Materials Required but Not Provided
You will also need several other items, some of which are included in the EnviroGard Soil Field Lab.

- Methanol-ACS reagent grade Methanol is required for soil extraction, but is not included in the EnviroGard Soil Extraction Kit. You must order it separately.
- EnviroGard Soil Extraction Bottle Kit

Use this kit for the extraction of DDT in soil samples. This kit contains enough devices to process 14 samples:
• 14, 30 mL LDPE Bottles with screw caps (each bottle contains stainless steel mixing beads)
• 14 filtration caps
• 14 Millex® HV_{13} filters
• 18 Wooden Spatulas
• 1 Syringe with coupler
• 1 Syringe coupler
• 14 Screw Top Glass Vials, 4.0 mL
• 14 Stoppers

• 18 Weigh Boats
• Gilson M-25 Microman Positive Displacement Pipettor
• Eppendorf™ Repeater® Pipettor and five Combitips® (3 x 12.5 mL, 1 x 5.0 mL, and 1 x 50 mL)
• Balance capable of accurately weighing 5 grams
• Differential Photometer or RPA-I Photometer
• Indelible marker for labeling test tubes
• Watch or timer
• Clean running water or a wash bottle containing tap or deionized water (500 mL)
• Calculator (optional)

Suggestions for Pipettor Use

• Practice using both pipettors (positive displacement and Repeater pipettor) with water and extra tips before you analyze your samples.
• Use a new tip each time you use the Repeater pipettor to avoid reagent cross-contamination. Label three 12.5 mL tips "Diluent", "Substrate" and "Stop," and one 5.0 mL tip "Conjugate".
• Draw the desired reagent volume into the Repeater pipettor and dispense one portion of the reagent back into the container to properly engage the ratchet mechanism. If you do not do this, the first volume delivered may be inaccurate.
• To add reagents using the Repeater pipettor, pipette down the side of the test tube just below the rim.
• To add samples and calibrators using the positive displacement pipettor, pipette down the side of the test tube just above the liquid level.
• The carryover volume of the positive displacement tips is minimal, but may affect results if you are going from a high to low DDT concentration. Use a new pipettor tip each time you pipette a new unknown.

Assay Procedure

Collect/Store the Sample

1. Collect soil in appropriately sized and labeled containers.
2. Take care to remove excess twigs, organic matter and rocks or pebbles from the sample. For best results, wet soils should be air-dried overnight and thoroughly mixed before testing.
3. Store soil samples at 4°C (39°F).

Prepare the Sample/Extract the Soil

1. Please follow the instructions from the EnviroGard Soil Extraction Bottle Kit to prepare the soil extract before the assay.
2. **5 ml** of **Methanol** will be used to extract DDT residue from a 5 gram soil sample. As per instructions, attach a **50 mL** Combitip to the Repeater pipettor and set the dial to **5**. Deliver once to add **5 mL** of **methanol** to the extraction vial, and cap tightly.

Perform the Test

NOTE: Allow all reagents and sample extracts to reach room temperature before you begin the test. Do not analyze more than 20 test tubes at a time.

1. The choice of calibrators to use in the test will depend on the selection of the analyst. The use of two calibrators may be appropriate if screening for a single level of DDT.

Remove the test tubes from the plastic bag and label them as follows*:

Tube Label	Tube Contents
NC	Negative Control
C1	0.2 ppm Calibrator
C2	1.0 ppm Calibrator
C3	10.0 ppm Calibrator
S1	sample 1
S2	sample 2
etc.	

You are not required to perform the assay in duplicate; however, doing so will increase the precision.
Place the test tubes in the test tube rack. Push down on each tube so that it is held firmly and does not fall out of the rack when shaken.
CAUTION: Do not "snap" the test tubes into the rack as this may result in a cracked tube.

2. Attach the **12.5 mL** Combitip labeled "Diluent" to the Repeater pipettor and adjust the dial to **2**. Add 500 microliters (µL) of Assay Diluent to each test tube.
3. Attach a clean pipette tip to the Microman pipettor and adjust the dial to "250". Add 25 µL of each calibrator (including Negative Control) to the corresponding test tube by placing the end of the pipette tip against the side of the tube (just above the level of the Assay Diluent) and dispensing the volume. Use a clean pipette tip each time.

CAUTION: Replace the caps on the calibrator vials immediately after use to minimize evaporation.
4. Using a clean tip for each sample, add 25 µL of each sample extract to the appropriately labeled test tube.
5. Attach the **5.0 mL** Combitip labeled "Conjugate" to the Repeater pipettor and adjust the dial to **1.** Add 100 µL of DDTEnzyme Conjugate to each test tube.
6. Shake the test tube rack to mix for 10 to 15 seconds. Leave the test tubes undisturbed for 15 minutes.
7. Vigorously shake out the test tube contents into a sink or suitable container. Fill the test tubes to **overflowing** with cool tap or distilled water, then decant and vigorously shake out the remaining water.
Repeat this wash step three more times, being certain to shake out as much water as possible on each wash. After the final wash, remove as much water as possible by tapping the inverted tubes on absorbent paper.
8. Attach the **12.5 mL** Combitip labeled "Substrate" to the Repeater pipettor and set the dial to **2**. Add 500 µL of Substrate to each test tube. Leave the test tubes undisturbed for 10 minutes.

NOTE: If a blue color does not develop in the Negative Control test tube within 10 minutes after adding the Substrate, the test is invalid and you must repeat it.

Interpret the Results

You can either interpret the results visually within 10 minutes after adding the Substrate to each test tube, or you can perform a more precise analysis with a photometer after you add the Stop Solution.

Visual Interpretation

After you add the Substrate, wait 10 minutes then mix the test tubes by shaking them for a few seconds until they are a uniform blue color. Compare the sample test tube to the calibrator test tubes against a white background. The test tube rack in the kit is well-suited for this purpose.

NOTE: The word DDT in the interpretation instructions below refers to "total DDT", i.e. the sum of p,p'-DDT, p,p'-DDD, and p,p'-DDE.

• If a sample test tube contains more color than the calibrator test tube, the sample contains DDT at a concentration lower than the calibrator.
• If a sample test tube contains less color than the calibrator test tube, the sample may contain DDT at a concentration greater than the calibrator.
• If the sample test tube contains color that is between the calibrator test tubes, the sample contains DDT at a concentration between the calibrator concentrations.
• If a sample test tube contains approximately the same amount of color as the calibrator test tube, the sample contains DDT at a concentration approximately equal to the calibrator.
• If the sample test tube contains less color than the 10 ppm Calibrator test tube, you may dilute a fraction of the soil extract in methanol (for example, 1:100) and perform the assay again. To determine the

concentration of the diluted extract multiply the result by the dilution factor. (Go to "Semi-Quantitative Interpretation" for further details.)

Photometric Interpretation

After you add the Substrate, wait 10 minutes then add the Stop Solution to each test tube.
WARNING: Stop solution is 1N Hydrochloric acid.

Attach the **12.5 mL** Combitip labeled "Stop" to the Repeater pipettor and set the dial to **2**. Add 500 µL of Stop Solution to each test tube. This converts the blue color in the test tubes to yellow.

NOTE: After you add Stop Solution to the test tubes, results should be read within 30 minutes.

Differential Photometer

1. Place a water blank test tube containing 1.5 mL of deionized water, or equivalent in the left (reference) well.
2. Place the Negative Control test tube into the right (sample) well. Record the optical density (OD) of the Negative Control.
3. Remove the Negative Control test tube and replace it with the 0.2 ppm Calibrator test tube to reactivate the photometer. Record the result. Repeat this step to determine the OD for each of the remaining calibrators and for each sample.

Semi-quantitative Interpretation

Compare the OD of each sample to the OD of each calibrator:
NOTE: The word DDT in the interpretation instructions below refers to "total DDT", i.e. the sum of p,p'-DDT, p,p'-DDD, and p,p'-DDE.

- If a sample OD is equal to the OD of a calibrator, the sample contains DDT at a concentration approximately equal to the calibrator.
- If a sample OD is greater than a calibrator OD, the sample contains less DDT than the calibrator.
- If a sample OD is lower than a calibrator OD, the sample may contain more DDT than that calibrator.
- If an assay result indicates that a soil sample contains greater than 10 ppm total DDT, but you need more specific information, the soil extract may be diluted 1:100 in neat methanol, and assayed again. You must then multiply the results of the re-assay by 100 to determine the approximate sample concentration.

NOTE: If you know in advance that the "action level" of interest is greater than 10 ppm total DDT in soil, the assay may be modified to pinpoint that particular concentration. For example:

If you wish to categorize samples as less than or greater than 250 ppm, you should dilute all sample extracts 1:250 in neat methanol (e.g. 20 µL extract plus 4.98 mL methanol) and compare the diluted extracts to the 1 ppm DDT kit calibrator. Due to the 250-fold dilution, the 1 ppm calibrator represents 250 ppm in the assay.

NOTE: If you are interested in action levels greater than 1000 ppm, please contact Technical Assistance for assistance.

Limitations of the Procedure

The EnviroGard DDT in Soil Test Kit is a qualitative/semi-quantitative screening test only. Actual quantitation of DDT by EnviroGard immunoassay is not possible due to the Test kit's cross-reactivity with DDT breakdown products and other similar compounds and to the variations in extraction efficiency inherent in the fast extraction protocol described in this product insert.

Soil sampling error may significantly affect testing reliability. The distribution of pesticides in different soils can be extremely heterogeneous. Soils should be dried and homogenized before analysis by any method. Split samples (i.e. for GC and immunoassay) should always derive from the same homogenate.

Ordering Information

Description	Catalog Number
EnviroGard DDT in Soil Test Kit	73100
EnviroGard Soil Extraction Bottle Kit	72010

Technical Assistance

Strategic Diagnostics Inc.
111 Pencader Drive
Newark, Delaware 19702-3322 USA
800-544-8881
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302-456-6782 Fax
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General Limited Warranty

Strategic Diagnostics Inc. warrants the products manufactured by it against defects in materials and workmanship when used in accordance with the applicable instructions for a period not to extend beyond a product's printed expiration date. **SDI MAKES NO OTHER WARRANTY, EXPRESSED OR IMPLIED. THERE IS NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.**

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Parafilm is a registered trademark of the American Can Corporation.
3099050 Rev 3 FEB 98

APPENDIX A.2
LEAD CHECK SOIL TEST KIT

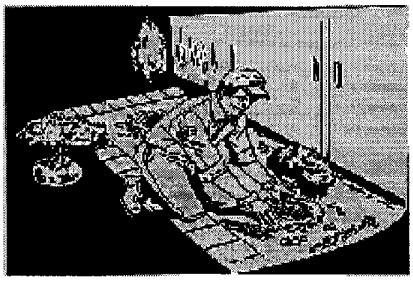
Lead Check

HybriVet Systems
INC.
P.O. Box 1210, Framingham, MA 01701
Fax: 1-(508)-651-8837
Telephone: 1-(508)-651-7881

Detect Lead in Soils...Instantly

Save time and minimize your liability

- *Inspections*
- *Quality Control*
- *Risk Assessment*
- *Fast Results*
- *Lead Specific*
- *Long Shelf Life*



Test Soil with Laboratory Sensitivity

With LeadCheck Soil you can minimize your liability in the disposal of hazardous waste and help control America's number one environmental health threat. There is no longer a need to stop an operation and wait for lab results. LeadCheck Soil is a proven and inexpensive means for the detection of lead in soil without hidden steps or lengthy procedures. It is completely transportable and will provide quick and accurate results in the field. Also, LeadCheck Soil comes with unlimited toll free support for anyone with further questions regarding product use or lead contamination.

Principle of Method

To detect the presence of lead in soil rapidly and sensitively, the lead complexes in soil must be solubilized and the lead disassociated from the complexes. The LeadCheck soil Kit includes an extraction liquid along with everything you need to screen your soil for lead. You must complete three basic steps: 1) Prepare soil sample for testing, 2) Extract the lead from the soil into the extraction liquid, 3) Test the extraction liquid for lead content.

Extraction prepares the sample for testing by making lead available. Detection of lead in the extraction liquid is based upon the known reactivity of lead with certain dyes capable of forming strong colored complexes with lead. The pink color that develops when the dye combines with lead is characteristic for lead and stable for hours.

Sensitivity

LeadCheck Soil provides a convenient method for detection of lead in soil at currently recognized hazard levels of 400ppm and above. Results can be obtained in as short a time as ten minutes.

Background

Lead is naturally present in all soils generally in the range of 15 to 40 parts per million (ppm) or milligrams per Kilogram (mg/kg). Pollution, however, can increase soil lead levels to several thousand mg/kg or higher. The major cause of soil contamination by lead in populated areas is the weathering, chipping, scraping, sanding, or sandblasting of structures bearing lead-based paints.

Advantages

LeadCheck Soil is:

- Easy to use - no special training required.
- Fast - results for most materials in 30 minutes or less.
- Sensitive - meets proposed EPA guidelines (400 ppm) for total lead content in soils.
- Easy disposal - no hazardous waste is generated.
- Versatile - accurately indicates lead content in a variety of materials.
- Long Stable Shelf Life.

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Lead Check

HYBRIVET SYSTEMS, INC.
P.O. BOX 1210, FRAMINGHAM, MA 01701
FAX (508) 651-8837
TELEPHONE (508) 651-7881

LEADCHECK SOIL PERFORMANCE CHARACTERISTICS

Early production lots of LeadCheck for Soil were used to determine the sensitivity of the test system.

Quantitative Testing Methods:

Total lead content for various soils was determined by the methods described below. These soils were then used to test the sensitivity range of LeadCheck Soil.

1. ASTM Method: E 1727-95 Standard Practice for Field Collection of Soil Samples for Lead Determination by Atomic Spectrometry.

2. EPA Method: EPA 600R-93\200 SOP for the Field Analysis of Lead in Paint, Bulk Dust, and Soil by Ultrasonic Acid Digestion and Colorimetric Measurement. EPA Research Triangle Park, NC 1993. The procedure for acid digestion was followed, lead content was determined using GFAAS.

LeadCheck Soil Method:

Standard LeadCheck extractions were done on both wet (25% water content by weight) and dry soils to simulate a range of field conditions.

Samples:

1. Certified Reference Material (CRM):

A Soil Certified Reference Material sample was purchased from the Research Technology Corporation. The sample was from a contaminated waste site in the Western United States and was analyzed by a minimum of twenty laboratories in a round-robin to meet the requirements specified by the EPA Cooperative Research and Development Agreement (CRADA). Lead content of this sample was certified at 414.7ppm.

2. Field Samples:

Field samples with high lead content were obtained from the certified testing laboratory and residences in Eastern Massachusetts. Values for lead content from the laboratory supplying the samples were used to confirm the analytical laboratory methods used by HybriVet Systems, as well as to confirm the sensitivity of LeadCheck for Soil.

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Results:

Sample	Extraction Method ASTM	Extraction Method EPA	LeadCheck Result Soil (Wet)*	LeadCheck Result Soil (Dry)
CRM	415	398		+
1	442	399	+	+
2	705	966	+	+
3	457	408	-*	-/+
4	329	388	+	+/-
5	589	642	+	+
6	990	871	+	+
7	1602	905	+	+
8	502	459	+	+
9	552	597	+	+
10	448	698	+	+
11	1100	1067	+	+
12	43	98		-
13	109	87		-
14	172	158		-

All Values are parts per million (ppm) *Tests + with 60 minute extraction

Summary:

LeadCheck for Soil was used to test for the presence of lead in soils with a range of concentrations (294ppm to 1674ppm) and moisture content. LeadCheck for Soil indicated the presence of lead in all of soils and conditions tested.

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APPENDIX B
TEST BORING AND WELL CONSTRUCTION RECORDS

APPENDIX B.1
TEST BORING RECORDS - SWMU 53

Baker

Baker Environmental

TEST BORING RECORD

PROJECT: SMWU 54 - Sampling and Analysis Report

PROJ. NO.: CTO-099 BORING NO.: 53-SB01

COORDINATES: EAST: 781405.227 NORTH: 148544.425

ELEVATION: SURFACE: 118.62

Rig: Mobile B-61	Split Spoon	Casing	Augers	Core Barrel	Date	Progress (Ft.)	Weather	Depth to Water (Ft.)
Size (ID)	1-3/8-in	--	4-1/4-in	--	12/14/00	0.0 - 8.5	M Sunny, low 80s	--
Length	2-ft	--	5-ft	--				
Type	Stainless	--	HSA	--				
Hammer Wt.	140	--	--	--				
Fall	30-in	--	--	--				

Remarks: Sample ID = 53-SB01-__ (with suffix shown below)

SAMPLE TYPE

S = Split Spoon A = Auger
T = Shelby Tube W = Wash
R = Air Rotary C = Core
D = Denison P = Piston
N = No Sample

DEFINITIONS

SPT = Standard Penetration Test (ASTM D1586)
PID = Photo Ionization Detector Measurement
MSL = Mean Sea Level
BG/PS = Background/Point Source
ppm = parts per million

Depth (Ft.)		Sample Type & No.	Sample Rec. (Ft.,%)	SPT	Lab ID	PID (ppm) ps/bg	Visual Description		Elevation (Ft. MSL)
1		S-1	0.8	7 6		0	SILT, little clay & fine gravel; brown; moist; stiff	1.0	117.62
			40%	6		0	Weathered BEDROCK; mottled gray;		
2	2.0			7			stiff; damp		
3		S-2	0.9	6 7		0	tan		
			45%	9		0			
4	4.0			16					
5		S-3	1.4	20 21	03	0	tan		
			70%	22		0			
6	6.0			32					
7		S-4	1.5	30 40		0	orangish-tan (mottled) w/ vertical fractures		
			75%	45		0	filled w/ black clay; hard; damp		
8	8.0			53/3"					
9		S-5	1.3	55 45	05	0	orangish-brown & gray		
			65%	45		0			
10	10.0			55/5"				10.0	108.62
							BOH at 10-ft bgs (Spoon refusal)		

DRILLING COMPANY: Geoworks, Inc. BAKER REP.: Mark DeJohn

DRILLER: Daniel Rolon BORING NO.: 53-SB01 SHEET 1 OF 1

Baker

Baker Environmental

TEST BORING RECORD

PROJECT: SMWU 54 - Sampling and Analysis Report

PROJ. NO.: CTO-099 BORING NO.: 53-SB02

COORDINATES: EAST: 781447.577 NORTH: 148534.321

ELEVATION: SURFACE: 121.43

Rig: Mobile B-61	Split Spoon	Casing	Augers	Core Barrel	Date	Progress (Ft.)	Weather	Depth to Water (Ft.)
Size (ID)	1-3/8-in	--	4-1/4-in	--	12/14/00	0.0 - 4.6	M Sunny, mid 70s	--
Length	2-ft	--	5-ft	--				
Type	Stainless	--	HSA	--				
Hammer Wt.	140	--	--	--				
Fall	30-in	--	--	--				

Remarks: Sample ID = 53-SB02-__ (with suffix shown below)

SAMPLE TYPE

S = Split Spoon A = Auger
T = Shelby Tube W = Wash
R = Air Rotary C = Core
D = Denison P = Piston
N = No Sample

DEFINITIONS

SPT = Standard Penetration Test (ASTM D1586)
PID = Photo Ionization Detector Measurement
MSL = Mean Sea Level
BG/PS = Background/Point Source
ppm = parts per million

Depth (Ft.)		Sample Type & No.	Sample Rec. (Ft.,%)	SPT	Lab ID	PID (ppm) ps/bg	Visual Description		Elevation (Ft. MSL)
1		S-1	0.5 25%	3 4 4 16		0 0	ROCK FRAG; some silt & clay; dk brown; stiff; moist		
2	2.0							1.9	119.53
3		S-2	0.6 36%	20 50 50 54/3"	02	0 0	Weathered BEDROCK; med brown; hard; dry		.
4	4.0								
	4.6	S-3	0.3	50-60/2"		0/0		4.6	116.83
5							BOH at 4.6-ft bgs (Spoon refusal)		
6									
7									
8									
9									
10									

DRILLING COMPANY: Geoworks, Inc. BAKER REP.: Mark DeJohn

DRILLER: Daniel Rolon BORING NO.: 53-SB02 SHEET 1 OF 1

Baker

Baker Environmental

TEST BORING RECORD

PROJECT: SMWU 54 - Sampling and Analysis Report

PROJ. NO.: CTO-099 BORING NO.: 53-SB03

COORDINATES: EAST: 781466.304 NORTH: 148520.4549

ELEVATION: SURFACE: 123.29

Rig: Mobile B-61	Split Spoon	Casing	Augers	Core Barrel	Date	Progress (Ft.)	Weather	Depth to Water (Ft.)
Size (ID)	1-3/8-in	--	4-1/4-in	--	12/14/00	0.0 - 4.5	M Sunny, mid 70s	--
Length	2-ft	--	5-ft	--				
Type	Stainless	--	HSA	--				
Hammer Wt.	140	--	--	--				
Fall	30-in	--	--	--				

Remarks: Sample ID = 53-SB03-__ (with suffix shown below)

SAMPLE TYPE

S = Split Spoon A = Auger
T = Shelby Tube W = Wash
R = Air Rotary C = Core
D = Denison P = Piston
N = No Sample

DEFINITIONS

SPT = Standard Penetration Test (ASTM D1586)
PID = Photo Ionization Detector Measurement
MSL = Mean Sea Level
BG/PS = Background/Point Source
ppm = parts per million

Depth (Ft.)		Sample Type & No.	Sample Rec. (Ft.,%)	SPT	Lab ID	PID (ppm) ps/bg	Visual Description		Elevation (Ft. MSL)
1		S-1	1.1	5 7	01	0	ROCK FRAG & SILT; some clay; brown & gray; moist; very stiff	1.0	122.29
			55%	14		0	Weathered BEDROCK; orangish-brown &		
2	2.0			23			greenish-gray; hard; damp		
3		S-2	0.8	22 47		0			
			48%	49		0			
4	4.0			56/3"					
	4.5	S-3	0.0	64/5"		--	No Recovery	4.5	118.79
5							BOH at 4.5-ft bgs (Spoon refusal)		
6									
7									
8									
9									
10									

DRILLING COMPANY: Geoworks, Inc. BAKER REP.: Mark DeJohn

DRILLER: Daniel Rolon BORING NO.: 53-SB03 SHEET 1 OF 1

Baker

Baker Environmental

TEST BORING RECORD

PROJECT: SMWU 54 - Sampling and Analysis Report

PROJ. NO.: CTO-099 BORING NO.: 53-SB04

COORDINATES: EAST: 781442.599 NORTH: 148506.6674

ELEVATION: SURFACE: 122.86

Rig: Mobile B-61	Split Spoon	Casing	Augers	Core Barrel	Date	Progress (Ft.)	Weather	Depth to Water (Ft.)
Size (ID)	1-3/8-in	--	4-1/4-in	--	12/14/00	0.0 - 6.0	M Sunny, mid 70s	--
Length	2-ft	--	5-ft	--				
Type	Stainless	--	HSA	--				
Hammer Wt.	140	--	--	--				
Fall	30-in	--	--	--				

Remarks: Sample ID = 53-SB04-__ (with suffix shown below)

SAMPLE TYPE

S = Split Spoon A = Auger
T = Shelby Tube W = Wash
R = Air Rotary C = Core
D = Denison P = Piston
N = No Sample

DEFINITIONS

SPT = Standard Penetration Test (ASTM D1586)
PID = Photo Ionization Detector Measurement
MSL = Mean Sea Level
BG/PS = Background/Point Source
ppm = parts per million

Depth (Ft.)		Sample Type & No.	Sample Rec. (Ft.,%)	SPT	Lab ID	PID (ppm) ps/bg	Visual Description		Elevation (Ft. MSL)
1		S-1	1.0	7 14		0	ROCK FRAG, some silt; trace clay; hard; dry		
			50%	27		0			
2	2.0			9					
				17				3.0	119.86
3		S-2	0.9	14	02	0	Weathered BEDROCK; greenish-gray, gray and tan - mottled; hard; damp		
			45%	17		0			
4	4.0			35					
				31					
5		S-3	0.9	37		0	mottled brown and gray		
	5.5		60%	50/4"		0			
6	6.0	S-4	0.4	62/5"		0/0	mottled dk brown	6.0	116.86
7							BOH at 6-ft bgs (Spoon refusal)		
8									
9									
10									

DRILLING COMPANY: Geoworks, Inc. BAKER REP.: Mark DeJohn

DRILLER: Daniel Rolon BORING NO.: 53-SB04 SHEET 1 OF 1

Baker

Baker Environmental

TEST BORING RECORD

PROJECT: SMWU 54 - Sampling and Analysis Report

PROJ. NO.: CTO-099 BORING NO.: 53-SB05

COORDINATES: EAST: 781434.016 NORTH: 148520.6589

ELEVATION: SURFACE: 121.00

Rig: Mobile B-61	Split Spoon	Casing	Augers	Core Barrel	Date	Progress (Ft.)	Weather	Depth to Water (Ft.)
Size (ID)	1-3/8-in	--	4-1/4-in	--	12/13/00	0.0 - 6.33	M Sunny, low 80s	--
Length	2-ft	--	5-ft	--				
Type	Stainless	--	HSA	--				
Hammer Wt.	140	--	--	--				
Fall	30-in	--	--	--				

Remarks: Sample ID = 53-SB05-__ (with suffix shown below)

SAMPLE TYPE

S = Split Spoon A = Auger
T = Shelby Tube W = Wash
R = Air Rotary C = Core
D = Denison P = Piston
N = No Sample

DEFINITIONS

SPT = Standard Penetration Test (ASTM D1586)
PID = Photo Ionization Detector Measurement
MSL = Mean Sea Level
BG/PS = Background/Point Source
ppm = parts per million

Depth (Ft.)		Sample Type & No.	Sample Rec. (Ft.,%)	SPT	Lab ID	PID (ppm) ps/bg	Visual Description		Elevation (Ft. MSL)
1		S-1	0.9 45%	10 10 10 17	00	0 0	ROCK FRAG, some silt, trace brick frag; gray; stiff; dry		
2	2.0							2.0	119.00
3		S-2	1 50%	9 10 12 14	02	0 0	Weathered BEDROCK; brown; very stiff; dry		.
4	4.0								
5	5.5	S-3	0.4 20%	8 15 55/5"		0 0	greenish-gray; hard; damp		
6	6.0	A-N	--	--		--			
	6.3	S-4		32-54/4"				6.3	114.70
7							BOH at 6.33-ft bgs (spoon refusal)		
8									
9									
10									

DRILLING COMPANY: Geoworks, Inc. BAKER REP.: Mark DeJohn

DRILLER: Daniel Rolon BORING NO.: 53-SB05 SHEET 1 OF 1

Baker

Baker Environmental

TEST BORING RECORD

PROJECT: SMWU 54 - Sampling and Analysis Report

PROJ. NO.: CTO-099 BORING NO.: 53-SB06

COORDINATES: EAST: 781424.190 NORTH: 148518.0624

ELEVATION: SURFACE: 120.98

Rig: Mobile B-61	Split Spoon	Casing	Augers	Core Barrel	Date	Progress (Ft.)	Weather	Depth to Water (Ft.)
Size (ID)	1-3/8-in	--	4-1/4-in	--	12/13/00	0.0 - 8.5	M Sunny, low 80s	--
Length	2-ft	--	5-ft	--				
Type	Stainless	--	HSA	--				
Hammer Wt.	140	--	--	--				
Fall	30-in	--	--	--				

Remarks: Sample ID = 53-SB06-__ (with suffix shown below)

SAMPLE TYPE

S = Split Spoon A = Auger
T = Shelby Tube W = Wash
R = Air Rotary C = Core
D = Denison P = Piston
N = No Sample

DEFINITIONS

SPT = Standard Penetration Test (ASTM D1586)
PID = Photo Ionization Detector Measurement
MSL = Mean Sea Level
BG/PS = Background/Point Source
ppm = parts per million

Depth (Ft.)		Sample Type & No.	Sample Rec. (Ft.,%)	SPT	Lab ID	PID (ppm) ps/bg	Visual Description		Elevation (Ft. MSL)
1		S-1	1.0 50%	11 15 17 19		0 0	ROCK FRAG, some silt; gray; dense; dry		
2	2.0							2.0	118.98
3		S-2	0.4 20%	17 13 13 17		0 0	Weathered BEDROCK; mottled red-brown, and gray; very stiff; damp		.
4	4.0								
5		S-3	0.7 35%	14 14 15 17	03	0 0	brown and greenish-gray		
6	6.0								
7		S-4	1.5 75%	23 23 27 31		0 0	hard		
8	8.0								
9	9.0	S-5	0.9 90%	47 50/5"		0 0		9.0	111.98
10							BOH at 9-ft bgs (Spoon refusal)		

DRILLING COMPANY: Geoworks, Inc. BAKER REP.: Mark DeJohn

DRILLER: Daniel Rolon BORING NO.: 53-SB06 SHEET 1 OF 1

APPENDIX B.2
TEST BORING AND WELL CONSTRUCTION RECORDS - SWMU 54

Baker

Baker Environmental

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT:	SMWU 54 - Sampling and Analysis Report		
PROJ. NO.:	CTO-099	BORING NO.:	54-TW01
COORDINATES:	EAST: 761672.759	NORTH:	139311.8611
ELEVATION:	SURFACE: 117.5	TOP OF PVC CASING:	118.13

Rig: Mobile B-61

	Split Spoon	Casing	Augers	Core Barrel	Date	Progress (Ft.)	Weather	Depth to Water (Ft.)
Size (ID)	2-3/8-in	--	4-1/4-in	--	12/15/00	0.0 - 20.0	M sunny, mid 80s	15.5
Length	2-ft	--	5-ft	--				
Type	Stainless	--	HSA	--				
Hammer Wt.	140	--	--	--				
Fall	30-in	--	--	--				

Remarks: Sample ID = 54-SB01-__ (with suffix shown below)
Surface elevation is an average elevation of nearby surface soil samples

SAMPLE TYPE

S = Split Spoon A = Auger
T = Shelby Tube W = Wash
R = Air Rotary C = Core
D = Denison P = Piston
N = No Sample

WELL INFORMATION

Type	Diam.	Top Depth (Ft.)	Bottom Depth (Ft.)
Sch 40 PVC Casing	2-in	0	10
Sch 40 PVC 10-Slot Screen	2-in	10	20

Depth (Ft.)	Sample Type & No.	Sample Rec. (Ft.,%)	SPT	Lab ID	PID (ppm) ps/bg	Visual Description	Well Installation Detail	Elevation (Ft. MSL)
1 / 2.0	S-1	1.9 / 95%	20 31 32 19	00	0 / 0	SILT, some f/c gravel, trace clay; black & dk brown; v dense; damp (FILL) 2.0		115.50
3 / 4.0	S-2	1.5 / 75%	13 13 21 21		0 / 0	CLAY, little silt, trace c sand; dk yellowish-brown; hard; damp (NATIVE)		
5 / 6.0	S-3	1.6 / 80%	18 25 31 33		0 / 0	little silt; mottled-reddish-brown & gray		
7 / 8.0	S-4	1.9 / 95%	33 29 48 47		0 / 0	SILT, some clay, trace f gravel; mottled rust & yellowish-brown; hard; damp		
9 / 10.0	S-5	1.7 / 85%	5 9 13 15		0 / 0	CLAY, little silt, trace f gravel; mottled yellow, brown, rust & gray v stiff; damp 10.0		117.50
			5			Match to Sheet 2		

DRILLING CO.:	Geoworks, Inc.	BAKER REP.:	Mark DeJohn
DRILLER:	Daniel Rolon	BORING NO.:	54-TW01 SHEET 1 OF 2

Baker

Baker Environmental

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: SMWU 54 - Sampling and Analysis Report

CTO NO.: CTO-099 BORING NO.: 54-TW01

SAMPLE TYPE

S = Split Spoon A = Auger
T = Shelby Tube W = Wash
R = Air Rotary C = Core
D = Denison P = Piston N = No Sample

DEFINITIONS

SPT = Standard Penetration Test (ASTM D1586)
PID = Photo Ionization Detector Measurement
MSL = Mean Sea Level
ps/bg = point source/background

Depth (Ft.)		Sample Type & No.	Sample Rec. (Ft.,%)	SPT	Lab ID	PID (ppm) ps/bg	Visual Description	Well Installation Detail			Elevation (Ft. MSL)
11			2.0	9		0	Continued from Sheet 1				
		S-6	100%	13		0	SILT, little - some clay; rust, gray,				
12	12.0			15			yellow & brown; v stiff; damp				
				19							
13		S-7	2.0	9		0	little clay; yellowish brown & gray;				
			100%	9		0	stiff; damp to moist (13.5-ft)				
14	14.0			9							
				2							
15		S-8	2.0	4	08	0	wet at 15.5-ft				
			100%	5		0					
16	16.0			6							
				6							
17		S-9	2.0	8		0	trace clay; orangish-brown, tan &				
			100%	13		0	pink - mottled w/ gray vert fracture				
18	18.0			21			v stiff; damp				
19		A-N	--	--	--	--					
20	20.0						20.0			20.0	97.50
							BOH at 20.0-ft bgs				
21											
22											
23											
24											
25											
26											
27											
28											
29											
30											

DRILLING CO.: Geoworks, Inc. BAKER REP.: Mark DeJohn

DRILLER: Daniel Rolon BORING NO.: 54-TW01 SHEET 2 OF 2

Baker

Baker Environmental

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT:	SMWU 54 - Sampling and Analysis Report		
PROJ. NO.:	CTO-099	BORING NO.:	54-TW02
COORDINATES:	EAST: 761635.567	NORTH:	139282.8632
ELEVATION:	SURFACE: 117.5	TOP OF PVC CASING:	118.22

Rig: Mobile B-61								
	Split Spoon	**Casing**	**Augers**	**Core Barrel**	**Date**	**Progress (Ft.)**	**Weather**	**Depth to Water (Ft.)**
Size (ID)	2-3/8-in	--	4-1/4-in	--	12/15/00	0.0 - 18.0	M sunny, mid 80s	13.5
Length	2-ft	--	5-ft	--				
Type	Stainless	--	HSA	--				
Hammer Wt.	140	--	--	--				
Fall	30-in	--	--	--				

Remarks: Sample ID = 54-SB02-__ (with suffix shown below)
Surface elevation is an average elevation of nearby surface soil samples

SAMPLE TYPE

S = Split Spoon A = Auger
T = Shelby Tube W = Wash
R = Air Rotary C = Core
D = Denison P = Piston
N = No Sample

WELL INFORMATION

Type	Diam.	Top Depth (Ft.)	Bottom Depth (Ft.)
Sch 40 PVC Casing	2-in	0	8
Sch 40 PVC 10-Slot Screen	2-in	8	18

Depth (Ft.)		Sample Type & No.	Sample Rec. (Ft.,%)	SPT	Lab ID	PID (ppm) ps/bg	Visual Description	Well Installation Detail			Elevation (Ft. MSL)
1		S-1	1.8 90%	15 24 18 10		0 / 0	F SAND, some silt & f/c gravel & cinders; dk brown & black, trace green staining; dense; damp (FILL)				
2	2.0									2.0	115.50
3		S-2	1.3 65%	8 17 22 19	02	26 / 0	CLAY, little silt; mottled orange & reddish-brown; hard; damp (NATIVE)				.
4	4.0										
5		S-3	1.3 65%	11 16 22 22		0 / 0	mottled red & gray				
6	6.0										
7		S-4	1.2 60%	12 18 19 22		6.5 / 0					
8	8.0									8.0	117.50
9		S-5	1.7 85%	5 10 9 10		0 / 0	little silt, trace c sand; mottled orangish & yellowish-brown w/ gray clay-filled vert fractures				
10	10.0										
				8			Match to Sheet 2				

DRILLING CO.:	Geoworks, Inc.	BAKER REP.:	Mark DeJohn
DRILLER:	Daniel Rolon	BORING NO.:	54-TW02 SHEET 1 OF 2

Baker

Baker Environmental

TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: SMWU 54 - Sampling and Analysis Report

CTO NO.: CTO-099 BORING NO.: 54-TW02

SAMPLE TYPE

S = Split Spoon A = Auger
T = Shelby Tube W = Wash
R = Air Rotary C = Core
D = Denison P = Piston N = No Sample

DEFINITIONS

SPT = Standard Penetration Test (ASTM D1586)
PID = Photo Ionization Detector Measurement
MSL = Mean Sea Level
ps/bg = point source/background

Depth (Ft.)		Sample Type & No.	Sample Rec. (Ft.,%)	SPT	Lab ID	PID (ppm) ps/bg	Visual Description	Well Installation Detail				Elevation (Ft. MSL)
11			2.0	6	06	0	Continued from Sheet 1					
		S-6	100%	5		0	moist					
12	12.0			5								
				5								
13		S-7	2.0	5		0	wet at 13.4-ft					
			100%	6		0						
14	14.0			6								
				6								
15		S-8	2.0	6		0	m stiff; damp					
			100%	1		0						
16	16.0			2								
17		A-N	--	--		--						
18	18.0						18.0			18.0		99.50
							BOH at 18.0-ft bgs					
19												
20												
21												
22												
23												
24												
25												
26												
27												
28												
29												
30												

DRILLING CO.: Geoworks, Inc. BAKER REP.: Mark DeJohn

DRILLER: Daniel Rolon BORING NO.: 54-TW02 SHEET 2 OF 2

SOIL BORING LOG

Exploration for: Site Characterization	Location
Date: March 17, 1995	510
Boring No.: SB-14	
Recorded By: L. Griffith	Water Table
Drill Type: Hollow Stem Auger	approx. 14.0 BLS
Weather: Sunny, 80°	

Sample No.	Type	Depth		No. of Blows	Soil Description and Boring Log
		From	To		
SB-14	SPT	0	2	24, 16, 17, 19	2.5 YR 5/4 light olive brown clay, top 6" of spoon, 2.5 YR 4/6 dark red clay, (see note A below)
SB-14	SPT	2	4	24, 24, 26, 27	7.5 YR 5/8 strong brown clay, trace fine gravel, moist, very stiff
SB-14	SPT	4	6	50 @ 4"	Same as above
SB-14	SPT	6	8	50 @ 4"	Same as above, trace coarse gravel
SB-14	SPT	8	10	21, 30, 50 @ 4"	2.5 YR 5/4 light olive brown clay, slightly moist, stiff
SB-14	SPT	10	12	25, 33, 44, 45	Same as above
SB-14	SPT	12	14	29, 38, 50 @ 6"	5 YR 5/3 olive clay, trace fine gravel, slightly moist, very stiff
SB-14	SPT	14	16	41, 50 @ 3"	5 YR 6/3 olive clay, trace fine to medium gravel, slightly moist
SB-14	SPT	16	18	50 @ 4"	5 YR 5/3 olive clay, trace fine to medium gravel, slightly moist, stiff
SB-14	SPT	18	20	50 @ 4"	2.5 YR 5/4 light olive brown clay, slightly moist

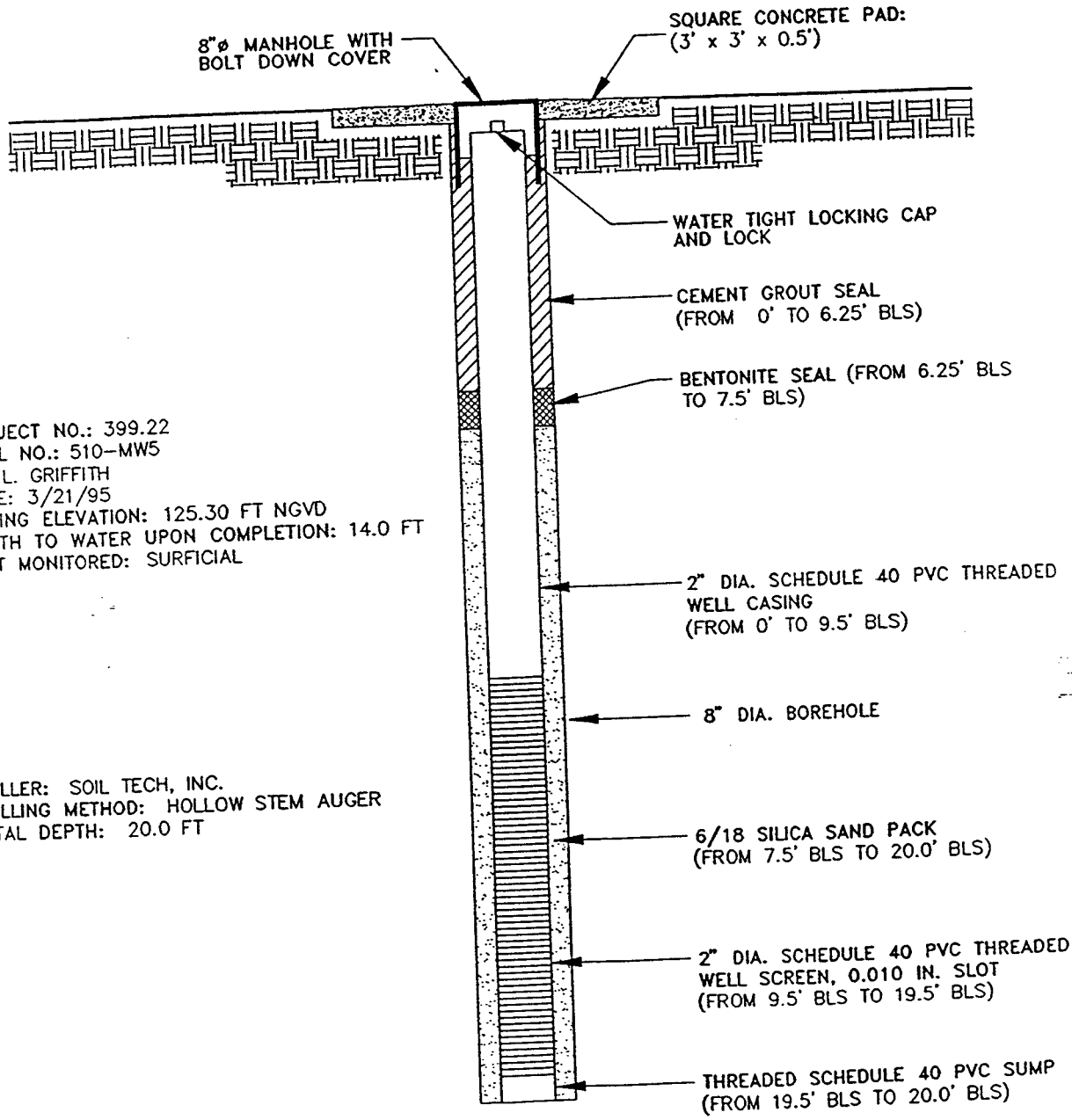
Remarks

PH - post hole

SPT - standard penetration test

Note: A = trace fine to coarse gravel, slightly moist, very stiff, bottom 18" of spoon

510–MW5



PROJECT NO.: 399.22
WELL NO.: 510–MW5
BY: L. GRIFFITH
DATE: 3/21/95
CASING ELEVATION: 125.30 FT NGVD
DEPTH TO WATER UPON COMPLETION: 14.0 FT
UNIT MONITORED: SURFICIAL

DRILLER: SOIL TECH, INC.
DRILLING METHOD: HOLLOW STEM AUGER
TOTAL DEPTH: 20.0 FT

(DRAWING NOT TO SCALE)

BLS = BELOW LAND SURFACE

BLASLAND, BOUCK & LEE, INC.
ENGINEERS & SCIENTISTS

ROOSEVELT ROADS U.S. NAVAL STATION
CEIBA, PUERTO RICO
SITE #510

MONITORING WELL 510-MW5 CONSTRUCTION DETAILS

FIGURE --

EDIT: 21JUN95 27 JD
19JUN95 26 JR
D:\399ZZ\399ZZWL1.DWG

SOIL BORING LOG

Exploration for: Site Characterization	Location
Date: Feb. 15, 1995	510
Boring No.: SB-4	Water Table
Recorded By: M. Bauer	approx. 9.92 ft BLS
Drill Type: Hollow Stem Auger	
Weather: Ptly Cloudy, 80° Breezy	

Sample No.	Type	Depth		No. of Blows	Soil Description and Boring Log
		From	To		
SB-4	PH	0	2	N/A	2.5/10 Y Greenish black clay
SB-4	PH	2	4	N/A	10 YR 3/1 dark gray clay with pebble sized fill
SB-4	SPT	4	6	3, 2, 4, 5	10 YR 3/6 dark yellowish brown clay with pebble sized fill
SB-4	SPT	6	8	2, 4, 9, 11	10 YR 4/4 dark yellowish brown clay with pebble sized pieces of carbon
SB-4	SPT	8	10	5, 10, 13, 22	10 YR 4/4 dark yellowish brown and 6/10 greenish gray clay
SB-4	SPT	10	12	4, 12, 19, 11	7.5 YR 4/4 brown clay (moist)
SB-4	SPT	12	14	5, 7, 9, 11	7.5 YR 7/1 light gray clay (moist)
SB-4	SPT	14	16	5, 7, 10, 13	2.5 YR 5/6 red clay (moist)
SB-4	SPT	16	18	5, 7, 11, 12	7.5 YR 7/1 light gray and 2.5 YR 5/6 red clay (moist)
SB-4	SPT	18	20	NA	Drillers misunderstood instructions. Did not collect sample from 18-20
SB-4	SPT	20	22	4, 7, 10, 12	Same as above with 5 YR 5/8 mottled clay (moist)
SB-4	SPT	23	25	4, 5, 6, 8	Same as above (moist)

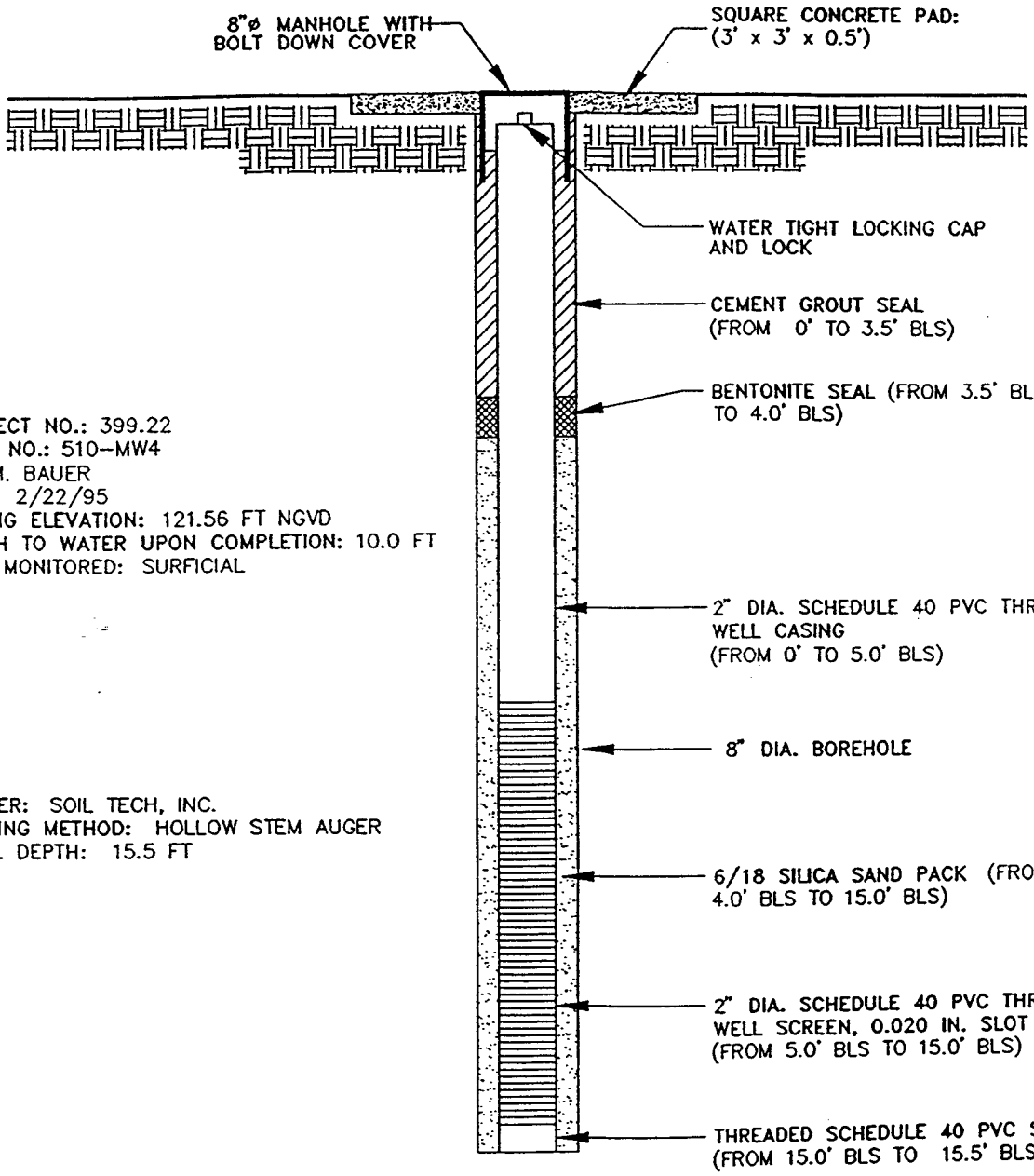
Remarks

PH - post hole

SPT - standard penetration test

NA - not applicable

510–MW4



PROJECT NO.: 399.22
WELL NO.: 510–MW4
BY: M. BAUER
DATE: 2/22/95
CASING ELEVATION: 121.56 FT NGVD
DEPTH TO WATER UPON COMPLETION: 10.0 FT
UNIT MONITORED: SURFICIAL

DRILLER: SOIL TECH, INC.
DRILLING METHOD: HOLLOW STEM AUGER
TOTAL DEPTH: 15.5 FT

(DRAWING NOT TO SCALE)

BLS = BELOW LAND SURFACE

BLASLAND, BOUCK & LEE, INC.
ENGINEERS & SCIENTISTS

ROOSEVELT ROADS U.S. NAVAL STATION
CEIBA, PUERTO RICO
SITE #510

MONITORING WELL 510-MW4 CONSTRUCTION DETAILS

FIGURE --

T: 21JUN95 27 JD
JUN95 26 JR
\39922\39922WL2.DWG

SOIL BORING LOG

Exploration for: Site Characterization	Location
Date: Feb. 20, 1995	510
Boring No.: SB-12	Water Table
Recorded By: M. Bauer	approx. 9.30 ft BLS
Drill Type: Hollow Stem Auger	
Weather: Sunny, breezy, 85°	

Sample No.	Type	Depth		No. of Blows	Soil Description and Boring Log
		From	To		
SB-12	PH	0	2	N/A	10 YR 3/2 very dark grayish brown clay with pebble sized fill
SB-12	PH	2	4	N/A	2.5 YR 4/4 olive brown clay
SB-12	SPT	4	6	2, 2, 3, 5	2.5 YR 5/3 light olive brown clay with gravel sized rocks
SB-12	SPT	6	8	2, 3, 5, 7	2.5 YR 4/3 olive brown clay with pebble sized limerock
SB-12	SPT	8	10	3, 6, 9, 9	5 YR 7/3 pale yellow clay (moist)
SB-12	SPT	10	12	6, 7, 13, 20	7.5 YR 4/3 brown and 2.5 YR 4/6 dark red clay with limerock pebbles (moist)

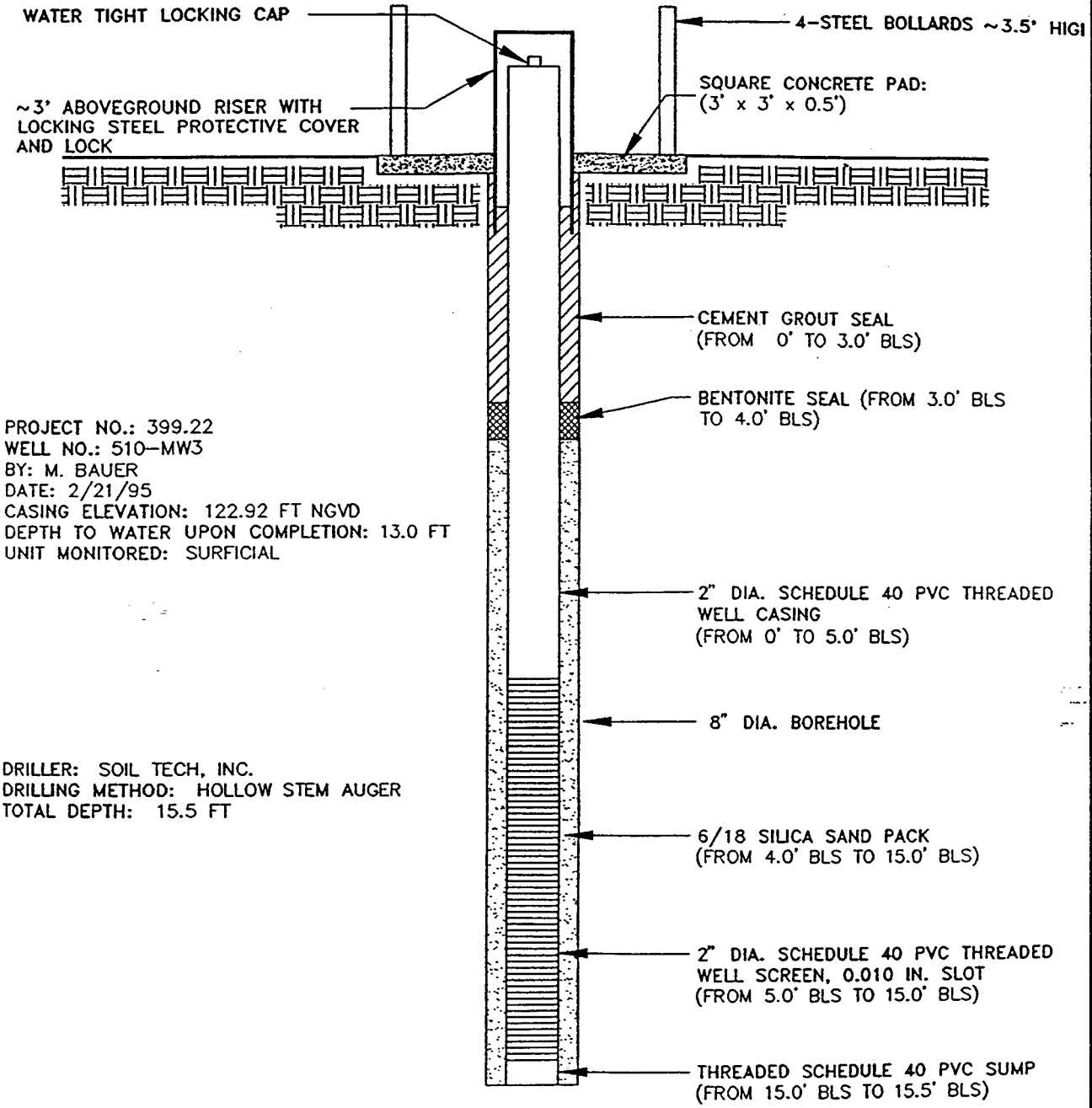
Remarks

PH - post hole

SPT - standard penetration test

NA - not applicable

510–MW3



PROJECT NO.: 399.22
WELL NO.: 510–MW3
BY: M. BAUER
DATE: 2/21/95
CASING ELEVATION: 122.92 FT NGVD
DEPTH TO WATER UPON COMPLETION: 13.0 FT
UNIT MONITORED: SURFICIAL

DRILLER: SOIL TECH, INC.
DRILLING METHOD: HOLLOW STEM AUGER
TOTAL DEPTH: 15.5 FT

(DRAWING NOT TO SCALE)

BLS = BELOW LAND SURFACE

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ENGINEERS & SCIENTISTS

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CEIBA, PUERTO RICO
SITE #510

MONITORING WELL 510-MW3 CONSTRUCTION DETAILS

FIGURE --

DATE: 21JUN95 27 JD
PLOTTED 26 JR
B:\399ZZ\399ZZWL5.DWG

SOIL BORING LOG

Exploration for: Site Characterization

Date: Feb. 16, 1995

Boring No.: SB-6

Recorded By: M. Bauer

Drill Type: Hollow Stem Auger

Weather: Sunny 80° light breeze

Location

510

Water Table

approx. 13.64 ft BLS

Sample No.	Type	Depth From	Depth To	No. of Blows	Soil Description and Boring Log
SB-6	PH	0	2	N/A	7.5 YR 3/2 dk brown clay with pebble sized carbon
SB-6	PH	2	4	N/A	7.5 YR 4/6 strong brown clay
SB-6	SPT	4	6	5, 8, 9, 12	7.5 YR 4/4 brown clay
SB-6	SPT	6	8	5, 9, 12, 16	7.5 YR 5/6 strong brown clay
SB-6	SPT	8	10	5, 8, 12, 17	7.5 YR 6/4 light brown clay with pebble sized limerock
SB-6	SPT	10	12	5, 8, 13, 16	7.5 YR 5/4 and 7.5 YR 7/4 mottled clay (moist)
SB-6	SPT	12	14	6, 10, 13, 17	7.5 YR 7/4 and 5 YR 5/6 mottled clay (moist)
SB-6	SPT	14	16	4, 5, 9, 14	5 YR 5/6 and 10 YR 6/4 mottled clay (moist)

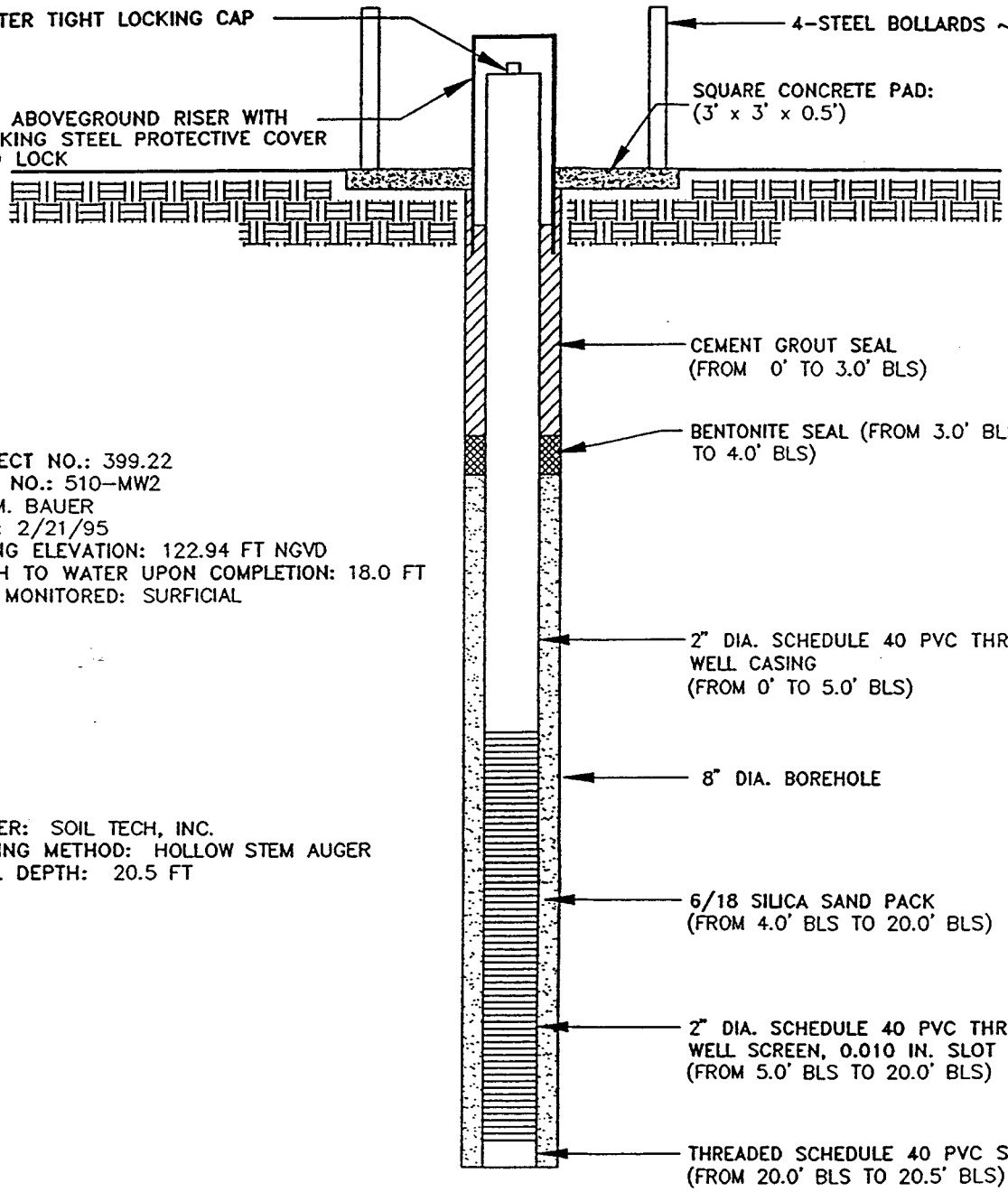
Remarks

PH - post hole

SPT - standard penetration test

NA - not applicable

510–MW2



'ROJECT NO.: 399.22
'VELL NO.: 510–MW2
3Y: M. BAUER
)ATE: 2/21/95
:ASING ELEVATION: 122.94 FT NGVD
)EPTH TO WATER UPON COMPLETION: 18.0 FT
JNIT MONITORED: SURFICIAL

)RILLER: SOIL TECH, INC.
)RILLING METHOD: HOLLOW STEM AUGER
OTAL DEPTH: 20.5 FT

(DRAWING NOT TO SCALE)

BLS = BELOW LAND SURFACE

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SITE #510

MONITORING WELL 510-MW2 CONSTRUCTION DETAILS

FIGURE --

3JUN95 27 JD
95 26 JR
92Z\399ZZWL4.DWG

SOIL BORING LOG

Exploration for: Site Characterization	Location
Date: Feb. 14, 1995	510
Boring No.: SB-2	Water Table
Recorded By: M. Bauer/J. Garrido	approx. 6.10 ft BLS
Drill Type: Hollow Stem Auger	1/100' Free product in bailer
Weather: Sunny, Breezy 85°	

Sample No.	Type	Depth		No. of Blows	Soil Description and Boring Log
		From	To		
SB-2	PH	0	2	N/A	7.5 YR 4/4 brown rocks & fine sand
SB-2	PH	2	4	N/A	7.5 YR 4/4 brown rocks & fine sand
SB-2	SPT	4	6	11, 9, 9, 9	Gravel size granite fill
SB-2	SPT	6	8	11, 11, 11, 7	Gravel sized granite fill (moist)
SB-2	SPT	8	10	7, 4, 2, 8	Coarse black sand, clay found at bottom of spoon (wet)

Remarks

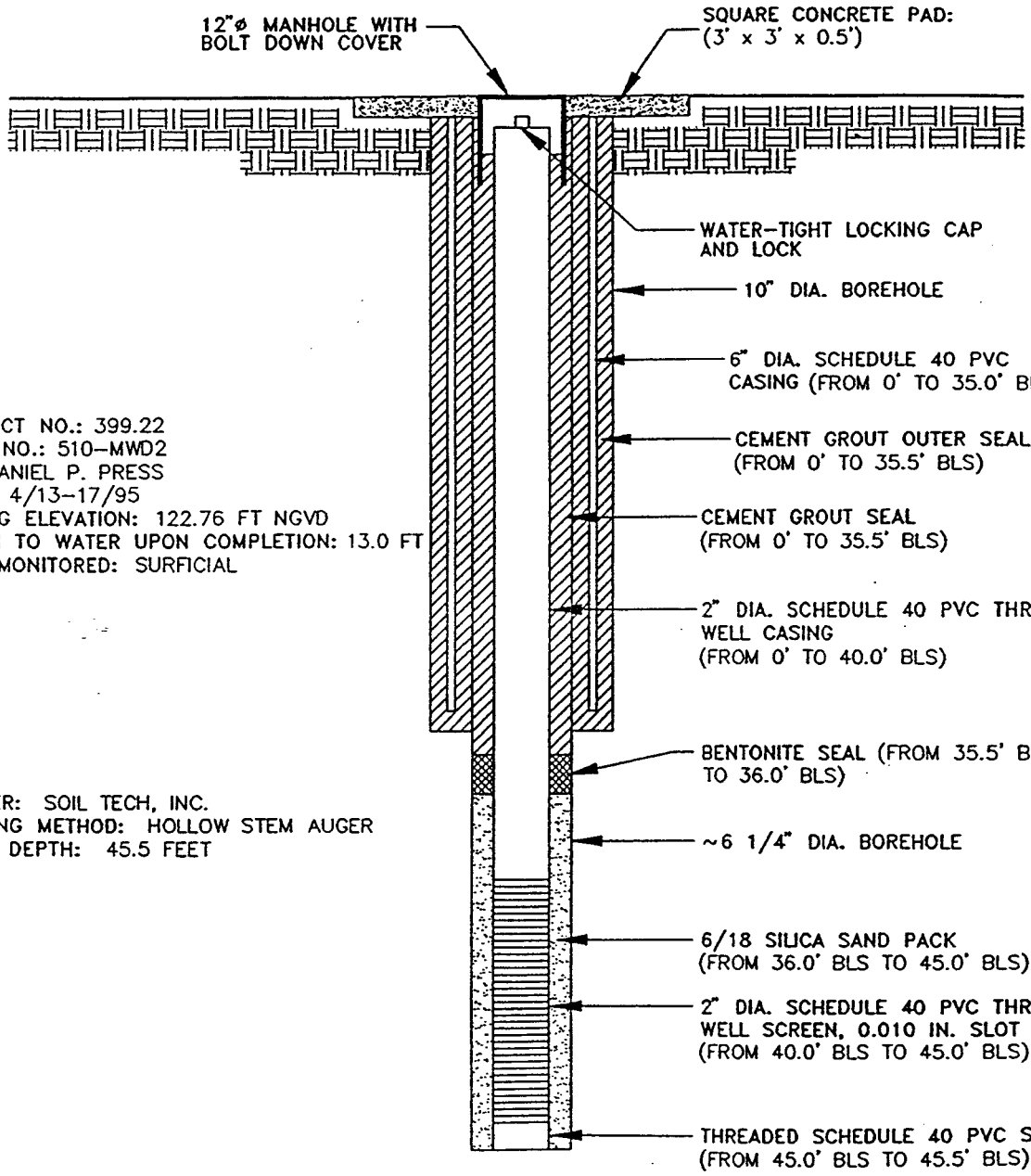
PH - post hole

SPT - standard penetration test

NA - not applicable

4991047G

510-DW2



PROJECT NO.: 399.22
WELL NO.: 510-MWD2
BY: DANIEL P. PRESS
DATE: 4/13-17/95
CASING ELEVATION: 122.76 FT NGVD
DEPTH TO WATER UPON COMPLETION: 13.0 FT
UNIT MONITORED: SURFICIAL

DRILLER: SOIL TECH, INC.
DRILLING METHOD: HOLLOW STEM AUGER
TOTAL DEPTH: 45.5 FEET

(DRAWING NOT TO SCALE)

BLS = BELOW LAND SURFACE

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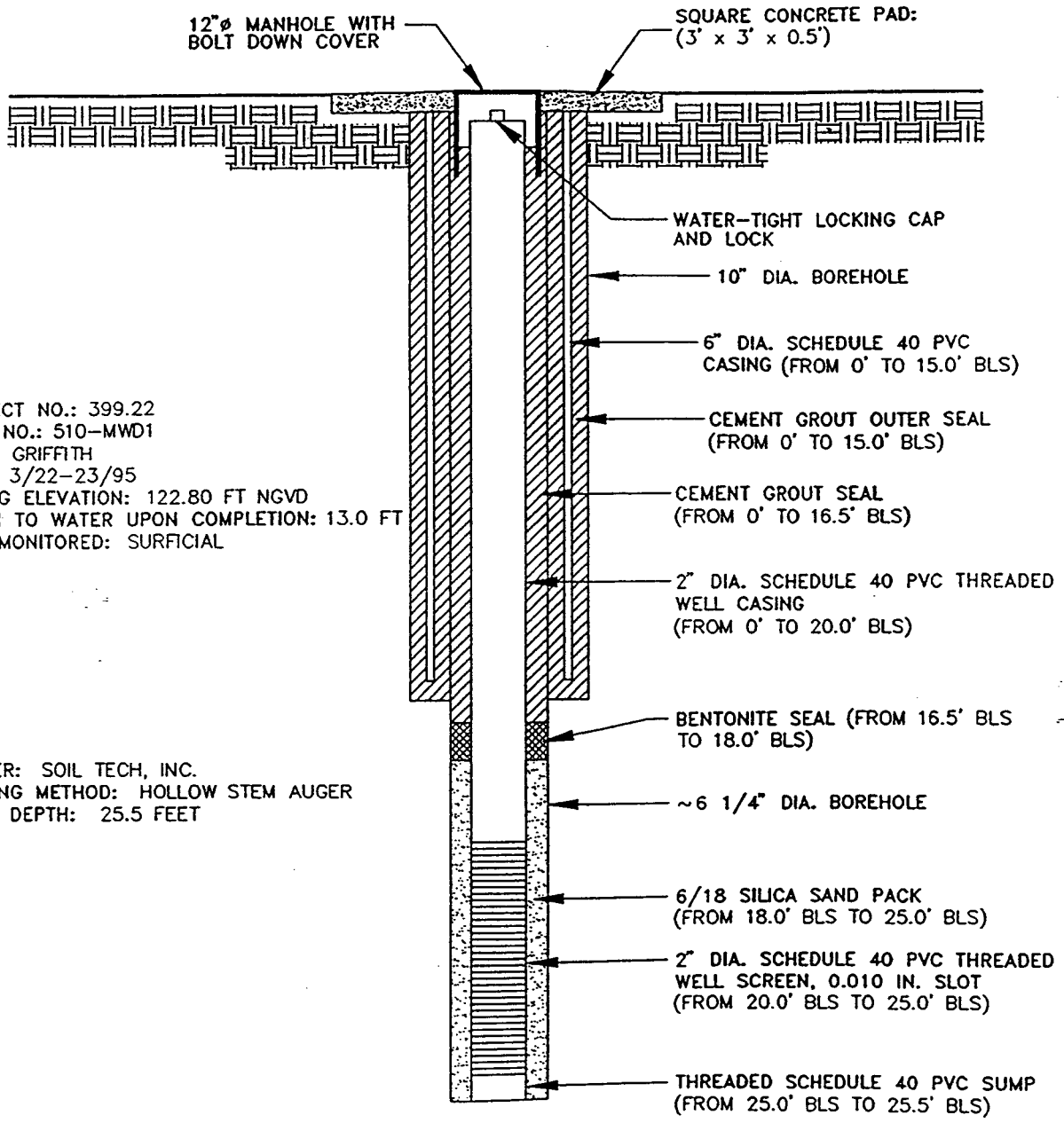
SITE #510

MONITORING WELL 510-DW2 CONSTRUCTION DETAILS

FIGURE --

EDIT: 21JUN95 27 JD
19JUN95 26 JR
R:\399ZZ\399ZZWL7.DWG

510–DW1



PROJECT NO.: 399.22
WELL NO.: 510–MWD1
BY: L. GRIFFITH
DATE: 3/22–23/95
CASING ELEVATION: 122.80 FT NGVD
DEPTH TO WATER UPON COMPLETION: 13.0 FT
UNIT MONITORED: SURFICIAL

DRILLER: SOIL TECH, INC.
DRILLING METHOD: HOLLOW STEM AUGER
TOTAL DEPTH: 25.5 FEET

(DRAWING NOT TO SCALE)

BLS = BELOW LAND SURFACE

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CEIBA, PUERTO RICO
SITE #510

MONITORING WELL 510-DW1 CONSTRUCTION DETAILS

FIGURE --

DWT: 21JUN95 27 JD
JUN95 26 JR
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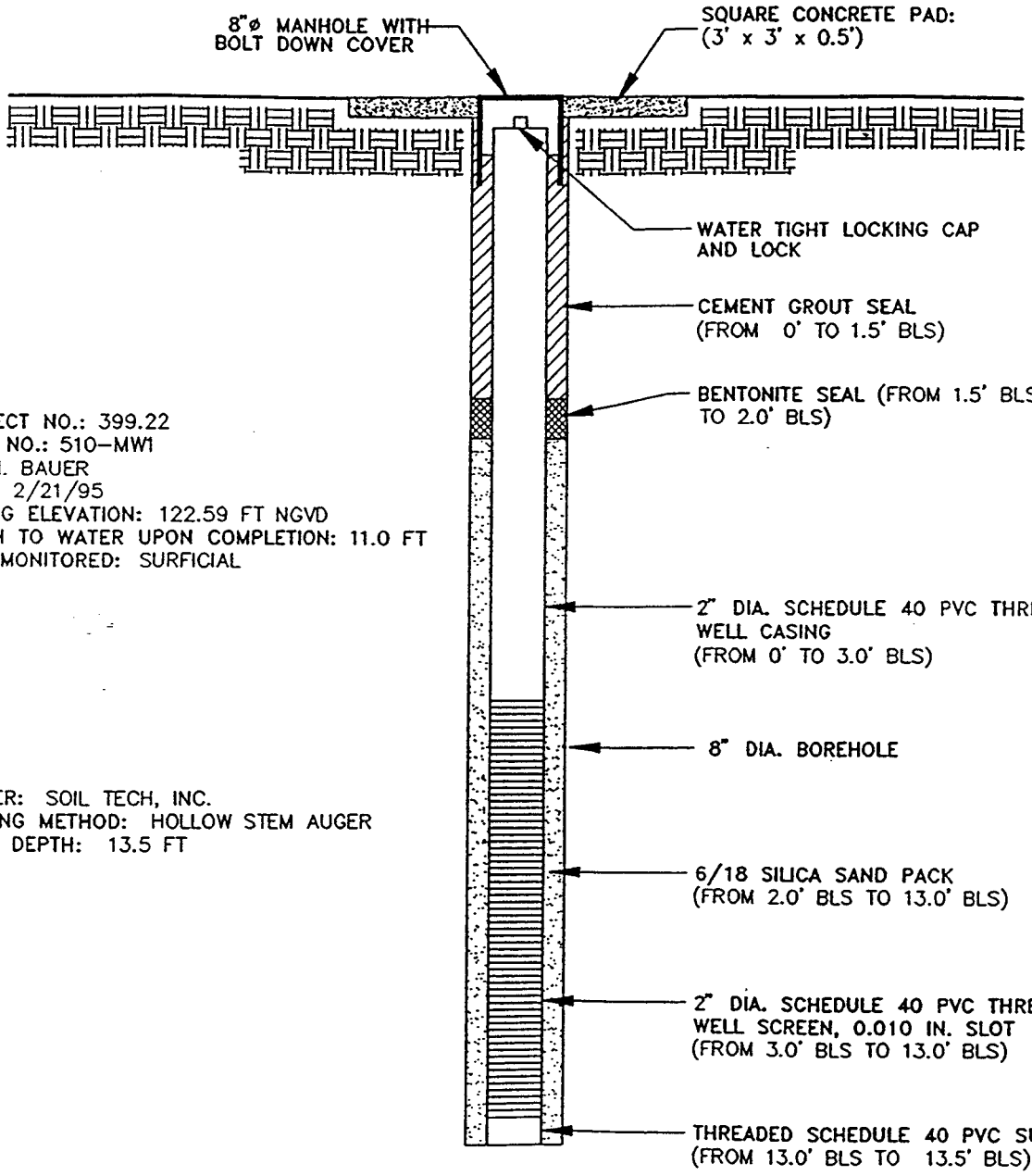
510-MW1



PROJECT NO.: 399.22
WELL NO.: 510-MW1
BY: M. BAUER
DATE: 2/21/95
CASING ELEVATION: 122.59 FT NGVD
DEPTH TO WATER UPON COMPLETION: 11.0 FT
UNIT MONITORED: SURFICIAL

DRILLER: SOIL TECH, INC.
DRILLING METHOD: HOLLOW STEM AUGER
TOTAL DEPTH: 13.5 FT

(DRAWING NOT TO SCALE)

BLS = BELOW LAND SURFACE

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SITE #510

MONITORING WELL 510-MW1 CONSTRUCTION DETAILS

FIGURE --

JUN95 26 JR
\39922\39922WL3.DWG

APPENDIX C
GROUND WATER SAMPLING PROCEDURE LOW STRESS (Low Flow) PURGING AND SAMPLING

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION II

GROUND WATER SAMPLING PROCEDURE
LOW STRESS (Low Flow) PURGING AND SAMPLING

I. SCOPE & APPLICATION

This Low Stress (or Low-Flow) Purging and Sampling Procedure is the EPA Region II standard method for collecting low stress (low flow) ground water samples from monitoring wells. Low stress Purging and Sampling results in collection of ground water samples from monitoring wells that are representative of ground water conditions in the geological formation. This is accomplished by minimizing stress on the geological formation and minimizing disturbance of sediment that has collected in the well. The procedure applies to monitoring wells that have an inner casing with a diameter of 2.0 inches or greater, and maximum screened intervals of ten feet unless multiple intervals are sampled. The procedure is appropriate for collection of ground water samples that will be analyzed for volatile and semi-volatile organic compounds (VOCs and SVOCs), pesticides, polychlorinated biphenyls (PCBs), metals, and microbiological and other contaminants in association with all EPA programs.

This procedure does not address the collection of light or dense non-aqueous phase liquids (LNAPL or DNAPL) samples, and should be used for aqueous samples only. For sampling NAPLs, the reader is referred to the following EPA publications: DNAPL Site Evaluation (Cohen & Mercer, 1993) and the RCRA Ground-Water Monitoring: Draft Technical Guidance (EPA/530-R-93-001), and references therein.

II. METHOD SUMMARY

The purpose of the low stress purging and sampling procedure is to collect ground water samples from monitoring wells that are representative of ground water conditions in the geological formation. This is accomplished by setting the intake velocity of the sampling pump to a flow rate that limits drawdown inside the well casing.

Sampling at the prescribed (low) flow rate has three primary benefits. First, it minimizes disturbance of sediment in the bottom of the well,

thereby producing a sample with low turbidity (i.e., low concentration of suspended particles). Typically, this saves time and analytical costs by eliminating the need for collecting and analyzing an additional filtered sample from the same well. Second, this procedure minimizes aeration of the ground water during sample collection, which improves the sample quality for VOC analysis. Third, in most cases the procedure significantly reduces the volume of ground water purged from a well and the costs associated with its proper treatment and disposal.

III. ADDRESSING POTENTIAL PROBLEMS

Problems that may be encountered using this technique include a) difficulty in sampling wells with insufficient yield; b) failure of one or more key indicator parameters to stabilize; c) cascading of water and/or formation of air bubbles in the tubing; and d) cross-contamination between wells.

Insufficient Yield

Wells with insufficient yield (i.e., low recharge rate of the well) may dewater during purging. Care should be taken to avoid loss of pressure in the tubing line due to dewatering of the well below the level of the pump=s intake. Purging should be interrupted before the water level in the well drops below the top of the pump, as this may induce cascading of the sand pack. Pumping the well dry should therefore be avoided to the extent possible in all cases. Sampling should commence as soon as the volume in the well has recovered sufficiently to allow collection of samples. Alternatively, ground water samples may be obtained with techniques designed for the unsaturated zone, such as lysimeters.

Failure to Stabilize Key Indicator Parameters

If one or more key indicator parameters fails to stabilize after 4 hours, one of four options should be considered: a) continue purging in an attempt to achieve stabilization; b) discontinue purging, do not collect samples, and document attempts to reach stabilization in the log book; c) discontinue purging, collect samples, and document attempts to reach stabilization in the log book; or d) Secure the well, purge and collect samples the next day (preferred). The key indicator parameter for samples to be analyzed for VOCs is dissolved

oxygen. The key indicator parameter for all other samples is turbidity.

Cascading

To prevent cascading and/or air bubble formation in the tubing, care should be taken to ensure that the flow rate is sufficient to maintain pump suction. Minimize the length and diameter of tubing (i.e., 1/4 or 3/8 inch ID) to ensure that the tubing remains filled with ground water during sampling.

Cross-Contamination

To prevent cross-contamination between wells, it is strongly recommended that dedicated, in-place pumps be used. As an alternative, the potential for cross-contamination can be reduced by performing the more thorough Adaily@ decontamination procedures between sampling of each well in addition to the start of each sampling day (see Section VII, below).

Equipment Failure

Adequate equipment should be on-hand so that equipment failures do not adversely impact sampling activities.

IV. PLANNING DOCUMENTATION AND EQUIPMENT

< Approved site-specific Field Sampling Plan/Quality Assurance Project Plan (QAPP). This plan must specify the type of pump and other equipment to be used. The QAPP must also specify the depth to which the pump intake should be lowered in each well. Generally, the target depth will correspond to the mid-point of the most permeable zone in the screened interval. Borehole geologic and geophysical logs can be used to help select the most permeable zone. However, in some cases, other criteria may be used to select the target depth for the pump intake. In all cases, the target depth must be approved by the EPA hydrogeologist or EPA project scientist.

< Well construction data, location map, field data from last sampling event.

< Polyethylene sheeting.

< Flame Ionization Detector (FID) and Photo Ionization Detector (PID).

< Adjustable rate, positive displacement ground water sampling pump (e.g., centrifugal or bladder pumps constructed of stainless steel or Teflon). A peristaltic pump may only be used for inorganic sample collection.

< Interface probe or equivalent device for determining the presence or absence of NAPL.

< Teflon or Teflon-lined polyethylene tubing to collect samples for organic analysis. Teflon or Teflon-lined polyethylene, PVC, Tygon or polyethylene tubing to collect samples for inorganic analysis. Sufficient tubing of the appropriate material must be available so that each well has dedicated tubing.

< Water level measuring device, minimum 0.01 foot accuracy, (electronic preferred for tracking water level drawdown during all pumping operations).

< Flow measurement supplies (e.g., graduated cylinder and stop watch or in-line flow meter).

< Power source (generator, nitrogen tank, etc.).

< Monitoring instruments for indicator parameters. Eh and dissolved oxygen must be monitored in-line using an instrument with a continuous readout display. Specific conductance, pH, and temperature may be monitored either in-line or using separate probes. A nephalometer is used to measure turbidity.

< Decontamination supplies (see Section VII, below).

< Logbook (see Section VIII, below).

< Sample bottles.

< Sample preservation supplies (as required by the analytical methods).

< Sample tags or labels, chain of custody.

V. SAMPLING PROCEDURES

Pre-Sampling Activities

1. Start at the well known or believed to have the least contaminated ground water and proceed systematically to the well with the most contaminated ground water. Check the well, the lock, and the locking cap for damage or evidence of tampering. Record observations.

2. Lay out sheet of polyethylene for placement of monitoring and sampling equipment.

3. Measure VOCs at the rim of the unopened well with a PID and FID instrument and record the reading in the field log book.

4. Remove well cap.

5. Measure VOCs at the rim of the opened well with a PID and an FID instrument and record the reading in the field log book.
6. If the well casing does not have a reference point (usually a V-cut or indelible mark in the well casing), make one. Note that the reference point should be surveyed for correction of ground water elevations to the mean geodesic datum (MSL).

7. Measure and record the depth to water (to 0.01 ft) in all wells to be sampled prior to purging. Care should be taken to minimize disturbance in the water column and dislodging of any particulate matter attached to the sides or settled at the bottom of the well.

8. If desired, measure and record the depth of any NAPLs using an interface probe. Care should be taken to minimize disturbance of any sediment that has accumulated at the bottom of the well. Record the observations in the log book. If LNAPLs and/or DNAPLs are detected, install the pump at this time, as described in step 9, below. Allow the well to sit for several days between the measurement or sampling of any DNAPLs and the low-stress purging and sampling of the ground water.

Sampling Procedures

9. Install Pump: Slowly lower the pump, safety cable, tubing and electrical lines into the well to the depth specified for that

well in the EPA-approved QAPP or a depth otherwise approved by the EPA hydrogeologist or EPA project scientist. The pump intake must be kept at least two (2) feet above the bottom of the well to prevent disturbance and resuspension of any sediment or NAPL present in the bottom of the well. Record the depth to which the pump is lowered.

10. Measure Water Level: Before starting the pump, measure the water level again with the pump in the well. Leave the water level measuring device in the well.

11. Purge Well: Start pumping the well at 200 to 500 milliliters per minute (ml/min). The water level should be monitored approximately every five minutes. Ideally, a steady flow rate should be maintained that results in a stabilized water level (drawdown of 0.3 ft or less). Pumping rates should, if needed, be reduced to the minimum capabilities of the pump to ensure stabilization of the water level. As noted above, care should be taken to maintain pump suction and to avoid entrainment of air in the tubing. Record each adjustment made to the pumping rate and the water level measured immediately after each adjustment.

12. Monitor Indicator Parameters: During purging of the well, monitor and record the field indicator parameters (turbidity, temperature, specific conductance, pH, Eh, and DO) approximately every five minutes. The well is considered stabilized and ready for sample collection when the indicator parameters have stabilized for three consecutive readings as follows (Puls and Barcelona, 1996):

    ±0.1 for pH
    ±3% for specific conductance (conductivity)
    ±10 mv for redox potential
    ±10% for DO and turbidity

    Dissolved oxygen and turbidity usually require the longest time to achieve stabilization. The pump must not be removed from the well between purging and sampling.

13. Collect Samples: Collect samples at a flow rate between 100 and 250 ml/min and such that drawdown of the water level within the well does not exceed the maximum allowable drawdown of 0.3 ft. VOC samples must be collected first and directly into sample

containers. All sample containers should be filled with minimal turbulence by allowing the ground water to flow from the tubing gently down the inside of the container.

Ground water samples to be analyzed for volatile organic compounds (VOCs) require pH adjustment. The appropriate EPA Program Guidance should be consulted to determine whether pH adjustment is necessary. If pH adjustment is necessary for VOC sample preservation, the amount of acid to be added to each sample vial prior to sampling should be determined, drop by drop, on a separate and equal volume of water (e.g., 40 ml). Ground water purged from the well prior to sampling can be used for this purpose.

14. Remove Pump and Tubing: After collection of the samples, the tubing, unless permanently installed, must be properly discarded or dedicated to the well for resampling by hanging the tubing inside the well.

15. Measure and record well depth.

16. Close and lock the well.

VI. FIELD QUALITY CONTROL SAMPLES

Quality control samples must be collected to determine if sample collection and handling procedures have adversely affected the quality of the ground water samples. The appropriate EPA Program Guidance should be consulted in preparing the field QC sample requirements of the site-specific QAPP.

All field quality control samples must be prepared exactly as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples should be collected during the sampling event:

< Field duplicates
< Trip blanks for VOCs only
< Equipment blank (not necessary if equipment is dedicated to the well)

As noted above, ground water samples should be collected systematically from wells with the lowest level of contamination

through to wells with highest level of contamination. The equipment blank should be collected after sampling from the most contaminated well.

VII. DECONTAMINATION

Non-disposable sampling equipment, including the pump and support cable and electrical wires which contact the sample, must be decontaminated thoroughly each day before use (Adaily decon@) and after each well is sampled (Abetween-well decon@). Dedicated, in-place pumps and tubing must be thoroughly decontaminated using Adaily decon@ procedures (see #17, below) prior to their initial use. For centrifugal pumps, it is strongly recommended that non-disposable sampling equipment, including the pump and support cable and electrical wires in contact with the sample, be decontaminated thoroughly each day before use (Adaily decon@).

EPA=s field experience indicates that the life of centrifugal pumps may be extended by removing entrained grit. This also permits inspection and replacement of the cooling water in centrifugal pumps. All non-dedicated sampling equipment (pumps, tubing, etc.) must be decontaminated after each well is sampled (Abetween-well decon,@ see #18 below).

17. **Daily Decon**

A) Pre-rinse: Operate pump in a deep basin containing 8 to 10 gallons of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.

B) Wash: Operate pump in a deep basin containing 8 to 10 gallons of a non-phosphate detergent solution, such as Alconox, for 5 minutes and flush other equipment with fresh detergent solution for 5 minutes. Use the detergent sparingly.

C) Rinse: Operate pump in a deep basin of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.

D) Disassemble pump.

E) Wash pump parts: Place the disassembled parts of the pump into a deep basin containing 8 to 10 gallons of non-phosphate

detergent solution. Scrub all pump parts with a test tube brush.

F) Rinse pump parts with potable water.

G) Rinse the following pump parts with distilled/ deionized water: inlet screen, the shaft, the suction interconnector, the motor lead assembly, and the stator housing.

H) Place impeller assembly in a large glass beaker and rinse with 1% nitric acid (HNO_3).

I) Rinse impeller assembly with potable water.

J) Place impeller assembly in a large glass bleaker and rinse with isopropanol.

K) Rinse impeller assembly with distilled/deionized water.

18. **Between-Well Decon**

A) Pre-rinse: Operate pump in a deep basin containing 8 to 10 gallons of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.
B) Wash: Operate pump in a deep basin containing 8 to 10 gallons of a non-phosphate detergent solution, such as Alconox, for 5 minutes and flush other equipment with fresh detergent solution for 5 minutes. Use the detergent sparingly.

C) Rinse: Operate pump in a deep basin of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.

D) Final Rinse: Operate pump in a deep basin of distilled/deionized water to pump out 1 to 2 gallons of this final rinse water.

VIII. FIELD LOG BOOK

A field log book must be kept each time ground water monitoring activities are conducted in the field. The field log book should document the following:

- Well identification number and physical condition.
- Well depth, and measurement technique.
- Static water level depth, date, time, and measurement technique.
- Presence and thickness of immiscible liquid layers and detection method.
- Collection method for immiscible liquid layers.
- Pumping rate, drawdown, indicator parameters values, and clock time, at three to five minute intervals; calculate or measure total volume pumped.
- Well sampling sequence and time of sample collection.
- Types of sample bottles used and sample identification numbers.
- Preservatives used.
- Parameters requested for analysis.
- Field observations of sampling event.
- Name of sample collector(s).
- Weather conditions.
- QA/QC data for field instruments.

IX. REFERENCES

Cohen, R.M. and J.W. Mercer, 1993, DNAPL Site Evaluation, C.K. Smoley Press, Boca Raton, Florida.

Puls, R.W. and M.J. Barcelona, 1996, Low-Flow (Minimal Drawdown) Ground-water Sampling Procedures, EPA/540/S-95/504.

U.S. EPA, 1993, RCRA Ground-Water Monitoring: Draft Technical Guidance, EPA/530-R-93-001.

U.S. EPA Region II, 1989, CERCLA Quality Assurance Manual.