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**U.S. NAVY NORTHERN DIVISION
REMEDIAL ACTION CONTRACT (RAC)
CONTRACT NO. N62472-94-D-0398
DELIVERY ORDER NO. 0006**

**SAMPLING AND ANALYSIS PLAN
FOR
SITE 13 GROUNDWATER MONITORING
NAVAL CONSTRUCTION BATTALION CENTER (NCBC)
DAVISVILLE, RHODE ISLAND**

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ACRONYMS

CED	Construction Equipment Division
COC	Chain of Custody
DI	Deionized
EPA	Environmental Protection Agency
MCL	Maximum Contaminant Level
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NAPL	Non-aqueous Phase Liquid
NCBC	Naval Construction Battalion Center
NORTHDIV	U.S. Navy Northern Division
NTU	Nephelometric Turbidity Units
ORP	Oxidation Reduction Potential
PCBs	Polychlorinated Biphenyls
ppb	parts per billion
ppm	parts per million
QA	Quality Assurance
QC	Quality Control
RAC	Remedial Action Contract
RIDEM	Rhode Island Department of Environmental Management
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
TSS	Total Suspended Solids
QAP	Quality Assurance Plan
VOC	Volatile Organic Compound

1.0 PROJECT DESCRIPTION

1.1 Introduction

Foster Wheeler Environmental Corporation (Foster Wheeler) has prepared this Sampling and Analysis Plan (SAP) for Delivery Order No. 0006 under the U.S. Navy Northern Division Remedial Action Contract (RAC) N62472-94-D-0398. This SAP discusses the procedures for the sampling and analysis of groundwater from five monitoring wells located within the boundaries of Site 13 at the Naval Construction Battalion Center (NCBC) Davisville in North Kingstown, Rhode Island.

1.2 Background

Site 13 consists of approximately six acres located in and surrounded by NCBC Davisville. The site, located north of Buildings W-3 and W-4 and northwest of the former location of Building T-1, is bounded on the south by "A" street, on the east by Exeter Street, and on the north by Foster Road.

From 1945 to 1955, the Construction Equipment Division (CED) was housed in Buildings W-3, W-4, and T-1. Overhaul and repair of construction equipment were conducted in these buildings. Drums of oils, thinners, and solvents were stored adjacent to the three buildings and vehicles awaiting repair lain on the fields to the north and west. Approximately 300 gallons of waste oils per month were reportedly spread on these fields for a period of ten years.

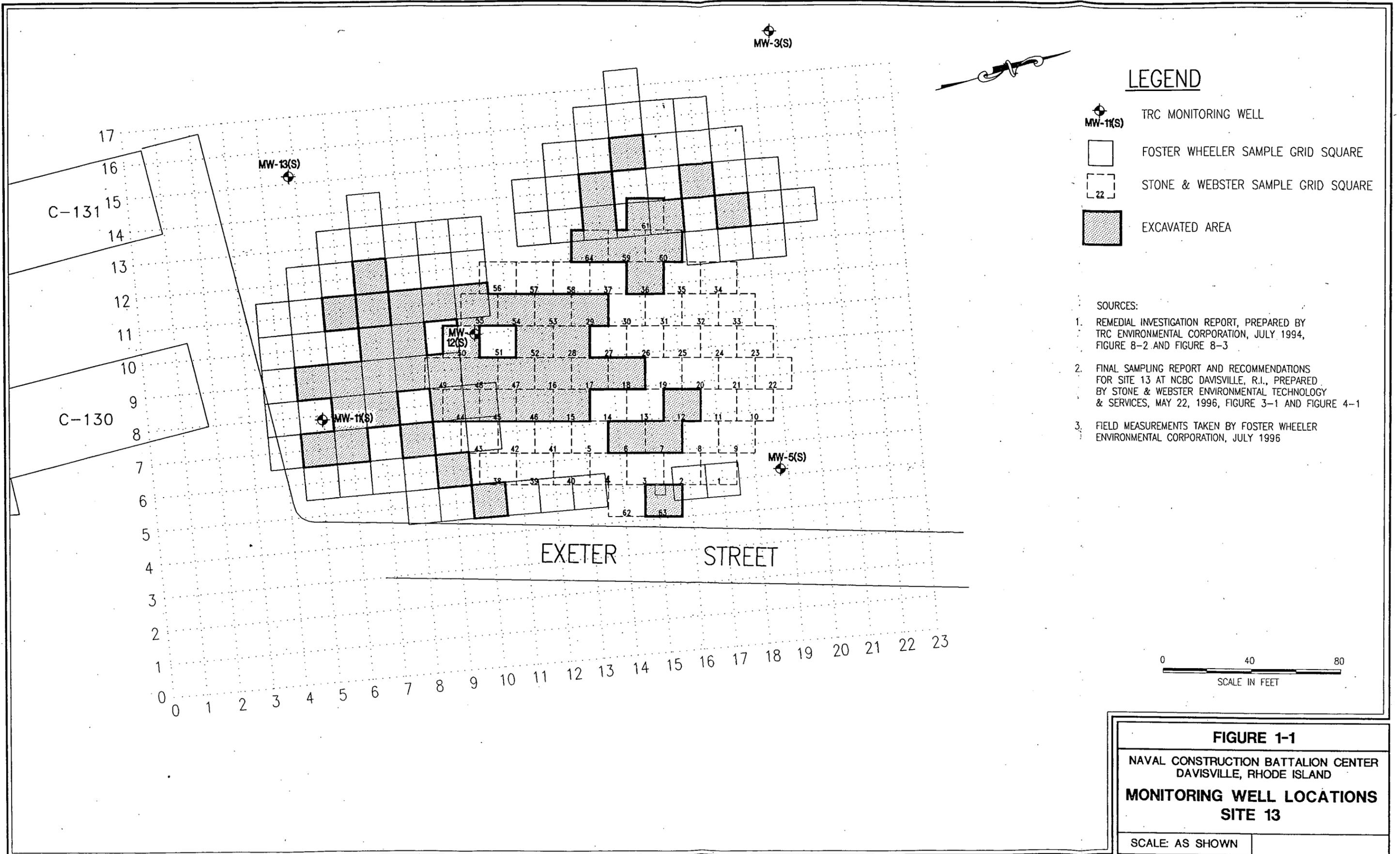
The results of TRC Environmental Corporation's (TRC's) Phase I and Phase II Remedial Investigation sampling programs (completed in May 1991 and July 1994, respectively) first indicated the presence of polychlorinated biphenyl (PCB) contamination in the surface soil and storm sewer catch basin sediment at Site 13. PCBs were not detected in area monitoring wells. Subsequent investigations were conducted by Stone & Webster Environmental Technology & Services (Stone & Webster) and Foster Wheeler to delineate the horizontal and vertical extent of PCB contaminated soil at Site 13 and, in turn, determine the limits of excavation required for the proposed time-critical removal action. Stone & Webster's sampling results were issued in the *Final Sampling Report and Recommendations for Site 13 at NCBC Davisville, RI*, dated May 22, 1996. Foster Wheeler's immunoassay field screening results were issued in a July 26, 1996 letter report.

Foster Wheeler is currently performing the time-critical removal action at Site 13 which, in part, involves the excavation of PCB contaminated soil. Confirmatory soil samples are being collected from the excavation and analyzed to ensure that the established site cleanup criterion of 10 parts per million (ppm) total PCBs has been met. In several locations, elevated levels of PCBs have been detected in soil which is in contact with the groundwater. Thus, Foster Wheeler will perform groundwater monitoring at Site 13 to ensure that the excavation of PCB contaminated soil has not mobilized PCBs into the groundwater.

1.3 Hydrogeology

The current configuration of groundwater monitoring wells at Site 13 is the result of TRC's Phase I and Phase II Remedial Investigations. The well configuration is intended to monitor groundwater conditions both upgradient and downgradient of the areas which exhibited soil contamination in the Phase I Remedial Investigation.

Shallow groundwater levels measured in the monitoring wells at Site 13 suggest that a groundwater divide exists near monitoring well MW-3(S) (see Figure 1-1). Groundwater flow is both northeasterly



and southwesterly from this point. The locations of the existing monitoring wells allow for evaluation of potential contamination which may be originating from the current soil removal activities at Site 13.

1.4 Groundwater Monitoring Program

The groundwater monitoring program will involve the sampling and analysis of five existing shallow monitoring wells {MW-3(S), MW-5(S), MW-11(S), MW-12(S), and MW-13(S)}, as depicted in Figure 1-1, for PCBs and total suspended solids (TSS). All wells are located in and around the area of excavated soil. Monitoring well screen data is presented in Table 1-1. Initially, two quarterly groundwater sampling events will be performed. Samples will be collected using low flow sampling procedures to minimize the quantity of suspended sediments present.

This SAP describes the data acquisition procedures, the type of samples to be collected, the frequency of sampling, the methods of analyses, and the quality assurance/quality control (QA/QC) measures to be used in support of the performance of this investigation. This document also serves as a procedural guide for all field personnel and subcontractors involved in sampling and analysis data acquisition activities.

**Table 1-1
Monitoring Well Screen Data**

Well Number	Date Installed	Screen Depth (ft from ground surface)	
		Top	Bottom
MW-3(S)	10/13/89	2.50	12.50
MW-5(S)	06/04/93	4.00	18.00
MW-11(S)	06/09/93	4.00	14.00
MW-12(S)	06/09/93	4.00	14.00
MW-13(S)	06/09/93	4.00	14.00

2.0 SAMPLING AND ANALYSIS DATA QUALITY OBJECTIVES

2.1 Data Quality Objectives

The objective of the groundwater monitoring program is to ensure that removal activities have not mobilized PCBs into the groundwater in the vicinity of the excavated area. Field sampling procedures and analytical data collected must be of a quality that supports the decision making process. The sampling and analysis program will ensure that chemical data meet the *Navy Installation Restoration Laboratory Quality Assurance Guide*, dated February 1996, requirements for completeness, precision, accuracy, representativeness, comparability, dependability, and legal defensibility.

Samples will be analyzed for PCBs and TSS in strict accordance with U.S. Environmental Protection Agency (EPA) Methods 8080 and 160.2, respectively. Detection limits will be sufficiently below regulatory criteria so as to provide accurate and usable data. Sample collection will utilize approved techniques that will ensure the sample is representative of current environmental conditions. QA/QC samples will be collected and analyzed for the purpose of assessing the quality of the sampling effort and of the analytical data. Table 5-1 indicates the number of samples to be collected per sampling event, the number of QA/QC samples, the analytical methods, and associated detection limit requirements.

Laboratory data deliverables will include a full data package in order to support any data review or validation requirements.

All laboratory analysis will be performed by National Environmental Testing, Inc. (NET) Cambridge Division of Bedford, MA. NET Cambridge Division is a Navy and Rhode Island certified laboratory using EPA approved methodologies. NET's laboratory certifications, which have previously been submitted to the Navy, will remain current throughout the duration of the project. NET's laboratory quality control criteria are identified in their Laboratory Quality Assurance Plan (QAP) which was included as an appendix to the Work Plan for Site 13, issued by Foster Wheeler in August 1996. Additional copies of NET's laboratory certifications or QAP will be forwarded as required.

2.2 Regulatory Criteria

The Rhode Island Department of Environmental Management (RIDEM) developed groundwater quality standards based primarily on the maximum contaminant levels (MCLs) promulgated by the Rhode Island Department of Health's *Rules and Regulations Pertaining to Public Drinking Water*, amended January 1995, which adopted the federal MCL for PCBs of 0.0005 mg/L. Rule 10 of RIDEM's *Rules and Regulations for Groundwater Quality*, amended May 1995, establishes groundwater quality standards and preventive action limits for class GAA and class GA groundwater in the state of Rhode Island. The groundwater quality standard for PCBs in class GAA and class GA groundwater is 0.0005 mg/L. Although the groundwater at Site 13 has been classified GB by RIDEM, the groundwater quality standard of 0.0005 mg/L (0.5 ppb) PCBs will be adhered to until otherwise directed by the state of Rhode Island.

3.0 SAMPLING PROCEDURES AND REQUIREMENTS

This section of the SAP discusses and describes field sampling activities and procedures as well as QA/QC sample requirements.

3.1 Quality Control Sample Requirements

QA/QC samples will be analyzed for the purpose of assessing the quality of the sampling effort and of the analytical data. QA/QC samples include field and referee duplicates, equipment blanks, field blanks, and trip blanks. The descriptions below include sampling methodologies and sample frequencies, as well as details on the purpose of each individual QA/QC sample. QA/QC samples to be collected as part of this groundwater monitoring program are outlined in Table 5-1.

3.1.1 Field Duplicate Samples

Field duplicate samples are multiple grab or composite samples, collected separately, that equally represent a medium at a given location and time. Field duplicates will be collected at a frequency of 10% per sample matrix. A minimum of one field duplicate will be collected for each sampling event. Each duplicate sample will be assigned a designated field identification number similar to the other samples collected during that sampling event. There will be no reference to the fact that the sample is a field duplicate. In this manner, the sample will be submitted to the testing laboratory and analyzed as a "blind" duplicate which can then be used to assess the quality of the analytical data generated by the laboratory. Note that the same samples used for field duplicates will be split by the laboratory and used as the laboratory duplicate or matrix spike/matrix spike duplicate (MS/MSD) at a frequency of one for every twenty field samples collected.

3.1.2 Referee Duplicate QA Samples

Referee duplicates are samples which are collected, homogenized, split, and placed into separate containers. Volatile organic compound (VOC) samples, however, are not homogenized and must therefore be collected first as grab samples which are taken separately at the same location and time. Referee duplicates may be sent to a referee QA laboratory if the Navy or regulatory agencies collect split samples or if a special problem occurs in sample collection or analysis. Referee duplicates are not anticipated for this project at this time.

3.1.3 Equipment Blanks

Equipment blanks are samples consisting of a reagent (analyte-free) water collected daily during a sampling event from a final rinse of sampling equipment after the decontamination procedure has been performed. The purpose of equipment blanks is to determine whether the sampling equipment is causing cross contamination of samples. One equipment blank per day per sampling event will be collected for this project as necessary. None are currently anticipated, however, due to the use of dedicated sampling equipment.

3.1.4 Field Blanks

Field blanks, sometimes referred to as ambient blanks, are samples consisting of contaminant-free media (typically reagent grade water) which are prepared at the site and handled in the field in the same manner as all other field samples. Field blanks are not collected using the same sampling equipment as the field samples. The contaminant-free medium is placed directly in the same container, and preserved and in the same manner as the field samples. One field blank will be collected for each sampling event.

3.1.5 Trip Blanks

Trip blanks are containers of organic-free reagent water that are kept with the field sample containers from the time they leave the laboratory until they are returned to the laboratory. One trip blank will accompany each cooler containing samples to be analyzed for VOCs, and will be stored at the laboratory with the samples. Trip blanks will be analyzed in order to evaluate the effect of ambient site conditions and sample shipment integrity, and to ensure proper sample container preparation and handling techniques. Trip blanks are not required for this project.

3.2 Decontamination Procedures

No sampling equipment will be coming into direct contact with an analytical sample. The electronic water level indicator and in-line flow cell should be the only equipment requiring decontamination between each sampling interval using the following procedure:

- Rinse with a non-phosphate detergent in potable water;
- Rinse with potable water;
- Rinse with deionized (DI) water;
- Rinse with methanol;
- Rinse with DI water; and
- Air dry.

All rinsate will be collected into 55-gallon drums, labeled appropriately, and stored on site for later disposal with the other decontamination fluids.

3.3 Low Flow Sampling Procedures

Groundwater samples will be collected from shallow monitoring wells MW-3(S), MW-5(S), MW-11(S), MW-12(S), and MW-13(S) and analyzed for PCBs and TSS. Sample containers, preservatives, and holding times are included in Table 3-1. Samples will be collected using low flow sampling procedures to minimize the quantity of suspended sediments present. Low flow sampling will be performed as described in EPA Region I Standard Operating Procedure (SOP) # GW 0001 entitled "Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells", issued in draft form on July 22, 1996. A copy of the SOP is included in Appendix A. All monitoring wells will be purged and sampled using these procedures with the modifications and additional specifications provided below.

**Table 3-1
Sample Containers, Preservatives, and Holding Times**

Analysis	Container	Preservative	Holding Time ¹
PCBs	(2) 1-liter amber glass bottles with Teflon-lined lids	Ice to 4 °C	Extraction within 7 days, analyze within 40 days of extraction.
TSS	(1) 1-liter plastic	Ice to 4 °C	Analyze within 7 days.

Note: ¹ Holding times are measured from the time of sample collection.

3.3.1 Sampling Equipment

Water and total well depth measurements will be made with an electronic water level indicator (Solinst Water Level Meter or equivalent). A DC powered peristaltic pump with dedicated Teflon or Teflon-lined polyethylene tubing will be used to purge and sample each well. Field parameters, including temperature, pH, specific conductance, and oxidation reduction potential (ORP), will be monitored with an in-line flow cell and associated water quality meter (YSI 3560 Water Quality Monitoring System). Turbidity will be monitored separately using a field portable battery-operated turbidity meter.

3.3.2 Preliminary Site Activities

Based on historical data, there is no need to check for non-aqueous phase liquid (NAPL) with an interface probe. All other preliminary site activities will be conducted in accordance with the aforementioned SOP.

3.3.3 Sampling Collection

Groundwater samples will be collected once the minimum purge volume has been removed and the following parameters show stability over three consecutive readings taken at five minute intervals:

- Turbidity (within 10% for values greater than 1 NTU);
- Temperature (within 3%)
- pH (within ± 0.1 unit)
- Specific conductance (within 3%)
- ORP (within ± 10 millivolts)

3.4 Documentation Procedures

A bound, weatherproof field notebook with numbered pages will be maintained by the field geologist/hydrogeologist to record all information related to groundwater monitoring activities. All information will be written in blue or black ink and will document the following:

- Date and time of site visit.
- Weather conditions.
- Key personnel on-site.
- Well identification.
- Well depth and measurement technique.
- Static water level depth, date, time, and measurement technique.
- Pumping rate, drawdown, indicator parameter values, and clock time at five minute intervals.
- Calculated or measured total volume pumped.
- Well sampling sequence and time of sample collection.
- Types of sample bottles and sample identifiers used.
- Preservatives used.
- Parameters requested for analysis.
- Field observations of sampling event, including sample conditions (sample matrix, sample volume, color, consistency, odor, evidence of contamination, etc.).
- Name of sample collector(s).
- Description of equipment used, including trade names, model numbers, diameters, material compositions, etc.
- Calibration data for field instruments.
- Description of any problems encountered in the field.

4.0 SAMPLE IDENTIFICATION, CHAIN OF CUSTODY, PACKING, AND SHIPPING

4.1 Sample Identification and Labeling

4.1.1 Sample Identification

The sample identification system that will be used for this investigation will assign a unique sample identifier to each sample collected. The sample identifier will consist of an alpha-numeric code that will reference the site designation, the type of sample, the sampling round, and the monitoring well number. The QC sample identifier will also consist of an alpha-numeric code that will identify the QC sample designation and sample collection date. Note: all sample identifiers and their corresponding locations will be carefully logged in the field notebook and may be identified on figures or drawings.

Davisville site designation:	DV13	Site 13
Sample type:	GW	Groundwater Sample
Sampling rounds:	R1 R2	Round 1 Round 2
QC sample designations:	RD EB	Referee Duplicate Equipment Blank

FB Field Blank
MS/MSD Matrix Spike/Matrix Spike Duplicate

Examples: **Round I Groundwater Sample**
Identifier: DV13-GWR1-MW3(S)
where: DV13 = Site 13
 GW = Groundwater Sample
 R1 = Sampling Round 1
 MW3(S) = Monitoring Well MW-3(S)

Referee Duplicate of Above Groundwater Sample: DV13-GWR1-MW3(S)-RD

Field Duplicate of Above Groundwater Sample: DV13-GWR1-MW20(S), where MW-20(S) is used as a fictitious monitoring well designation

Equipment Blank Collected on November 21, 1996: EB112196

Field Blank Collected on November 21, 1996: FB112196

MS/MSD: indicate on chain of custody forms under remarks

4.1.2 Sample Labeling

Sample labels will be completed by field personnel in indelible ink. If practicable, labels will include the following: project identification, sample identification, date and time of collection, sampler's initials, sample matrix, type of sample (grab or composite), analysis to be performed, and preservative(s) used.

4.2 Chain of Custody

To maintain and document sample possession, chain of custody (COC) procedures will be implemented. These procedures are necessary to insure the integrity of samples from the time of collection to data reporting. The COC protocol provides the ability to trace possession and handling of samples. A sample is considered under custody if:

- It is in a person's possession;
- It is in a person's view after being in your possession;
- It is in a person's possession and then locked up; or
- It is in a designated secure area.

Personnel collecting samples are responsible for the care and integrity of those samples until they are properly transferred or dispatched. Therefore, the number of people handling samples will be kept to a minimum.

COC records (see Appendix B) will be completed by the sampler and shall accompany the samples at all times. The following information shall be indicated on the COC record:

- Project identification;
- Signature of samplers;

- Sample identification, sample matrix, date and time of collection, grab or composite sample designation, number of containers corresponding to that sample identification, analyses required, remarks or sample location (if applicable), and preservation method(s);
- Signature of the individual relinquishing the samples; and
- Name of the individual(s) receiving the samples and air bill number, if applicable.

The COC preparer will then check the sample label and COC record for accuracy and completeness.

4.3 Sample Tracking

When transferring custody of samples, individuals relinquishing custody and individuals receiving custody will sign, date, and record the time on the COC. When samples are being shipped to the laboratory via courier or shipping company (Federal Express), the shipping company will be indicated as receiving custody. Upon receipt of shipment at the laboratory, a designated sample custodian will accept custody of the samples and verify that information on the sample labels matches the COC record. Pertinent information on shipment, air bill number, pickup, courier, date, and time will be recorded on the COC. It is then the laboratory's responsibility to maintain logbooks and custody records throughout sample preparation and analysis.

4.4 Sample Packing and Shipping

Samples for off-site laboratory analysis will be shipped via Federal Express or by courier for overnight delivery in waterproof coolers using the procedures outlined below. The samples taken for this project shall be considered low-level or environmental samples for packaging and shipping purposes. The sample packing procedures are as follows:

- After filling out the pertinent information on the sample label, cover the label with clear tape.
- Place about 3 inches of inert cushioning material, such as vermiculite or bubblepack, in the bottom of the cooler.
- Wrap the sample containers in bubblepack. Place containers upright in the cooler in such a way that they will not touch during shipment.
- Put in additional inert packing material to partially the cover sample containers (more than halfway).
- Place ice, sealed in plastic bags, around and on top of the containers. The temperature of the samples must be maintained at or below 4 °C during shipment to the laboratory.
- Fill cooler with cushioning material.
- Put COC record in a waterproof plastic bag and tape it with masking tape to the inside lid of the cooler.
- Tape the drain shut.
- Affix two signed and dated custody seals on opposite corners of the cooler so that the cooler cannot be opened without breaking the seals.
- Secure the lid by wrapping the cooler completely with nylon strapping tape or duct tape at a minimum of two locations.
- Attached completed shipping label to top of the cooler.

From the time of sample collection, samples will be stored on ice. Prior to sample shipping, a cooler temperature blank (labeled "COOLER TEMPERATURE INDICATOR") will be included in every cooler so that the temperature of the samples can be indirectly measured upon their receipt by the laboratory.

5.0 LABORATORY ANALYTICAL PROCEDURES

The anticipated number of field samples, analytical procedures, and number of QC samples are identified in Table 5-1, below. All analytical methods used for this project will be EPA approved methods, and all laboratory analyses will be performed in strict accordance with method QA/QC requirements and protocols.

**Table 5-1
Summary of Sampling Parameters, QC Requirements, and Analytical Procedures**

Sampling Parameter	Field Samples ¹	Field Duplicates ²	MS/MSD ³	Equip. Blanks ⁴	Field Blanks ⁵	Method No.	Detection Limit
PCB	5	1	1/1	na	1	SW846 8080	0.1 ppb
TSS	5	1	1/1	na	1	EPA600 160.2	4.0 ppm

- Notes:
- ¹ Represents maximum number of field samples to be analyzed per sampling round, or event
 - ² 10% of field samples
 - ³ Duplicate substituted for MS/MSD for TSS (one per event)
 - ⁴ None currently anticipated for this project due to use of dedicated sampling equipment
 - ⁵ One per event

6.0 REPORTING REQUIREMENTS

6.1 Laboratory Reporting Requirements

Laboratory reports submitted to Foster Wheeler will be in compliance with the *Navy Installation Restoration Laboratory Quality Assurance Guide* specified reporting requirements and will include, but are not limited to, the following:

- The name, address, and phone number of the analytical laboratory.
- Signature of an authorized laboratory individual, indicating the acceptability of the data.
- A copy of signed COC records, indicating the condition of samples at the time of receipt by the laboratory.
- Sample results reported in units of microgram or milligram per liter.
- Sample results will include a summary of pertinent chain of custody and tracking information (i.e., dates of preparation and analysis, analytical instrumentation, associated QC samples, etc.).
- Quality control results reported are to include spiking concentrations and acceptable limits. QC results that exceeded criteria and corrective actions should be discussed by the laboratory.

Copies of chromatograms, quantitation reports, other instrument output data, and relevant logbooks, including instrument injection logs, standard preparation logs, and sample preparation logs, must remain on file at the laboratory and be made available for review by Foster Wheeler or the Navy upon request.

6.2 Data Validation

Data validation will be performed by EA Engineering, Science, and Technology (EA) following the completion of groundwater sampling activities at Site 13. Data validation will be performed in accordance with the currently available EPA guidance document: *USEPA Region I Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses*, dated February 1, 1988, revised November 1, 1988. Discussions with EPA indicated that the more recent July 1996 guidelines have not

been released. Once available, however, all data validation will follow *Region I, EPA New England Data Validation Functional Guidelines for Evaluating Environmental Analysis*, dated July 1996.

6.3 Sampling Analysis Report

Following the completion of field activities, Foster Wheeler will submit a letter-style Sampling Analysis Report which shall include the following:

- A tabulated representation of the laboratory analytical results;
- Copies of full data packages; and
- A discussion of field investigation activities.

APPENDIX A

Low Stress (Low Flow) Standard Operating Procedure

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION I

LOW STRESS (low flow) PURGING AND SAMPLING PROCEDURE
FOR THE COLLECTION OF GROUND WATER SAMPLES
FROM MONITORING WELLS

DRAFT

I. SCOPE & APPLICATION

This standard operating procedure (SOP) provides a general framework for collecting ground water samples that are indicative of mobile organic and inorganic loads at ambient flow conditions (both the dissolved fraction and the fraction associated with mobile particulates). The SOP emphasizes the need to minimize stress by low water-level drawdowns, and low pumping rates (usually less than 1 liter/min) in order to collect samples with minimal alterations to water chemistry. This SOP is aimed primarily at sampling monitoring wells that can accept a submersible pump and have a screen, or open interval length of 10 feet or less (this is the most common situation). However, this procedure is flexible and can be used in a variety of well construction and ground-water yield situations. Samples thus obtained are suitable for analyses of ground-water contaminants (volatile and semi-volatile organic analytes, pesticides, PCBs, metals and other inorganics), or other naturally occurring analytes.

This procedure does not address the collection of samples from wells containing light or dense non-aqueous phase liquids (LNAPLs and DNAPLs). For this the reader may wish to check: Cohen, R.M. and J.W. Mercer, 1993, DNAPL Site Evaluation; C.K. Smoley (CRC Press), Boca Raton, Florida and U.S. Environmental Protection Agency, 1992, RCRA Ground-water Monitoring: Draft Technical Guidance; Washington, DC (EPA/530-R-93-001).

The screen, or open interval of the monitoring well should be optimally located (both laterally and vertically) to intercept existing contaminant plume(s) or along flowpaths of potential contaminant releases, and that the analytes of interest move (or potentially move) primarily through the more permeable zones within the screen, or open interval.

Use of trademark names does not imply endorsement by U.S.EPA but is intended only to assist in identification of a specific type of device.

Proper well construction and development cannot be overemphasized, since the use of installation techniques that are appropriate to the hydrogeologic setting often prevents "problem well" situations from occurring. It is also recommended that as part of development or redevelopment the well should be tested to determine the appropriate pumping rate to obtain stabilization of field indicator parameters with minimal drawdown in shortest amount of time. With this information field crews can then conduct purging and sampling in a more expeditious manner.

The mid-point of the saturated screen length (which should not exceed 10 feet) is used by convention as the location of the pump intake. However, significant chemical or permeability contrast(s) within the screen may require additional field work to determine the optimum vertical location(s) for the intake, and appropriate pumping rate(s) for purging and sampling more localized target zone(s). Primary flow zones ((high(er) permeability and/or high(er) chemical concentrations)) should be identified in wells with screen lengths longer than 10 feet, or in wells with open boreholes in bedrock. Targeting these zones for water sampling will help insure that the low stress procedure will not underestimate contaminant concentrations.

Stabilization of indicator field parameters is used to indicate that conditions are suitable for sampling to begin. Achievement of turbidity levels of less than 5 NTU and stable drawdowns of less than 0.3 feet, while desirable, are not mandatory. Sample collection may still take place provided the remaining criteria in this procedure are met. If after 4 hours of purging indicator field parameters have not stabilized, one of 3 optional courses of action may be taken: a) continue purging until stabilization is achieved, b) discontinue purging, do not collect any samples, record in log book that stabilization could not be achieved (documentation must describe attempts to achieve stabilization) c) discontinue purging, collect samples and provide full explanation of attempts to achieve stabilization (note: there is a risk that the analytical data obtained, especially metals and strongly hydrophobic organic analytes, may not meet the sampling objectives).

Changes to this SOP should be proposed and discussed when the site sampling and analysis plan is submitted for approval. Subsequent requests for modifications of an approved plan must include adequate technical justification for proposed changes. All changes and modifications must be approved before implementation in field.

II. EQUIPMENT

A. Extraction device

Adjustable rate, submersible pumps are preferred (for example, centrifugal or bladder pump constructed of stainless steel or Teflon).

Adjustable rate, peristaltic pumps (suction) may be used with caution. Note that EPA guidance states: "Suction pumps are not recommended because they may cause degassing, pH modification, and loss of volatile compounds" (EPA/540/P-87/001, 1987, page 8.5-11).

The use of inertial pumps is discouraged. These devices frequently causes greater disturbance during purging and sampling and are less easily controlled than the pumps listed above. This can lead to sampling results that are adversely affected by purging and sampling operations, and a higher degree of data variability.

B. Tubing

Teflon or Teflon lined polyethylene tubing are preferred when sampling is to include VOCs, SVOCs, pesticides, PCBs and inorganics.

In addition to the above, PVC, Tygon, polypropylene or polyethylene tubing may be used when collecting samples for inorganics analyses.

The use of 1/4 inch or 3/8 inch (inner diameter) tubing is preferred. This will help ensure the tubing remains liquid filled when operating at very low pumping rates.

Stainless steel tubing may be used when sampling for VOCs, SVOCs, pesticides, and PCBs. However, it should be used with caution when sampling for metals.

Pharmaceutical grade (Pharmed) tubing should be used for the section around the rotor head of a peristaltic pump, to minimize gaseous diffusion.

C. Water level measuring device(s), capable of measuring to 0.01 foot accuracy (electronic "tape", pressure transducer). Recording pressure transducers, mounted above the pump, are especially helpful in tracking water levels during pumping operations, but their use must include check measurements with a water level "tape" at the start and end of each record.

- D. Flow measurement supplies (e.g., graduated cylinder and stop watch).
- E. Interface probe, if needed.
- F. Power source (generator, nitrogen tank, etc.). If a gasoline generator is used, it must be located downwind and at least 30 feet from the well so that the exhaust fumes do not contaminate the samples.
- G. Indicator field parameter monitoring instruments - pH, Eh, dissolved oxygen (DO), turbidity, specific conductance, and temperature. Use of a flow-through-cell is required when measuring all listed parameters, except turbidity. Standards to perform field calibration of instruments. Analytical methods are listed in 40 CFR 136, 40 CFR 141, and SW-846. For Eh measurements, follow manufacturer's instructions.
- H. Decontamination supplies (for example, non-phosphate detergent, distilled/deionized water, isopropyl alcohol, etc.).
- I. Logbook(s), and other forms (for example, well purging forms).
- J. Sample Bottles.
- K. Sample preservation supplies (as required by the analytical methods).
- L. Sample tags or labels.
- M. Well construction data, location map, field data from last sampling event.
- N. Well keys.
- O. Site specific Sample and Analysis Plan/QAPP.
- P. PID or FID instrument (if appropriate) to detect VOCs for health and safety purposes, and provide qualitative field evaluations.

III. PRELIMINARY SITE ACTIVITIES

Check well for security damage or evidence of tampering, record pertinent observations.

Lay out sheet of clean polyethylene for monitoring and sampling equipment.

Remove well cap and immediately measure VOCs at the rim of the well with a PID or FID instrument and record the reading in the field logbook.

If the well casing does not have a reference point (usually a V-cut or indelible mark in the well casing), make one. Record the date of the mark in the logbook.

A synoptic water level measurement round should be performed (in the shortest possible time) before any purging and sampling activities begin. It is recommended that water level depth (to 0.01 ft.) and total well depth (to 0.1 ft.) be measured the day before, in order to allow for re-settlement of any particulates in the water column. If measurement of total well depth is not made the day before, it should not be measured until after sampling of the well is complete. All measurements must be taken from the established referenced point. Care should be taken to minimize water column disturbance.

Check newly constructed wells for the presence of LNAPLs or DNAPLs before the initial sampling round. If none are encountered, subsequent check measurements with an interface probe are usually not needed unless analytical data or field head space information signal worsening situation. Note: procedures for collection of LNAPL and DNAPL samples are not addressed in this SOP.

IV. PURGING AND SAMPLING PROCEDURE

Sampling wells in order of increasing chemical concentrations (known or anticipated) is preferred.

1. Install Pump

Lower pump, safety cable, tubing and electrical lines slowly (to minimize disturbance) into the well to the midpoint of the zone to be sampled. The Sampling and Analysis Plan should specify the sampling depth, or provide criteria for selection of intake depth for each well (see Section I). If possible keep the pump intake at least two feet above the bottom of the well, to minimize mobilization of particulates present in the bottom of the well. Collection of turbid free water samples may be especially difficult if there is two feet or less of standing water in the well.

2. Measure Water Level

Before starting pump, measure water level. If recording pressure transducer is used-initialize starting condition.

3. Purge Well

3a. Initial Low Stress Sampling Event

Start the pump at its lowest speed setting and slowly increase the speed until discharge occurs. Check water level. Adjust pump speed until there is little or no water level drawdown (less than 0.3 feet). If the minimal drawdown that can be achieved exceeds 0.3 feet but remains stable, continue purging until indicator field parameters stabilize.

Monitor and record water level and pumping rate every three to five minutes (or as appropriate) during purging. Record any pumping rate adjustments (both time and flow rate). Pumping rates should, as needed, be reduced to the minimum capabilities of the pump (for example, 0.1 - 0.4 l/min) to ensure stabilization of indicator parameters. Adjustments are best made in the first fifteen minutes of pumping in order to help minimize purging time. During pump start-up, drawdown may exceed the 0.3 feet target and then "recover" as pump flow adjustments are made. Purge volume calculations should utilize stabilized drawdown values, not the initial drawdown. Do not allow the water level to fall to the intake level (if the static water level is above the well screen, avoid lowering the water level into the screen). The final purge volume must be greater than the stabilized drawdown volume plus the extraction tubing volume.

Wells with low recharge rates may require the use of special pumps capable of attaining very low pumping rates (bladder, peristaltic), and/or the use of dedicated equipment. If the recharge rate of the well is lower than extraction rate capabilities of currently manufactured pumps and the well is essentially dewatered during purging, then the well should be sampled as soon as the water level has recovered sufficiently to collect the appropriate volume needed for all anticipated samples (ideally the intake should not be moved during this recovery period). Samples may then be collected even though the indicator field parameters have not stabilized.

3b. Subsequent Low Stress Sampling Events

After synoptic water level measurement round, check intake depth and drawdown information from previous sampling event(s) for each well. Duplicate, to the extent practicable, the intake depth and extraction rate (use final pump dial setting information) from previous

event(s). Perform purging operations as above.

4. Monitor Indicator Field Parameters

During well purging, monitor indicator field parameters (turbidity, temperature, specific conductance, pH, Eh, DO) every three to five minutes (or less frequently, if appropriate). Note: during the early phase of purging emphasis should be put on minimizing and stabilizing pumping stress, and recording those adjustments. Purging is considered complete and sampling may begin when all the above indicator field parameters have stabilized. Stabilization is considered to be achieved when three consecutive readings, taken at three (3) to five (5) minute intervals, are within the following limits:

- turbidity (10% for values greater than 1 NTU),
- DO (10%),
- specific conductance (3%),
- temperature (3%),
- pH (± 0.1 unit),
- ORP/Eh (± 10 millivolts).

All measurements, except turbidity, must be obtained using a flow-through-cell. Transparent flow-through-cells are preferred, because they allow field personnel to watch for particulate build-up within the cell. This build-up may affect indicator field parameter values measured within the cell and may also cause an underestimation of turbidity values measured after the cell. If the cell needs to be cleaned during purging operations, continue pumping and disconnect cell for cleaning, then reconnect after cleaning and continue monitoring activities.

The flow-through-cell must be designed in a way that prevents air bubble entrapment in the cell. When the pump is turned off or cycled on/off (when using a bladder pump), water in the cell must not drain out. Monitoring probes must be submerged in water at all times. If two flow-through-cells are used in series, the one containing the dissolved oxygen probe should come first (this parameter is most susceptible to error if air leaks into the system).

5. Collect Water Samples

Water samples for laboratory analyses must be collected before water has passed through the flow-through-cell (use a by-pass assembly or disconnect cell to obtain sample).

VOC samples should be collected first and directly into pre-preserved

sample containers. Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

During purging and sampling, the tubing should remain filled with water so as to minimize possible changes in water chemistry upon contact with the atmosphere. It is recommended that 1/4 inch or 3/8 inch (inside diameter) tubing be used to help insure that the sample tubing remains water filled. If the pump tubing is not completely filled to the sampling point, use one of the following procedures to collect samples: (1) add clamp, connector (Teflon or stainless steel) or valve to constrict sampling end of tubing; (2) insert small diameter Teflon tubing into water filled portion of pump tubing allowing the end to protrude beyond the end of the pump tubing, collect sample from small diameter tubing; (3) collect non-VOC samples first, then increase flow rate slightly until the water completely fills the tubing, collect sample and record new drawdown, flow rate and new indicator field parameter values.

Add preservative, as required by analytical methods, to samples immediately after they are collected if the sample containers are not pre-preserved. Check analytical methods (e.g. EPA SW-846, water supply, etc.) for additional information on preservation. Check pH for all samples requiring pH adjustment to assure proper pH value. For VOC samples, this will require that a test sample be collected during purging to determine the amount of preservative that needs to be added to the sample containers prior to sampling.

If determination of filtered metal concentrations is a sampling objective, collect filtered water samples using the same low flow procedures. The use of an in-line filter is required, and the filter size (0.45 um is commonly used) should be based on the sampling objective. Pre-rinse the filter with approximately 25 - 50 ml of groundwater prior to sample collection. Preserve filtered water sample immediately. Note: filtered water samples are not an acceptable substitute for unfiltered samples when the monitoring objective is to obtain chemical concentrations of total mobile contaminants in ground water for human health risk calculations.

Label each sample as collected. Samples requiring cooling (volatile organics, cyanide, etc.) will be placed into a cooler with ice or refrigerant for delivery to the laboratory. Metal samples after acidification to a pH less than 2 do not need to be cooled.

6. Post Sampling Activities

If recording pressure transducer is used, remeasure water level with

tape. Measure and record well depth (to 0.1ft), if not measured along with water level on the day prior to start up of purging operations. Note: measurement of total well depth is optional after the initial low stress sampling event. However, it is recommended if the well has a "silting" problem or if confirmation of well identity is needed.

After collection of the samples, the pump tubing may either be dedicated to the well for resampling (by hanging the tubing inside the well), decontaminated, or properly discarded.

Before securing the well, measure and record the well depth (to 0.1 ft.), if not measured the day before purging began.

Secure the well.

V. DECONTAMINATION

Decontaminate sampling equipment prior to use in the first well and following sampling of each subsequent well. Pumps will not be removed between purging and sampling operations. The pump and tubing (including support cable and electrical wires which are in contact with the well) will be decontaminated by one of the procedures listed below.

Procedure 1

The decontaminating solutions can be pumped from either buckets or short PVC casing sections through the pump or the pump can be disassembled and flushed with the decontaminating solutions. It is recommended that detergent and isopropyl alcohol be used sparingly in the decontamination process and water flushing steps be extended to ensure that any sediment trapped in the pump is removed. The pump exterior and electrical wires must be rinsed with the decontaminating solutions, as well. The procedure is as follows:

Flush the equipment/pump with potable water.

Flush with non-phosphate detergent solution. If the solution is recycled, the solution must be changed periodically.

Flush with potable or distilled/deionized water to remove all of the detergent solution. If the water is recycled, the water must be changed periodically.

Flush with isopropyl alcohol (pesticide grade). If equipment blank data from the previous sampling event show that the level of

contaminants is insignificant, then this step may be skipped.

Flush with distilled/deionized water. The final water rinse must not be recycled.

Procedure 2

Steam clean the outside of the submersible pump.

Pump hot potable water from the steam cleaner through the inside of the pump. This can be accomplished by placing the pump inside a three or four inch diameter PVC pipe with end cap. Hot water from the steam cleaner jet will be directed inside the PVC pipe and the pump exterior will be cleaned. The hot water from the steam cleaner will then be pumped from the PVC pipe through the pump and collected into another container. Note: additives or solutions should not be added to the steam cleaner.

Pump non-phosphate detergent solution through the inside of the pump. If the solution is recycled, the solution must be changed periodically.

Pump potable water through the inside of the pump to remove all of the detergent solution. If the solution is recycled, the solution must be changed periodically.

Pump distilled/deionized water through the pump. The final water rinse must not be recycled.

VI. FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not compromised the quality of the ground water samples. All field quality control samples must be prepared the same as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples shall be collected for each batch of samples (a batch may not exceed 20 samples). Trip blanks are required for the VOC samples at a frequency of one set per VOC sample cooler.

Field duplicate.

Matrix spike.

Matrix spike duplicate.

Equipment blank.

Trip blank (VOCs).

Temperature blank (one per sample cooler).

Equipment blank shall include the pump and the pump's tubing. If tubing is dedicated to the well, the equipment blank will only include the pump in subsequent sampling rounds.

Collect samples in order from wells with lowest contaminant concentration to highest concentration. Collect equipment blanks after sampling from contaminated wells and not after background wells.

Field duplicates are collected to determine precision of sampling procedure. For this procedure, collect duplicate for each analyte group in consecutive order (VOC original, VOC duplicate, SVOC original, SVOC duplicate, etc.).

If split samples are to be collected, collect split for each analyte group in consecutive order (VOC original, VOC split, etc.). Split sample should be as identical as possible to original sample.

All monitoring instrumentation shall be operated in accordance with EPA analytical methods and manufacturer's operating instructions. EPA analytical methods are listed in 40 CFR 136, 40 CFR 141, and SW-846 with exception of Eh, for which the manufacturer's instructions are to be followed. Instruments shall be calibrated at the beginning of each day. If a measurement falls outside the calibration range, the instrument should be re-calibrated so that all measurements fall within the calibration range. At the end of each day, check calibration to verify that instruments remained in calibration. Temperature measuring equipment, thermometers and thermistors, need not be calibrated to the above frequency. They should be checked for accuracy prior to field use according to EPA Methods and the manufacturer's instructions.

VII. FIELD LOGBOOK

A field log shall be kept to document all ground water field monitoring activities (see attached example matrix), and record all of the following:

Well identification.

Well depth, and measurement technique.

Static water level depth, date, time and measurement technique.

Presence and thickness of immiscible liquid (NAPL) layers and detection method.

Pumping rate, drawdown, indicator parameters values, and clock time, at the appropriate time intervals; calculated or measured total volume pumped.

Well sampling sequence and time of each sample collection.

Types of sample bottles used and sample identification numbers.

Preservatives used.

Parameters requested for analysis.

Field observations during sampling event.

Name of sample collector(s).

Weather conditions.

QA/QC data for field instruments.

Any problems encountered should be highlighted.

Description of all sampling equipment used, including trade names, model number, diameters, material composition, etc.

VIII. DATA REPORT

Data reports are to include laboratory analytical results, QA/QC information, and whatever field logbook information is needed to allow for a full evaluation of data useability.

APPENDIX B

Chain of Custody Record

