



FINAL PHASE I RCRA FACILITY INVESTIGATION WORK PLAN SWMU 67 - FORMER GAS STATION



***For* NAVAL ACTIVITY PUERTO RICO
EPA I.D. No. PR2170027203
CEIBA, PUERTO RICO**



Prepared for:

**Department of the Navy
NAVFAC SOUTHEAST**
North Charleston, South Carolina



Prepared by:

Baker

Michael Baker Jr., Inc.
Moon Township, PA

Contract No. N62470-07-D-0502
DO 0002

December 20, 2007

**IQC for A/E Services for Multi-Media Environmental Compliance
Engineering Support**

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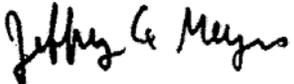
**DEPARTMENT OF THE NAVY
NAVFAC SOUTHEAST
*North Charleston, South Carolina***

**Contract N62470-07-D-0502
Delivery Order 0002**

Prepared by:

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I certify under penalty of law that I have examined and am familiar with the information submitted in this document and all attachments and that this document and its attachments were prepared either by me personally or under my direction or supervision in a manner designed to ensure that qualified and knowledgeable personnel properly gather and present the information contained therein. I further certify, based on my personal knowledge or on my inquiry of those individuals immediately responsible for obtaining the information, that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowingly and willfully submitting a materially false statement.

Signature  _____

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Title: BRAC Env. Coordinator

Date: December 20, 2007

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LIST OF ACRONYMS AND ABBREVIATIONS

APA	Aerial Photo Analysis
Baker	Baker Environmental, Inc.
bgs	below ground surface
BRAC	Base Realignment and Closure
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CERFA	Community Environmental Response Facilitation Act
DI	Deionized
DO	Delivery Order
DPT	Direct Push Technology
DRO	Diesel Range Organics
Eco-SSL	Ecological Soil Screening Level
ECP	Environmental Condition of Property
EPA	Environmental Protection Agency
ERA	Ecological Risk Assessment
FID	Flame Ionization Detector
FMTUD	Facility Management Transportation and Utility Division
GIS	Geographic Information System
GPS	Global Positioning System
GRO	Gasoline Range Organics
HSA	Hollow-Stem Auger
ID	Internal Diameter
IDW	Investigation Derived Waste
LANTDIV	Naval Facilities Engineering Command Atlantic Division
MCL	Maximum Contaminant Level
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NAPR	Naval Activity Puerto Rico
NAVFAC	Naval Facilities Engineering Command
NFESC	Naval Facilities Engineering Service Center
NSRR	Naval Station Roosevelt Roads
NTR	Navy Technical Representative
PI	Photo Identified
PID	Photoionization Detector
PMO	Program Management Office
PRG	Preliminary Remediation Goals
PR LRA	Puerto Rico Local Reuse Authority
PVC	polyvinyl chloride

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RBC	Risk Based Concentration
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SE	Southeast
SOP	Standard Operating Procedure
SVOC	Semivolatile Organic Compounds
SWMU	Solid Waste Management Unit
TPH	Total Petroleum Hydrocarbons
UCL	Upper Confidence Limit of the mean
UST	Underground Storage Tank
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

1.0 INTRODUCTION

This document describes the activities required for the implementation of a Phase I Resource Conservation Recovery Act (RCRA) Facility Investigation (RFI) at Solid Waste Management Unit (SWMU) 67 –Former Gas Station located at Naval Activity Puerto Rico (NAPR), formerly Naval Station Roosevelt Roads (NSRR), located in Ceiba, Puerto Rico.

This work plan has been prepared by Michael Baker Jr., Inc. (Baker), for the Navy Base Realignment and Closure (BRAC) Program Management Office (PMO) Southeast (SE) office under contract with the Naval Facilities Engineering Command (NAVFAC), SE (Contract Number N62470-07-D-0502, Delivery Order [DO] 0002).

1.1 NAPR Description and History

NAPR occupies over 8,800 acres on the northern side of the east coast of Puerto Rico (see Figure 1-1), along Vieques Passage with Vieques Island lying to the east about 10 miles off the harbor entrance. NAPR also occupies the immediately adjacent islands of Piñeros and Cabeza de Perro, as presented on Figure 1-2. The northern entrance to NAPR is about 35 miles east along the coast road (Route 3) from San Juan. The property consists of 3,938 acres of upland (developable) property and 4,955 acres of environmentally sensitive areas including wetlands, mangrove, and wildlife habitat. The closest large town is Fajardo (population approximately 37,000), which is about 5 miles north of NAPR off Route 3. Ceiba (population approximately 17,000) adjoins the west boundary of NAPR (see Figure 1-1).

The facility was commissioned in 1943 as a Naval Operations Base, and finally re-designated a Naval Station in 1957. NSRR operated as a Naval Station from 1957 until March 31, 2004. NSRR has undergone operational closure as of March 31, 2004 and has been designated as Naval Activity Puerto Rico. NAPR will continue until the real estate disposal/transfer is completed. The mission of NAPR is to protect the physical assets remaining, comply with environmental regulations, and sustain the value of the property until final disposal of the property.

In anticipation of operational closure of NSRR, the Naval Facilities Engineering Command, Atlantic Division (LANTDIV) prepared Phase I/Phase II Environmental Condition of Property (ECP) Reports to document the environmental condition of NSRR. Section 8132 of fiscal year 2004 Defense Appropriations Act, signed into law on September 30, 2003, directed that NSRR be disestablished within 6 months, and that the real estate disposal/transfer be carried out in accordance with procedures contained in the BRAC Act of 1990. This legislation requires that the base closure be conducted in accordance with the Comprehensive Environmental Response Compensation and Liability Act (CERCLA), as amended by the Community Environmental Response Facilitation Act (CERFA).

The Draft Phase I ECP Report dated March 31, 2004 (LANTDIV, 2004) identified new sites at NAPR based on the results of a review of records, an analysis of historic aerial photographs, physical site inspections, and interviews with persons familiar with past and current operations and activities. The new ECP sites had not been previously identified or investigated under existing environmental program areas. A Phase II ECP field investigation was conducted in April 2004 to conduct environmental sampling to determine if a release/disposal actually occurred at any of the Phase I ECP sites recommended for further evaluation in the Phase I ECP and, if so, whether any potential risk to human health was present. The Final Phase I/II ECP Report recommended additional sampling (to be undertaken as part of the RCRA Program) at several sites to permit a more detailed assessment (NAVFAC Atlantic, 2005).

The United States Environmental Protection Agency (USEPA) issued a RCRA 7003 Administrative Order on consent (Environmental Protection Agency [EPA] Docket No. RCRA-02-2007-7301) identifying SWMU 67 (formerly referred to as ECP 13) as having documented releases of solid and/or hazardous waste and hazardous constituents, and requires the submittal to the USEPA for their approval an acceptable work plan to complete the equivalent of a Phase I RFI investigation. Following a public comment period the Consent Order became effective on January 29, 2007. This document meets the requirement for a phase I RFI workplan.

1.2 Site Location and History

This site is located on the east side of Langley Drive north of the tennis courts in a predominantly level area covered with secondary growth vegetation as shown on Figure 1-2. The aerial photo analysis (APA) identified this area as photo identified (PI) Site 18, due to the observation of a small building that could potentially be consistent with a gas station in 1958 (shown as a rectangle on Figure 1-3). Although the records review (historic maps) identified the structure as a gas station, no records were available to determine locations of fuel storage tanks. Interviews were also conducted which confirmed the former use as a gas station; however, possible locations of fuel storage tanks remained unknown. During the physical site inspection, a building foundation was observed, but there was no evidence of underground storage tanks (USTs).

Initially, a Phase I ECP was conducted in which various sites with certain environmental conditions were identified and recommended for further evaluation (including SWMU 67 – Former Gas Station). Therefore, a Phase II ECP was conducted and finalized in April 2004 to determine whether or not the environment has been impacted by past operations at NAPR. The sampling locations from this investigation are shown on Figure 1-4. The SWMU boundary shown on this figure was the original ECP investigation boundary. The 1958 polygon features have also been overlaid onto this figure for reference. Details of the results from this investigation are discussed in Section 2.2.

During the Phase II ECP investigation, a concrete pad and building foundation mentioned above were observed north of the tennis courts within the secondary growth vegetation. The building foundation contained an area where suspected previous vehicle maintenance was performed. The suspected vehicle maintenance was performed in a service bay accessed by a ladder. After thoroughly searching the area, no USTs were identified and there were no signs of stressed vegetation. A down-gradient storm water drainage swale (i.e., the 1958 drainage feature with flow direction shown on Figure 1-3) was observed north of the building structure.

In an effort to gather additional site data and document any significant changes that may have occurred after the Phase II ECP investigation, the area was visited on Tuesday, May 22, 2007 upon completion of ecological field work at a separate SWMU nearby. A brief walkthrough was conducted and multiple photographs (see Appendix A) were taken which confirmed the concrete pad, storm water drainage swale and overall vegetative cover mentioned above. However, the building foundation was not identified. No significant changes to the site were observed.

1.3 Objectives

The purpose of this work plan is to describe the activities necessary to obtain the data to further characterize the impacts to the environment due to past operations at SWMU 67. A Phase I RFI is required as outlined in the NAPR RCRA 7003 Order issued by the USEPA Region II. Therefore, this RCRA Order provides for the development of a work plan, field investigation, and reporting on the findings of the investigation, with recommendations of follow-up actions necessary to ensure protection of human health and the environment.

The site of the former gas station is associated with a drainage ditch/swale. Fluids associated with the former gas station operations may have discharged to this drainage ditch that eventually terminates within a freshwater wetland unit. Because this E2SS3 wetland unit represents a potential exposure point where ecological receptors could contact affected media (i.e, surface water and sediment),... The sampling and analysis program proposed within this work plan will involve the collection and analysis of drainage ditch soil samples. Analytical data for the soil samples will be used to determine if the drainage ditch represents a potential transport pathway for the migration of chemicals associated with the former gas station to the E2SS3 wetland unit.

The area of SWMU 67 is shown on Figure 1-4. The objectives of the investigation to be performed at SWMU 67 are outlined below.

An investigation consisting of the collection of soil and groundwater samples will be performed at SWMU 67 to further characterize impacts to the environment. A surface and subsurface soil sampling program is proposed to further characterize and delineate volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and total petroleum hydrocarbons (TPH) / diesel range organics (DRO) and gasoline range organics (GRO). The groundwater sampling program is proposed to further characterize VOCs and both TPH DRO, and TPH GRO that were detected during the Phase II ECP investigation.

1.4 Organization of the Work Plan

This work plan is organized into seven sections. Section 1.0 of this document includes the site history and objectives of this RFI. Section 2.0 provides a description of the current conditions and usage of the site, as well as a summary of previous investigations. Section 3.0 provides a description of the scope of investigations for the upcoming field work. The proposed scope of investigations include soil sampling and analysis program, permanent monitoring well installation program, groundwater sampling and analysis program, and quality assurance/quality control (QA/QC) samples, as well as other investigation considerations. The reporting activities that will be conducted following the completion of the field investigation are described in Section 4.0. Section 5.0 discusses the proposed project schedule that will be followed for this Phase I RFI investigation. The site management structure that will be utilized during this investigation, including project team responsibilities and field reporting requirements, is presented in Section 6.0, while Section 7.0 presents the report references.

2.0 SITE BACKGROUND AND CURRENT CONDITIONS

The following sections provide a discussion of the current conditions that exist at SWMU 67 along with any previous investigations that may have been conducted.

2.1 Current Site Conditions/Usage

This former gas station is no longer utilized and previous site investigations identified a concrete pad and remnants of an existing foundation. Tennis courts are located immediately adjacent (south of) the area. The small grassy areas surrounding the perimeter of the tennis courts and along-side Langley Drive are routinely mowed. A culvert is also located adjacent to the tennis courts and parallels Langley Drive that captures roadway runoff during local precipitation events. The culvert outlet diverts drainage (north) to a small swale which eventually drains to the Estuarine Intertidal Scrub Shrub Broad Leaved Evergreen system (E2SS3).

2.2 Previous Investigations

As reported in the Final Phase I/II ECP report, three subsurface soil samples were collected from this site. In the subsurface soil, three VOCs, three SVOCs and TPH DRO were detected and quantified at estimated concentrations. Twelve inorganic compounds were also quantified in the subsurface soil. Location 13E-SB03 contained the highest concentrations of VOCs and DRO compounds, with the exception of acetone, which was found at a slightly higher concentration at location 13E-SB02. Location 13E-SB01 contained the highest concentrations of SVOCs, while some SVOCs were also found at location 13E-SB02. In addition, groundwater environmental samples indicated that two VOCs and both TPH DRO and GRO were present in low concentrations. Previous sampling locations from the Phase I/II ECP investigation (13E-SB01 through 13E-SB03) are shown on Figure 1-4.

Dibenzo(a,h)anthracene was found in soil at a concentration exceeding the USEPA Region III Residential Risk Based concentration (RBC) at location 13E-SB01. Arsenic at 13E-SB02, and chromium at 13E-SB03, exceeded their USEPA Region III Residential RBCs. Vanadium concentrations in soil at all locations exceeded their USEPA Region III Residential RBCs. However, none of these metals was found in excess of twice the average detected background concentrations that were used for screening purposes for soil at NAPR during the ECP. Mercury and vanadium were also detected in groundwater exceeding their USEPA Region III Tap Water RBCs. High naturally occurring vanadium in soil has likely contributed to the elevated vanadium concentration in groundwater.

In general, the organic compounds detected at this site were typical of those associated with fuel and solvent use. The inorganic compounds found in soil were associated with background levels at NAPR. Some dissolution of these compounds from the soil matrix is expected to have results in the concentrations found in the groundwater.

Based on the detections of dibenzo(a,h)anthracene in soil, TPH DRO in soil and groundwater, the GRO in groundwater, and exceedance of criteria for dibenzo(a,h)anthracene in soil, it is concluded that this site has been impacted by previous activities at NAPR. Please refer to the tables located in Appendix B that summarize the organic and inorganic detections in subsurface soil and groundwater.

3.0 SCOPE OF INVESTIGATION

Sampling locations presented in this section were identified based on the historical aerial photograph from 1958 and ECP investigation results. Consideration was given to site topography, site features and historical operational features of the facility. Furthermore, it is anticipated that the sampling locations depicted on Figure 3-1 will ultimately provide a better understanding of groundwater flow direction necessary to assess the potential migration of any detected compounds (i.e., VOCs, SVOCs and TPH DRO and GRO as previously detected in the ECP investigation).

A summary of the sampling and analytical program for this investigation is provided in Table 3-1. The proposed sampling locations for SWMU 67 are shown on Figure 3-1. The various investigation elements are described in detail in the subsections that follow.

SWMU 67 – Former Gas Station

- Five surface soil samples will be collected from the drainage swale leading from the historic site towards the estuarine wetland (E2SS3)
- Eight surface soil samples will be collected from eight boring locations.
- Sixteen subsurface soil samples will be collected from eight boring locations. A minimum of two samples will be collected from different depths at each boring location. One sample will be collected from any area of suspected contamination and the other will be obtained just above the groundwater interface. If suspected contamination is noticed in multiple samples, additional samples will be obtained from the boring location.
- Eight groundwater samples will be collected from permanent monitoring wells installed at the same locations as the soil borings.

3.1 Soil Sampling and Analysis Program

Surface and subsurface soil samples will be collected from SWMU 67. The following outlines the specific sampling protocol.

Figure 3-1 identifies the locations of the five surface soil samples from the drainage swale as well as the eight soil borings that will be advanced at SWMU 67 pertaining to this RFI and previous sample locations advanced as a result of the Phase II ECP. Three soil boring locations (67-SB01 to 67-SB03) are north of the tennis courts in the immediate vicinity of the former gas station. The remaining five boring locations encircle the tennis courts: 67-SB04 is immediately north of the tennis courts; 67-SB05 is northeast and 67-SB06 is east of the courts; 67-SB-07 is south and 67-SB08 is west of the tennis courts and Langley Drive.

One surface soil sample (0 to 1 foot below ground surface [bgs]) and a minimum of two subsurface soil samples [based on flame ionization detector (FID), photo ionization detector (PID), olfactory and visual screening just above the water table interface] will be collected from each boring location (see SOP F102 in Baker, 1995). All the surface and subsurface soil samples will be analyzed for Appendix IX VOCs, SVOCs, metals, TPH GRO and TPH DRO, as presented in Table 3-1.

All soil sampling locations will be flagged in the field and will be surveyed for horizontal location utilizing a portable GPS unit.

The surface soil samples will be obtained from a depth of 0 to 1 foot bgs with a stainless steel spoon (see SOP F102 in Baker, 1995). The subsurface soil samples will be obtained using split-spoon samplers during boring advancement for monitoring well installation (see SOP F102 in Baker, 1995).

The soil boring samples will be labeled consecutively (beginning with 67SB01) in a manner consistent with previous sample designations at NAPR. Extensions to the sample identification will reflect the depth at which the sample was obtained. For the purposes of this work plan, two-foot discrete depths will be used. Sample identification extensions will follow the pattern shown below.

67SB01-00 — SMWU 67 Sample
67SB01-00 — Soil Boring Sample
67SB01-00 — Soil boring location identifier
67SB01-00 — 0 to 1 foot bgs (surface soil) sampling interval

Subsurface soil samples will be designated as follows:

67SB01-01 — First subsurface sampling interval, 1-3 feet bgs
67SB01-02 — Second subsurface sampling interval, 3-5 feet bgs, and so on.

Sample identification extensions will follow the pattern shown above. However, the actual sample depth will be determined in the field. In addition, a boring log will be prepared indicating, blow counts, lithology, water occurrence, FID/PID measurement and miscellaneous (visual and olfactory) observations.

Samples will be packed in ice and shipped next day air to the “fixed base” laboratory. Because of previously encountered delays associated with sample shipments from Puerto Rico to the United States, additional insurance to cover re-sampling costs should be claimed on the bill of lading. At least one member of the field team will remain on the island until verification by the laboratory of receipt of all shipments. This will minimize any potential re-sampling costs associated with mobilization. Tracking numbers for each shipment will be forwarded to the project manager for assisting in verification of receipt.

All analysis at the laboratory will be performed using current methodologies as presented in Table 3-2. All analytical work conducted on the mainland of the United States of America must be certified by a Puerto Rico licensed chemist. The specific laboratory and third party validator, as well as a certified licensed chemist from Puerto Rico, will be determined at a later date. Standard Operating Procedures (SOPs) used by the analytical laboratory will be requested from the laboratory after selection.

3.2 Monitoring Well Installation Program

A total of eight permanent monitoring wells will be installed at each of the soil boring locations at SWMU 67. The locations of these monitoring wells (located at 67-SB01 through 67-SB08) are presented on Figure 3-1. Monitoring wells at 67-SB01 through 67-SB05 are proposed in the vicinity of the former gas station, whereas the wells at 67-SB06 through 67-SB08 are proposed in a downgradient direction, which is assumed to be generally southward towards the nearest shoreline to the ocean.

Hollow-stem augers (HSAs) or air rotary techniques will be used to advance the boreholes (see SOP F102 in Baker, 1995), depending on the underlying stratigraphy. The wells will be constructed of 2-inch ID, Schedule 40 PVC, with flush joint threads. Well screens will be 10-feet long and installed to

straddle the water table (estimated at 15 feet below the ground surface). The following provides an outline of the well installation activities:

- Soil sampling will be conducted in order to classify the soil during well installation. Upon completion of soil sampling, the borehole will be reamed as necessary to the desired depth using the prescribed drilling method. The well construction materials will be installed through the HSAs, casing, or in an open borehole.
- The well screen and bottom cap will be set at the bottom of the borehole. The screen will be connected to threaded, flush-joint, riser. An expandable, water tight locking cap or slip-cap with a vent hole will be placed at the top of the casing.
- The annular space around the well screen will be backfilled with a well-graded, fine to medium sand as the HSAs or casing are being withdrawn from the borehole. The sand will extend to approximately 2 feet above the top of the screened interval. The thickness of the sand above the screened interval may be reduced if the well is too shallow to allow for placement of adequate sealing material.
- An approximate 2-foot thick sodium bentonite seal (minimum of 6 inches for very shallow wells) will be placed above the sand pack. If bentonite pellets or chips are used, they will be sized appropriately given the well and borehole diameter and placed in a careful manner that will prevent bridging. The bentonite will be hydrated with potable water, as necessary.
- The annular space above the bentonite seal will be backfilled with cement/bentonite grout to prevent surface and near subsurface water from infiltrating into the screened groundwater monitoring zone. The grout will consist of five to ten percent (by dry weight) of bentonite powder and seven gallons of potable water per 94-pound bag of portland cement. For very shallow wells, the cement/bentonite grout may be omitted.
- The depth intervals of all backfilled materials will be measured with a weighted measuring tape to the nearest 0.1-foot and recorded in the field logbook.
- The entire site area is heavily vegetated; therefore the wells will be provided with 2 to 3 feet of "stickup" above ground surface. Steel protective casing will be placed over the riser and surrounded by a concrete pad. The pad will be a minimum of 2 feet by 2 feet (length x width) and 6 inches in thickness (with 2 inches set into the ground outside the casing), and extending 2 feet bgs inside the annular space around the well. If water table conditions prevent having a 24-inch thick bentonite seal, the concrete pad depth in the annular space around the well may be decreased. Steel bollards will be installed around the concrete pad as additional protection and painted a bright color to aid in visibility.
- All wells will have a locking cap installed on the PVC riser or protective steel casing.

In the event of shallow refusal or other reason for relocating a monitoring well location, the borehole will be abandoned by backfilling with the drill cuttings to the extent practicable, in order to minimize the burden of waste disposal. The surface of the borehole will then be patched with bentonite grout.

Each new permanent monitor well will be developed using pumping and surging methods (see SOP F103 in Baker, 1995) after allowing suitable time for the cement/bentonite grout to cure (typically a minimum of 24 hours). The purpose of well development is to restore the permeability of the formation which may have been reduced by the drilling operations and to remove fine-grained

materials that may have entered/accumulated in the well or filter pack. The wells will be developed until the discharged water runs relatively clear of fine-grained materials. It should be noted that the water in some wells does not clear with continued development. Typical limits placed on well development may include any one or a combination of the following:

- Clarity of water based on visual determination
- A maximum time period (typically two hours for shallow wells)
- A maximum borehole volume (typically three to five borehole volumes plus the amount of any water added during the drilling or installation process)
- Stability of pH, specific conductance, and temperature measurements (typically less than 10 percent change between three successive measurements)
- Clarity based on turbidity measurements [typically less than 20 Nephelometric Turbidity Units (NTU)]

A record of the well development will be completed to document the development process.

Each well boring will be sampled and logged as described in Section 3.1. Permanent monitoring well locations will be assigned the same number as the associated boring. For example, a permanent monitoring well installed at boring location 67-SB01 will be assigned as 67-GW01.

3.3 Groundwater Sampling and Analysis Program

The groundwater sampling will be used to aid in characterization of the groundwater potentially affected by activities associated with SWMU 67. Eight groundwater samples will be collected from each of the eight monitoring wells. Each sample will be analyzed for Appendix IX VOCs, SVOCs and total and dissolved metals, and TPH DRO and GRO (refer to Table 3-1). Groundwater samples collected from permanent monitoring wells installed at 67-SB01 through 67-SB08 will be designated as 67-GW01 through 67-GW08, respectively.

The groundwater will be sampled using a low flow sampling technique to the extent practicable, in view of the slow recharge experienced at several NAPR sites. Appendix C includes a detailed description of low flow sampling technique. Field parameters of pH, temperature, turbidity, conductivity, dissolved oxygen, and oxidation-reduction potential will be obtained with appropriate instrumentation during sampling of the monitoring wells if an adequate volume of groundwater is present. Prior to sampling, a synoptic set of static water levels will also be recorded in order to obtain data to more accurately interpret the groundwater flow direction at the SWMU,

Samples will be packed in ice and shipped next day air to the “fixed base” laboratory. Because of previously encountered delays associated with sample shipments from Puerto Rico to the United States, additional insurance to cover re-sampling costs should be claimed on the bill of lading. At least one member of the field team will remain on the island until verification by the laboratory of receipt of all shipments. This will minimize any potential re-sampling costs associated with mobilization. Tracking numbers for each shipment will be forwarded to the Project Manager for assisting in verification of receipt.

All analyses at the laboratory will be performed using current methodologies as presented in Table 3-2. All analytical work conducted on the mainland of the United States of America must be certified by a Puerto Rico licensed chemist. The specific laboratory and validator, as well as a certified licensed chemist from Puerto Rico, will be determined at a later date.

3.4 Quality Assurance/Quality Control Samples

Field specific quality assurance/quality control (QA/QC) procedures are given below. QA/QC samples will be analyzed for parameters as shown in Table 3-3 by methods presented in Table 3-2.

QA/QC samples will be obtained during this investigation. These will include the collection of equipment rinsate samples, field blanks, trip blanks, field duplicates, and matrix spike/matrix spike duplicate (MS/MSD).

Equipment rinsate blanks will be collected daily from reusable (non-dedicated and non-disposable) sampling equipment during the sampling event. Initially, samples from every other day should be analyzed. If analytes pertinent to the project are detected in any equipment rinsate blank, the remaining rinsate blanks will be analyzed. As an added level of QA/QC, a rinsate blank will also be collected from each batch of disposable sampling tools such as stainless steel spoons, Macro Core liners, groundwater sample tubing, etc. The results from the blanks will be used to verify that the decontamination of reusable equipment had rendered them free of cross-contaminating chemicals at levels of concern for the site; and to verify that disposable sampling tools were free of contaminants at levels of concern for the site. This comparison is made during data validation, and the equipment rinsate blank is analyzed for the same parameters as the related samples. One equipment rinsate will be collected per day of field sampling.

Field blank samples will consist of lab grade deionized water (DI), store-bought distilled water, and NAPR potable water if they are used during this investigation.

Trip blank samples will be required to accompany the samples to the laboratory for volatile organic constituent and TPH-GRO samples scheduled for analysis. One trip blank sample will accompany each cooler containing samples of the afore-mentioned analyses.

Soil sample field duplicates will be homogenized and split and collected at a frequency of ten percent per media. Groundwater duplicates will be collected at a frequency of ten percent, and will include at least one total and one filtered groundwater sample.

Analysis of duplicate and blanks associated with soil and groundwater sampling will include Appendix IX VOCs, SVOCs, metals and TPH DRO and GRO.

MS/MSD samples 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 (e.g., surface soil). MS/MSD samples will be collected at a frequency of five percent per media. Please refer to Table 3-3 which summarizes the QA/QC sampling and analytical program.

3.5 Data Validation

All mainland laboratory data generated by the investigation will be subjected to independent, third party, validation. The USEPA Region II Data Validation Standard Operating Procedures will be followed. The specific data validator will be determined at a later date.

3.6 Other Field Activities

During the investigation, the following activities will be performed:

- Utility Clearance
- Investigation Derived Waste (IDW) Management

- Decontamination
- Surveying
- Health and Safety Procedures
- Chain of Custody

3.6.1 Utility Clearance

If this work plan is initiated while NAPR is still under operation, the following procedure must be followed to obtain utility clearance. Fifteen days prior to the initiation of the proposed fieldwork, a digging permit request will be submitted to the Facility Management Transportation and Utility Division (FMTUD) of the Public Works Department at NAPR. Utilities are identified on the Geographic Information System (GIS) utility layer, and all proposed soil borings and monitoring well locations will be cleared by the base utility department.

3.6.2 Investigation Derived Wastes

The generation of IDW associated with soil sampling and monitoring well installation, including soil cuttings and decontamination fluids, will be collected and stored temporarily in 55-gallon drums. However, the soil cuttings from any abandoned boreholes, will be placed back into the boring from which they came, unless gross visible contamination is present. As much as possible, soils last out of the hole will be returned first, thereby maintaining the original stratigraphy.

Two IDW samples will be collected during this investigation. One composite aqueous sample will be collected from all drums containing decontamination fluid (from sampling equipment and drill rig), and one composite soil sample will be collected from all drums containing drill cuttings. The samples will be analyzed for parameters as shown in Table 3-3 by methods presented in Table 3-2. These samples will provide the necessary data to be able to dispose of the generated IDW at an appropriate disposal facility. Upon completion of the field program, the drums will be moved and stored at a secure location. The soil and water IDW will be removed and disposed of from the site by an approved vendor upon receipt and review of the IDW sample analytical data.

3.6.3 Decontamination

All reusable (non-dedicated and non-disposable) soil sampling equipment (i.e. augers, bits,, etc.), will be decontaminated between each sampling location in accordance SOPs F501 and F502 (Baker, 1995). The drill rig will be decontaminated before arriving at the site and before leaving the site. The remaining contaminant-free sampling equipment and materials utilized during this investigation will be disposable.

3.6.4 Surveying

All sampling locations will be surveyed. Traditional survey equipment or survey grade global positioning system (GPS) unit will be utilized to obtain vertical (+/- 0.01 foot) and horizontal (+/- 0.1 foot) locations and top of PVC elevations of the monitoring wells for generating groundwater contours used for reporting purposes.

3.6.5 Health and Safety Procedures

The health and safety procedures previously presented in the RFI Management Plans (Baker, 1995) will be employed during this investigation.

3.6.6 Chain-of-Custody

Chain-of-Custody procedures will be followed to ensure a documented, traceable link between measurement results and the sample/parameter that they represent. These procedures are intended to provide a legally acceptable record of sample preparation, storage, and analysis.

To track sample custody transfers before ultimate disposition, sample custody will be documented using a similar chain-of-custody form as presented in the RFI Management Plans (Baker, 1995). A chain-of-custody form will be completed for each shipment in which the samples are shipped. After the samples are properly packaged, the shipping container will be sealed and prepared for shipment to the analytical laboratory.

4.0 REPORTING

This section outlines the reporting activities that are associated with the field investigation. The reports shall include at a minimum:

- Introduction and Site Background
- SWMU Investigation
- Physical Characteristics of Study Area
- Nature and Extent of Contamination
- Conclusions and Recommendations
- References

The Phase I RFI reports sections are discussed in the following subsection.

4.1 Introduction and Site Background

The introduction will consist of a discussion of the site location, its current conditions and its historical background, including any investigations conducted at the SWMU. The introduction will also provide a regulatory framework for NAPR and the SWMU.

4.2 Physical Characteristics of Study Area

The physical characteristics of the SWMU will be recorded in the field. Those observations will be photographically recorded and summarized in this section.

4.3 SWMU Investigation

The investigation methodologies employed to fulfill the Phase I RFI work plan objectives for the SWMU will be discussed, including the sample locations, sample collection and handling procedures, QA/QC procedures, and analytical methods used. This section will also discuss any problems encountered, including any deviations from the work plan, and problem resolution.

4.4 Nature and Extent of Contamination

The nature and extent of contamination section will present analytical results and interpretation of the data. The surface and subsurface soil analytical data will be screened against USEPA Region IX Preliminary Remediation Goals (PRGs). Analytical data for surface soil and subsurface soil collected from the 1 to 3-foot depth interval also will be compared to ecological soil screening values previously developed for use in ecological risk assessments (ERAs) at NAPR (Baker, 2006a and 2006b). The ecological soil screening values will be updated as necessary to reflect current information from the literature (i.e., ecological soil screening levels [Eco-SSLs] available at <http://www.epa.gov/ecotox/ecossl/>). Analytical data for subsurface soil collected from deeper depth intervals (e.g., 3 to 5-foot bgs) will not be compared to ecological soil screening values since these depths are not likely to represent a significant exposure point for ecological receptors (most heterotrophic activity and soil invertebrates occur on the surface or within the oxidized root zone [Suter II, 1995]). The groundwater analytical data will be compared to USEPA Region IX Tap Water PRGs and Federal maximum contaminant levels (MCLs), and ecological surface water screening values. The groundwater analytical data will be compared to ecological surface water screening values based on the close proximity of SWMU 67 to the Estuarine Wetland E2SS3 (see Figure 3-1). Identical to the ecological soil screening values, ecological surface water and sediment screening values used in the comparison will be those previously developed for use in ERAs at NAPR (Baker, 2006a and 2006b). Ecological surface water and sediment screening values will be updated as

necessary to reflect current information from the literature. A comparison of groundwater data to ecological surface water screening values will not be performed because SWMU 67 is not located contiguous to a surface water body (see Figure 1-2).

For a given medium (surface soil, subsurface soil, and groundwater), analytical data for inorganic chemicals exceeding one or more of the screening values (human health or ecological) will be statistically compared to background analytical data in accordance with Navy guidance (Naval Facilities Engineering Service Center [NFESC], 2002 and 2004). The background analytical data used in the statistical evaluations will be those contained in the Revised Final Summary Report for Environmental Background Concentrations of Inorganic Compounds (Baker, 2006c). The process that will be used to statistically evaluate the data is depicted in Figure 4-1. As shown by the figure, statistical evaluations will include descriptive summaries of each data set (range of detected values, range of non-detected values, maximum, mean, and 95 percent upper confidence limit [UCL] of the mean concentrations), statistical tests on the mean/median of the distributions (i.e., student's t-test, Gehan test, Satterthwaite's t-test, or Wilcoxon rank sum test), statistical tests on the right tail of the distributions (i.e., quantile test and slippage test), and proportional statistics (two-sample test of proportions). The significance level (the probability criteria for rejecting the null hypotheses that data sets were sampled from the same population) will be set at 0.05 for all statistical tests in accordance with Navy guidance (NFESC, 2002 and 2004).

The results of the screening and statistical evaluations will be presented on tables and figures with textual explanation. Results of QA/QC procedures also will be presented within the nature and extent of contamination section.

4.5 Conclusions and Recommendations

Information from the nature and extent of contamination will be synthesized into conclusions regarding the extent of the releases previously detected at the site. Recommendations will be made from these conclusions as to whether a full RFI is needed or the SWMU can proceed toward a determination of Corrective Action Complete.

5.0 SCHEDULE

A schedule for the implementation of this work plan, and follow-up reports for the Phase I RFI reports for SWMU 67 is provided as Figure 5-1.

It should be noted that this schedule is dependent upon USEPA 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 delays by the Navy, or consensus cannot be reached on how the USEPA's comments are to be incorporated.

6.0 SITE MANAGEMENT

An organization chart presenting the proposed staffing for this project is provided on Figure 6-1. This section also outlines the responsibilities and reporting requirements of field personnel and staff.

6.1 Project Team Responsibilities

Mr. Mark Kimes, P.E., Activity Coordinator for all work in Puerto Rico, will manage the Baker Project Team. His responsibilities will be to direct the technical performance of the project staff, costs and schedule, ensuring that QA/QC procedures are followed during the course of the project. He will maintain communication with the BRAC PMO SE, Navy Technical Representative (NTR), Mr. Mark Davidson. Mr. John Mentz will administer overall QA/QC for this project.

The field activities of this project will consist of one field team managed by the Geologist, Mr. Joseph Burawa. Mr. Burawa's responsibilities include directing the field team and subcontractors. Mr. Rick Aschenbrenner, P.E. will direct the reporting effort associated with the field investigation, ensuring that all necessary staffing is utilized to assist in developing the Phase I RFI Reports for SWMU 67.

6.2 Field Reporting Requirements

The Geologist will maintain a daily summary of each day's field activities. The following information will be included in this summary:

- Contractor and subcontractor personnel on site
- Major activities of the day
- Samples collected
- Problems encountered
- Other pertinent site information

The Geologist will receive direction from the Project Manager regarding any changes in scope of the investigation.

7.0 REFERENCES

- Baker Environmental, Inc. (Baker). 2006a. Final Additional Data Collection Report and Screening-Level Ecological Risk Assessment and Step 3a of the Baseline Ecological Risk Assessment at SWMUs 1 and 2, Naval Station Roosevelt Roads, Ceiba, Puerto Rico. Coraopolis, Pennsylvania. May 18, 2006.
- Baker. 2006b. Final Additional Data Collection Report and Screening-Level Ecological Risk Assessment and Step 3a of the Baseline Ecological Risk Assessment at SWMU 45, Naval Activity Puerto Rico, Ceiba, Puerto Rico. Coraopolis, Pennsylvania. January 11, 2006.
- Baker. 2006c. Revised Final Summary Report for Environmental Background Concentrations of Inorganic Compounds, Naval Activity Puerto Rico, Ceiba, Puerto Rico. Coraopolis, Pennsylvania. October 17, 2006.
- Baker. 1995. Final RCRA Facility Investigation Management Plans, Naval Station Roosevelt Roads, Ceiba, Puerto Rico. September 14, 1995.
- Naval Facilities Engineering Command, Atlantic Division (LANTDIV). 2004. Draft Phase I Environmental Condition of Property Report. Norfolk, Virginia. March 31, 2004.
- Naval Facilities Engineering Command Atlantic (NAVFAC Atlantic). 2005. Final Phase I/II Environmental Condition of Property, Former U.S. Naval Station Roosevelt Roads, Ceiba, Puerto Rico. Norfolk, Virginia.
- Naval Facilities Engineering Service Center (NFESC). 2004. Guidance for Environmental Background Analysis. Volume III: Groundwater. NFESC User's Guide UG-2059-ENV,
- NFESC. 2002. Guidance for Environmental Background Analysis. Volume I: Soil. NFESC User's Guide UG-209-ENV. April 2002.
- Suter II, G.W. 1995. Guide for Performing Screening Ecological Risk Assessments at DOE Facilities. Oak Ridge National Laboratory, Environmental Restoration Division, ORNL Environmental Restoration Program. ES/ER/TM-153.

TABLES

TABLE 3-1

**SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM
SWMU 67 - FORMER GAS STATION
PHASE I RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO**

Media	Sample Depth (ft bgs)	Fixed Based Analytical Lab Analysis						Comment
		App IX VOCs	App IX SVOCs	App IX Metals	App IX Metals (Dissolved)	TPH DRO	TPH GRO	
Surface Soil Samples								
67SS01	0.0 - 1.0	X	X	X		X	X	
67SS01D	0.0 - 1.0	X	X	X		X	X	Duplicate
67SS01MS/MSD	0.0 - 1.0	X	X	X		X	X	Matrix Spike/Matrix Spike Duplicate
67SS02-00	0.0 - 1.0	X	X	X		X	X	
67SS03-00	0.0 - 1.0	X	X	X		X	X	
67SS04-00	0.0 - 1.0	X	X	X		X	X	
67SS05-00	0.0 - 1.0	X	X	X		X	X	
67SB01-00	0.0 - 1.0	X	X	X		X	X	
67SB02-00	0.0 - 1.0	X	X	X		X	X	
67SB03-00	0.0 - 1.0	X	X	X		X	X	
67SB04-00	0.0 - 1.0	X	X	X		X	X	
67SB05-00	0.0 - 1.0	X	X	X		X	X	
67SB06-00	0.0 - 1.0	X	X	X		X	X	Duplicate
67SB07-00	0.0 - 1.0	X	X	X		X	X	
67SB08-00	0.0 - 1.0	X	X	X		X	X	
67SB08-00D	0.0 - 1.0	X	X	X		X	X	
Subsurface Soil Samples⁽²⁾								
67SB01-XX ⁽¹⁾	TBD	X	X	X		X	X	
67SB01-XX ⁽¹⁾	TBD	X	X	X		X	X	
67SB02-XX ⁽¹⁾	TBD	X	X	X		X	X	
67SB02-XX ⁽¹⁾	TBD	X	X	X		X	X	
67SB03-XX ⁽¹⁾	TBD	X	X	X		X	X	
67SB03-XX ⁽¹⁾	TBD	X	X	X		X	X	
67SB04-XXD ⁽¹⁾	TBD	X	X	X		X	X	Duplicate
67SB04-XXMS/MSD ⁽¹⁾	TBD	X	X	X		X	X	Matrix Spike/Matrix Spike Duplicate
67SB04-XX ⁽¹⁾	TBD	X	X	X		X	X	
67SB04-XX ⁽¹⁾	TBD	X	X	X		X	X	
67SB05-XX ⁽¹⁾	TBD	X	X	X		X	X	
67SB05-XX ⁽¹⁾	TBD	X	X	X		X	X	
67SB06-XX ⁽¹⁾	TBD	X	X	X		X	X	
67SB06-XX ⁽¹⁾	TBD	X	X	X		X	X	
67SB07-XX ⁽¹⁾	TBD	X	X	X		X	X	
67SB07-XX ⁽¹⁾	TBD	X	X	X		X	X	
67SB08-XX ⁽¹⁾	TBD	X	X	X		X	X	
67SB08-XX ⁽¹⁾	TBD	X	X	X		X	X	
67SB08-XXD ⁽¹⁾	TBD	X	X	X		X	X	Duplicate

TABLE 3-1

**SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM
SWMU 67 - FORMER GAS STATION
PHASE I RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO**

Media	Sample Depth (ft bgs)	Fixed Based Analytical Lab Analysis						Comment
		App IX VOCs	App IX SVOCs	App IX Metals	App IX Metals (Dissolved)	TPH DRO	TPH GRO	
Groundwater Samples								
67GW01	NA	X	X	X	X	X	X	
67GW02	NA	X	X	X	X	X	X	
67GW03	NA	X	X	X	X	X	X	
67GW04	NA	X	X	X	X	X	X	
67GW05	NA	X	X	X	X	X	X	
67GW06	NA	X	X	X	X	X	X	
67GW07	NA	X	X	X	X	X	X	
67GW08	NA	X	X	X	X	X	X	
67GW08D	NA	X	X	X	X	X	X	Duplicate
67GW08MS	NA	X	X	X	X	X	X	Matrix Spike
67GW08MSD	NA	X	X	X	X	X	X	Matrix Spike Duplicate

Notes:

⁽¹⁾ - This indicates the proper designation for the depth interval from which the sample will be collected (i.e., 01 = 1-3ft bgs, 02 = 3-5 ft bgs, etc.). This will be established in the field.

⁽²⁾ - Although two subsurface soil samples are proposed per boring, additional subsurface soil will be collected if areas of staining or other indicators of contamination are encountered at other depths. In this event, the number of QA/QC samples listed on Table 3-3 will be adjusted.

ft bgs - feet below ground surface.

NA - Not Applicable.

TBD - To be determined in the field

TABLE 3-2
METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)
SWMU 67 - FORMER GAS STATION
PHASE I RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO

Volatiles	Quantitation Limits*		Method Number
	Water (µg/L)	Low Soil (µg/kg)	
Acetone	25	50	8260B (5030)(low level)
Acetonitrile	40	200	8260B (5030)(low level)
Acrolein	20	100	8260B (5030)(low level)
Acrylonitrile	20	100	8260B (5030)(low level)
Benzene	1.0	5.0	8260B (5030)(low level)
Bromodichloromethane	1.0	5.0	8260B (5030)(low level)
Bromoform	1.0	5.0	8260B (5030)(low level)
Bromomethane	1.0	10	8260B (5030)(low level)
Carbon Disulfide	1.0	5.0	8260B (5030)(low level)
Carbon Tetrachloride	1.0	5.0	8260B (5030)(low level)
Chlorobenzene	1.0	5.0	8260B (5030)(low level)
Chloroethane	1.0	10	8260B (5030)(low level)
Chloroform	1.0	5.0	8260B (5030)(low level)
Chloromethane	1.0	10	8260B (5030)(low level)
Chloroprene	1.0	5.0	8260B (5030)(low level)
3-Chloro-1-propene	1.0	5.0	8260B (5030)(low level)
1,2-Dibromo-3-chloropropane	1.0	10	8260B (5030)(low level)
Dibromochloromethane	1.0	5.0	8260B (5030)(low level)
1,2-Dibromoethane	1.0	5.0	8260B (5030)(low level)
Dibromomethane	1.0	5.0	8260B (5030)(low level)
trans-1,4-Dichloro-2-butene	2.0	10	8260B (5030)(low level)
Dichlorodifluoromethane	1.0	5.0	8260B (5030)(low level)
1,1-Dichloroethane	1.0	5.0	8260B (5030)(low level)
1,2-Dichloroethane	1.0	5.0	8260B (5030)(low level)
trans-1,2-dichloroethene	1.0	5.0	8260B (5030)(low level)
1,1-Dichloroethene	1.0	5.0	8260B (5030)(low level)
Methylene Chloride	5.0	5.0	8260B (5030)(low level)
1,2-Dichloropropane	1.0	5.0	8260B (5030)(low level)
cis-1,3-Dichloropropene	1.0	5.0	8260B (5030)(low level)
trans-1,3-Dichloropropene	1.0	5.0	8260B (5030)(low level)
Ethyl benzene	1.0	5.0	8260B (5030)(low level)
Ethyl methacrylate	1.0	5.0	8260B (5030)(low level)
2-Hexanone	10	25	8260B (5030)(low level)
Iodomethane	5.0	5.0	8260B (5030)(low level)
Isobutanol	40	200	8260B (5030)(low level)
Methacrylonitrile	20	100	8260B (5030)(low level)
2-Butanone	10	25	8260B (5030)(low level)
Methyl methacrylate	1.0	5.0	8260B (5030)(low level)
4-Methyl-2-pentanone	10	25	8260B (5030)(low level)

TABLE 3-2
METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)
SWMU 67 - FORMER GAS STATION
PHASE I RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO

Volatiles (Cont.)	Quantitation Limits*		Method Number
	Water (µg/L)	Low Soil (µg/kg)	
Pentachloroethane	5.0	25	8260B (5030)(low level)
Propionitrile	20	100	8260B (5030)(low level)
Stryene	1.0	5.0	8260B (5030)(low level)
1,1,1,2-Tetrachloroethane	1.0	5.0	8260B (5030)(low level)
1,1,2,2-Tetrachloroethane	1.0	5.0	8260B (5030)(low level)
Tetrachloroethene	1.0	5.0	8260B (5030)(low level)
Toluene	1.0	5.0	8260B (5030)(low level)
1,1,1-Trichloroethane	1.0	5.0	8260B (5030)(low level)
1,1,2-Trichloroethane	1.0	5.0	8260B (5030)(low level)
Trichloroethene	1.0	5.0	8260B (5030)(low level)
Trichlorofluoromethane	1.0	5.0	8260B (5030)(low level)
1,2,3-Trichloropropane	1.0	5.0	8260B (5030)(low level)
Vinyl Acetate	2.0	10	8260B (5030)(low level)
Vinyl Chloride	1.0	10	8260B (5030)(low level)
Xylene	2.0	10	8260B (5030)(low level)

TABLE 3-2
METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)
SWMU 67 - FORMER GAS STATION
PHASE I RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO

Semivolatiles	Quantitation Limits*		Method Number
	Water (µg/L)	Low Soil (µg/kg)	
Acenaphthene	10	330	8270C
Acenaphthylene	10	330	8270C
Acetophenone	10	330	8270C
2-Acetylaminofluorene	10	330	8270C
4-Aminobiphenyl	20	330	8270C
Aniline	20	660	8270C
Anthracene	10	330	8270C
Aramite	10	330	8270C
Benzo(a)anthracene	10	330	8270C
Benzo(b)fluoranthene	10	330	8270C
Benzo(k)fluoranthene	10	330	8270C
Benzo(g,h,i)perylene	10	330	8270C
Benzo(a)pyrene	10	330	8270C
Benzyl alcohol	10	330	8270C
Bis(2-chloroethoxyl)methane	10	330	8270C
Bis(2-chloroethyl)ether	10	330	8270C
Bis(2-ethylhexyl)phthalate	10	330	8270C
4-Bromophenyl phenyl ether	10	330	8270C
Butylbenzylphthalate	10	330	8270C
4-Chloroaniline	20	660	8270C
4-Chloro-3-methylphenol	10	330	8270C
2-Chloronaphthalene	10	330	8270C
2-Chlorophenol	10	330	8270C
4-Chlorophenyl phenyl ether	10	330	8270C
Chrysene	10	330	8270C
3&4 Methylphenol	10	330	8270C
2-Methylphenol	10	330	8270C
Diallate	10	330	8270C
Dibenzofuran	10	330	8270C
Di-n-butyl phthalate	10	330	8270C
Dibenzo(a,h)anthracene	10	330	8270C
o-Dichlorobenzene	10	330	8270C
m-Dichlorobenzene	10	330	8270C
p-Dichlorobenzene	10	330	8270C
3,3'-Dichlorobenzidine	20	660	8270C
2,4-Dichlorophenol	10	330	8270C
2,6-Dichlorophenol	10	330	8270C
Diethylphthalate	10	330	8270C
p-(Dimethylamino)azobenzene	10	330	8270C
7,12-Dimethyl benz(a)anthracene	10	330	8270C
3,3-Dimethyl benzidine	20	1,700	8270C
2,4-Dimethylphenol	10	330	8270C
alpha, alpha-Dimethylphenethylamine	2,000	67,000	8270C
Dimethyl phthalate	10	330	8270C

TABLE 3-2
METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)
SWMU 67 - FORMER GAS STATION
PHASE I RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO

Semivolatiles (Cont.)	Quantitation Limits*		Method Number
	Water (µg/L)	Low Soil (µg/kg)	
m-Dinitrobenzene	10	330	8270C
4,6-Dinitro-2-methylphenol	50	1,700	8270C
2,4-Dinitrophenol	50	1,700	8270C
2,4-Dinitrotoluene	10	330	8270C
2,6-Dinitrotoluene	10	330	8270C
Di-n-octylphthalate	10	330	8270C
1,4-Dioxane	10	330	8270C
Dinoseb	10	330	8270C
Ethylmethanesulfonate	10	330	8270C
Fluoranthene	10	330	8270C
Fluorene	10	330	8270C
Hexachlorobenzene	10	330	8270C
Hexachlorobutadiene	10	330	8270C
Hexachlorocyclopentadiene	10	330	8270C
Hexachloroethane	10	330	8270C
Hexachlorophene	5,000	170,000	8270C
Hexachloropropene	10	330	8270C
Indeno(1,2,3-cd)pyrene	10	330	8270C
Isophorone	10	330	8270C
Isosafrole	10	330	8270C
Methapyrilene	2,000	67,000	8270C
3-Methylcholanthrene	10	330	8270C
Methyl methanesulfonate	10	330	8270C
2-Methylnaphthalene	10	330	8270C
Naphthalene	10	330	8270C
1,4-Naphthoquinone	10	330	8270C
1-Naphthylamine	10	330	8270C
2-Naphthylamine	10	330	8270C
2-Nitroaniline	50	1,700	8270C
3-Nitroaniline	50	1,700	8270C
4-Nitroaniline	50	1,700	8270C
Nitrobenzene	10	330	8270C
2-Nitrophenol	10	330	8270C
4-Nitrophenol	50	1,700	8270C
4-Nitroquinoline-1-oxide	20	3,300	8270C
n-Nitrosodi-n-butylamine	10	330	8270C
n-Nitrosodiethylamine	10	330	8270C
n-Nitrosodimethylamine	10	330	8270C
n-Nitrosodiphenylamine	10	330	8270C
n-Nitrosodi-n-propylamine	10	330	8270C
n-Nitrosomethylethylamine	10	330	8270C
n-Nitrosomorpholine	10	330	8270C
n-Nitrosopiperidine	10	330	8270C
n-Nitrosopyrrolidine	10	330	8270C

TABLE 3-2
METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)
SWMU 67 - FORMER GAS STATION
PHASE I RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO

Semivolatiles (Cont.)	Quantitation Limits*		Method Number
	Water (µg/L)	Low Soil (µg/kg)	
5-Nitro-o-toluidine	10	330	8270C
bis-(2-chloroisopropyl)ether	10	330	8270C
Pentachlorobenzene	10	330	8270C
Pentachloronitrobenzene	10	330	8270C
Pentachlorophenol	50	1,700	8270C
Phenacetin	10	330	8270C
Phenanthrene	10	330	8270C
Phenol	10	330	8270C
1,4-Phenylenediamine	2,000	1,700	8270C
2-Picolin	10	330	8270C
Pronamide	10	330	8270C
Pyrene	10	330	8270C
Pyridine	50	330	8270C
Safrole	10	330	8270C
1,2,4,5-Tetrachlorobenzene	10	330	8270C
2,3,4,6-Tetrachlorophenol	10	330	8270C
o-Toluidine	20	330	8270C
1,2,4-Trichlorobenzene	10	330	8270C
2,4,5-Trichlorophenol	10	330	8270C
2,4,6-Trichlorophenol	10	330	8270C
1,3,5-Trinitrobenzene	10	330	8270C
Total Petroleum Hydrocarbons	Quantitation Limits*		Method Number
	Water (µg/L)	Low Soil (µg/kg)	
TPH DRO	100	3300	5030B/8015B
TPH GRO	50	250	3550B/8015B

* 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.

µg/L - micrograms per liter.

µg/kg - micrograms per kilogram.

TABLE 3-2

**METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)
SWMU 67 - FORMER GAS STATION
PHASE I RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO**

Inorganics	Method Number	Quantitation Limits*		Method Description
		Water (µg/L)	Low Soil (mg/kg)	
Antimony	6010B	20	2.0	Inductively Coupled Plasma
Arsenic	6010B	10	1.0	Inductively Coupled Plasma
Barium	6010B	10	1.0	Inductively Coupled Plasma
Beryllium	6010B	4.0	0.4	Inductively Coupled Plasma
Cadmium	6010B	5.0	0.5	Inductively Coupled Plasma
Chromium	6010B	10	1.0	Inductively Coupled Plasma
Cobalt	6010B	10	1.0	Inductively Coupled Plasma
Copper	6010B	20	2.0	Inductively Coupled Plasma
Lead	6010B	5.0	0.5	Inductively Coupled Plasma
Mercury	7470A/7471A	0.2	0.02	Cold Vapor AA
Nickel	6010B	40	4.0	Inductively Coupled Plasma
Selenium	6010B	10	1.0	Inductively Coupled Plasma
Silver	6010B	10	1.0	Inductively Coupled Plasma
Thallium	6010B	10	1.0	Inductively Coupled Plasma
Tin	6010B	10	5.0	Inductively Coupled Plasma
Vanadium	6010B	10	1.0	Inductively Coupled Plasma
Zinc	6010	20	2.0	Inductively Coupled Plasma

RCRA Metals	Method Number	Quantitation Limits*		Method Description
		Soil (mg/kg)	Water (µg/L)	
Arsenic	6010B(3050B/3010A)	1.0	10	Inductively Coupled Plasma
Barium	6010B(3050B/3010A)	1.0	10	Inductively Coupled Plasma
Cadmium	6010B(3050B/3010A)	0.50	5	Inductively Coupled Plasma
Chromium	6010B(3050B/3010A)	1.0	10	Inductively Coupled Plasma
Lead	6010B(3050B/3010A)	0.50	5.0	Inductively Coupled Plasma
Mercury	7471A/7470A	0.020	0.20	Cold Vapor AA
Selenium	6010B(3050B/3010A)	1.0	10	Inductively Coupled Plasma
Silver	6010B(3050B/3010A)	1.0	10	Inductively Coupled Plasma

Notes:

* 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.

µg/L - micrograms per liter.

mg/kg - milligrams per kilogram.

TABLE 3-3

**SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM
QA/QC AND IDW SAMPLES
SWMU 67 - FORMER GAS STATION
PHASE I RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO**

Media	Aqueous Samples Analysis Requested								Solid Samples Analysis Requested		Comment
	App IX VOCs	App IX SVOCs	App IX PCBs	App IX Metals (Total)	TPH DRO	TPH GRO	Benzene	RCRA Metals	Benzene	RCRA Metals	
Trip Blank Samples											
2007TB01	X ⁽¹⁾					X ⁽¹⁾					
2007TB02	X ⁽¹⁾					X ⁽¹⁾					
2007TB03	X ⁽¹⁾					X ⁽¹⁾					
2007TB04	X ⁽¹⁾					X ⁽¹⁾					
Equipment Rinsate Samples											
2007ER01	X	X	X	X	X	X					Stainless Steel Spoon
2007ER02	X	X	X	X	X	X					Split Spoon Sampler or Macro Core Liner
2007ER03	X	X	X	X	X	X					Polyethylene and Silicon Tubing
Field Blank Samples											
2007FB01	X	X	X	X	X	X					Lab Grade Deionized Water
2007FB02	X	X	X	X	X	X					Store Bought Distilled Water
2007FB03	X	X	X	X	X	X					NAPR Potable Water
IDW Samples											
2007IDW01							X	X			Aqueous
2007IDW02									X	X	Solid

Note:

⁽¹⁾ - One trip blank sample will accompany each cooler containing samples for analysis of VOCs and TPH-GRO.

FIGURES

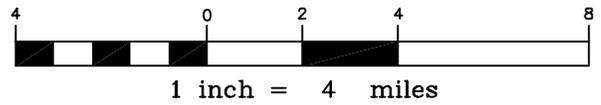
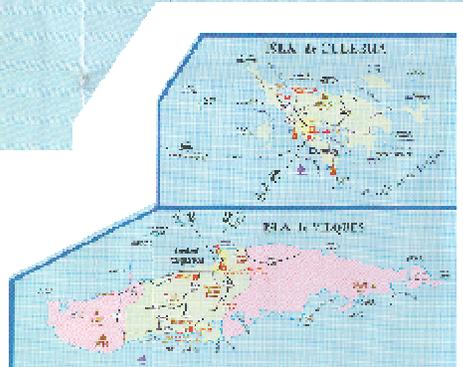
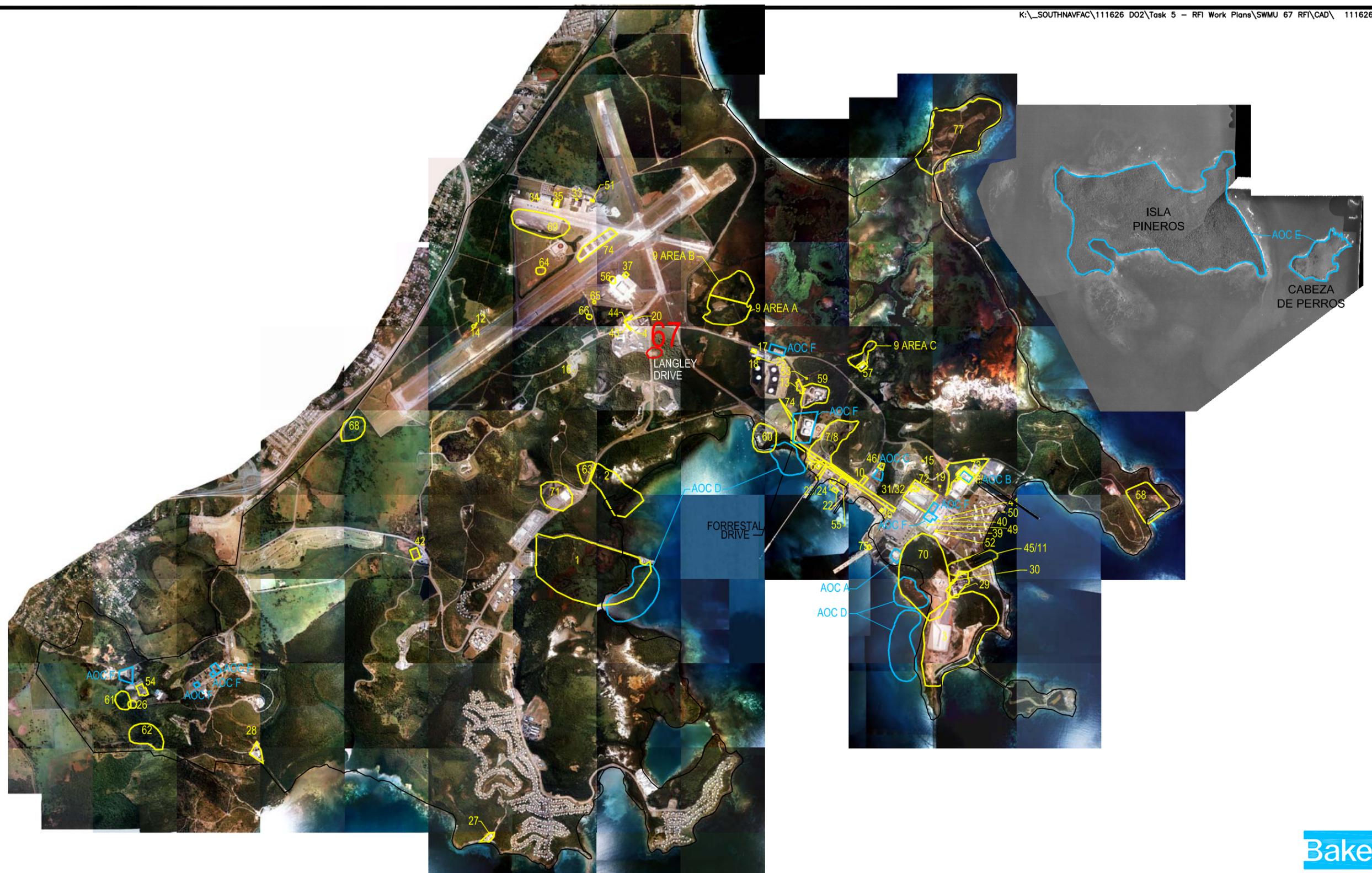


FIGURE 1-1
REGIONAL LOCATION MAP
SWMU 67-FORMER GAS STATION
PHASE I RFI WORK PLAN



LEGEND

-  - SWMUs
-  - AREA TO WHICH THIS INVESTIGATION PERTAINS
-  - AOCs

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

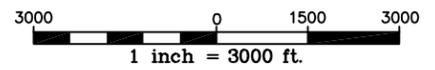
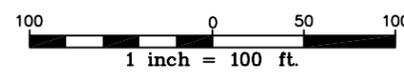
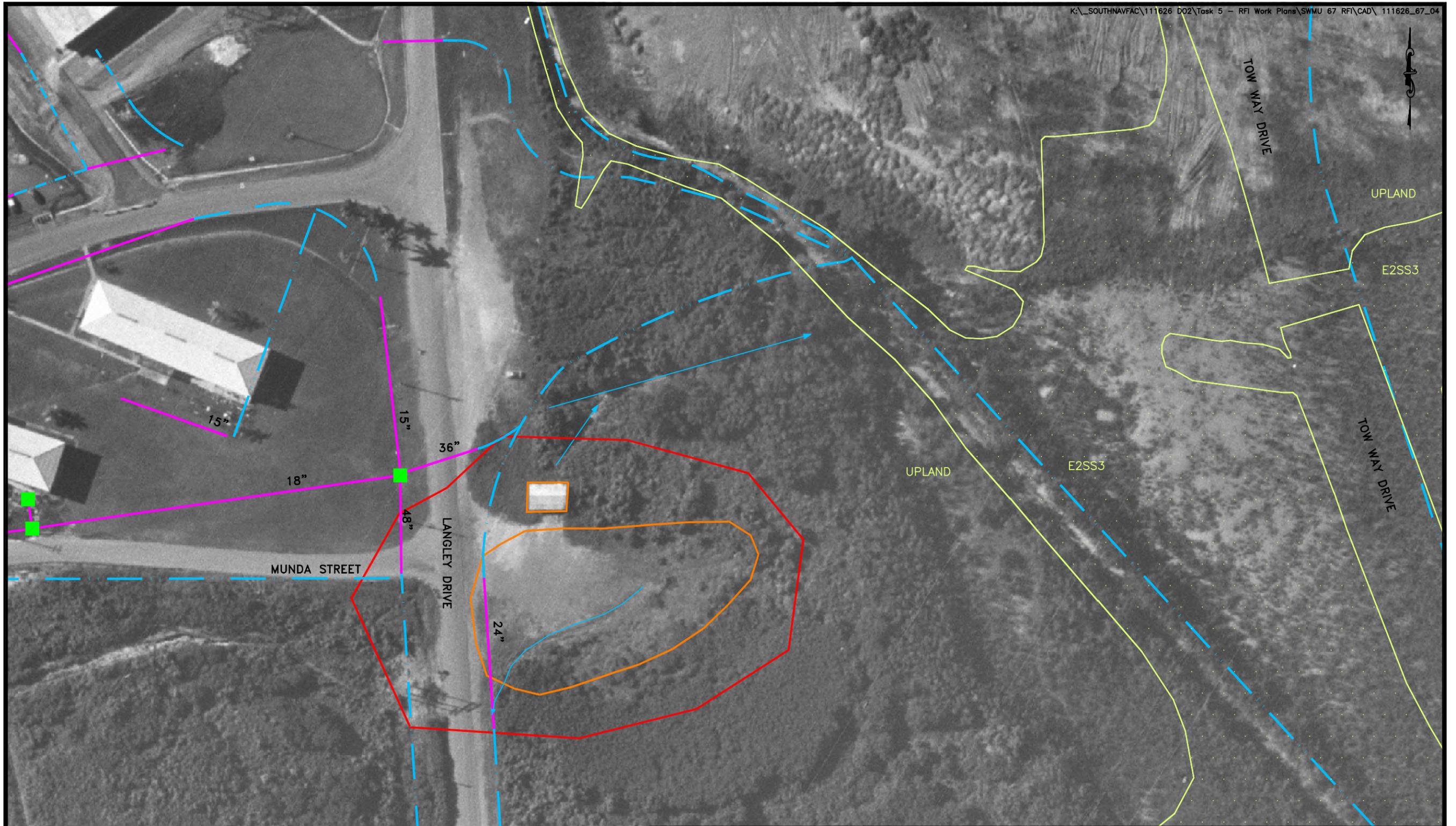


FIGURE 1-2
SWMU/AOC LOCATION MAP
SWMU 67-FORMER GAS STATION
PHASE I RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO



LEGEND	
	-1958 POLYGON FEATURE
	-1958 DRAINAGE AND FLOW DIRECTION
	-SWMU BOUNDARY
	-DITCH
	-INLET
	-24" -STORM SEWER AND SIZE
	-ESTUARINE WETLAND BOUNDARY
	-E2SS3 -ESTUARINE WETLAND IDENTIFICATION

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

FIGURE 1-3
1958 AERIAL PHOTOGRAPH
SWMU 67-FORMER GAS STATION
PHASE I RFI WORK PLAN

NAVAL ACTIVITY PUERTO RICO



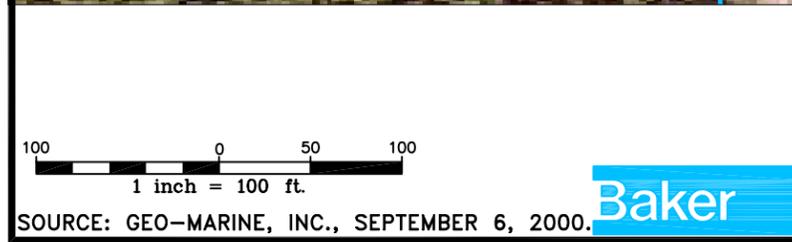
100 0 50 100
1 inch = 100 ft.

Baker

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

LEGEND	
	-1958 POLYGON FEATURE
	-1958 DRAINAGE SWALE AND FLOW
	-SWMU BOUNDARY
	-DITCH
	-INLET
	-24" STORM SEWER AND SIZE
	-ESTUARINE WETLAND BOUNDARY
	E2SS3 -ESTUARINE WETLAND IDENTIFICATION
	-EXISTING SOIL SAMPLING LOCATION (PHASE II ECP 2004)
	-EXISTING SOIL AND GROUNDWATER SAMPLING LOCATION (PHASE II ECP 2004)

FIGURE 1-4
SITE LAYOUT AND ECP
SAMPLE LOCATION MAP
SWMU 67-FORMER GAS STATION
PHASE I RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO

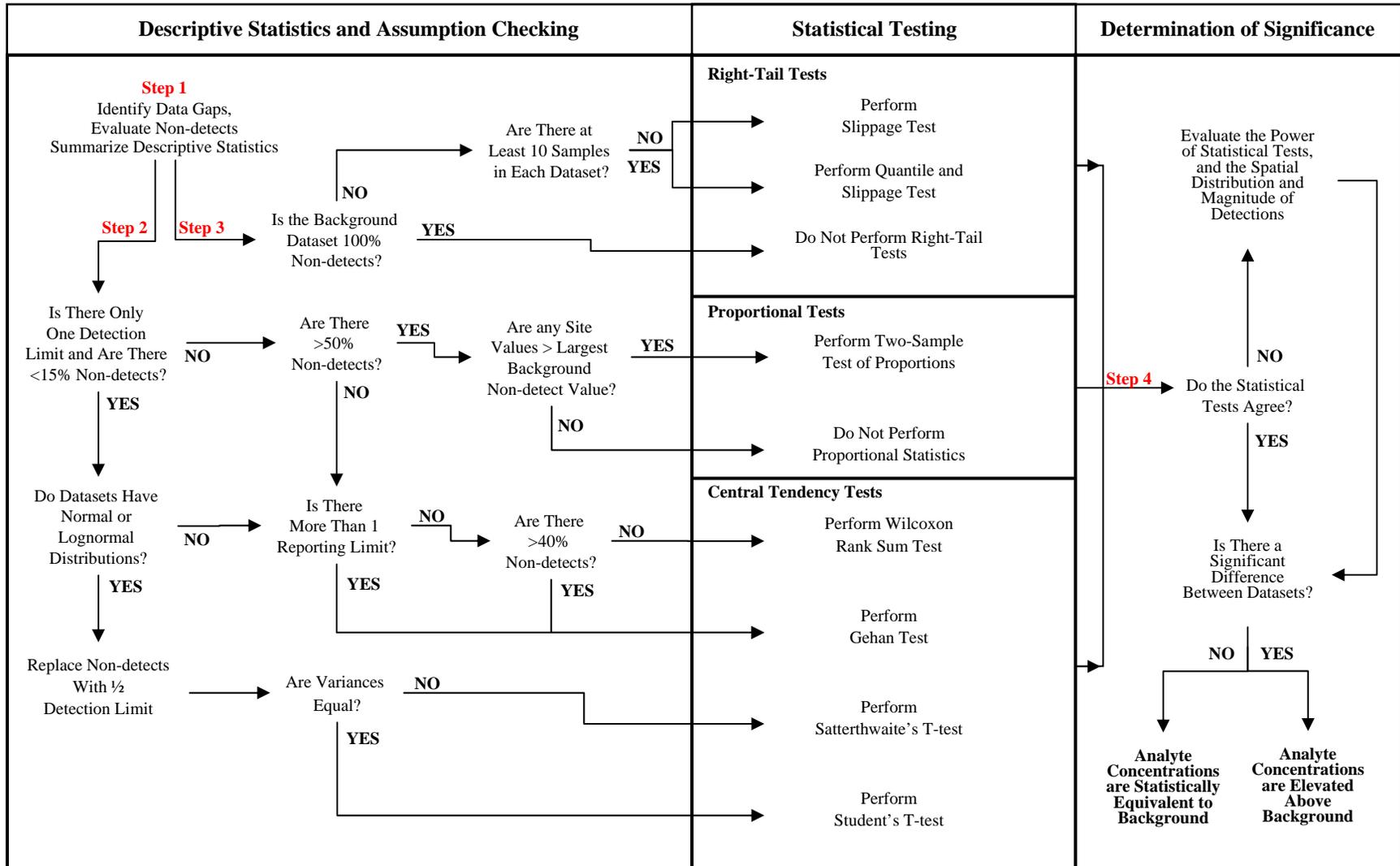


SOURCE: GEO-MARINE, INC., SEPTEMBER 6, 2000.

LEGEND	
	-1958 POLYGON FEATURE
	-1958 DRAINAGE SWALE AND FLOW
	-SWMU BOUNDARY
	-DITCH
	-INLET
	-24" -STORM SEWER AND SIZE
	-ESTUARINE WETLAND BOUNDARY
	-ESTUARINE WETLAND IDENTIFICATION
	-EXISTING SOIL SAMPLING LOCATION (PHASE II ECP 2004)
	-EXISTING SOIL AND GROUNDWATER SAMPLING LOCATION (PHASE II ECP 2004)
	-PROPOSED DRAINAGE SWALE SURFACE SOIL SAMPLING LOCATION
	-PROPOSED SOIL BORING AND MONITORING WELL LOCATION (PHASE I RFI WORKPLAN)

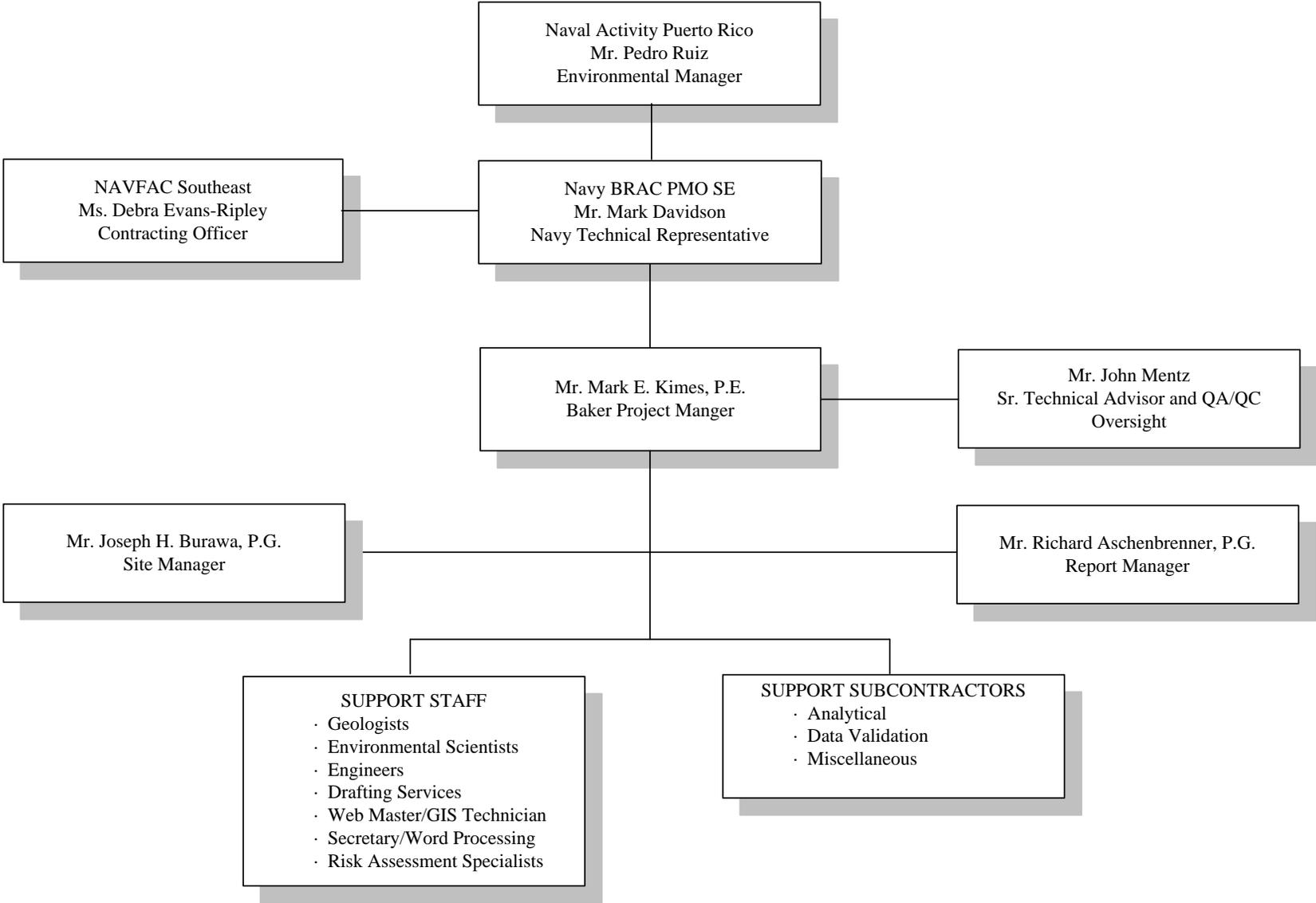
FIGURE 3-1
PROPOSED SAMPLE LOCATION MAP
SWMU 67-FORMER GAS STATION
PHASE I RFI WORK PLAN
 NAVAL ACTIVITY PUERTO RICO

**FIGURE 4-1
 STATISTICAL ANALYSIS PROCESS
 SWMU 67 – FORMER GAS STATION
 PHASE I RFI WORK PLAN
 NAVAL ACTIVITY PUERTO RICO**



T-tests performed on log-transformed data if datasets have lognormal distributions.

FIGURE 6-1
PROJECT ORGANIZATION
PHASE I RFI WORK PLAN – SWMU 67
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO



APPENDIX A
Photographs of SWMU 67, Former Gas Station

SWMU 67 – Former Gas Station



Photograph A-1: Tennis Courts and Storm Water Culvert Outlet Heading North through the Site



Photograph A-2: Concrete Structure Approximately 18 inches x 18 inches



Photograph A-3: Refuse Consisting of Corrugated Plastic Sheets



Photograph A-4: Another view of Storm Water Culvert Heading North through the Site



Photograph A-5: Refuse Consisting of Galvanized Pipe and Electrical Cable



Photograph A-6: Drainage Swale, Heading North through the Site

APPENDIX B

Summary of Analytical Results from Phase II ECP Study

TABLE B-1

Revised: December 20, 2007

**SUMMARY OF ORGANIC DETECTIONS IN SUBSURFACE SOIL
SWMU 67 - FORMER GAS STATION
PHASE II ECP REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO**

Site ID	EPA Region III Industrial RBCs (ug/kg)	EPA Region III Residential RBCs (ug/kg)	13E-SB01	13E-SB02	13E-SB03	Number Exceeding EPA Region III Industrial RBCs	Range Exceeding EPA Region III Industrial RBCs	Number Exceeding EPA Region III Residential RBCs	Range Exceeding EPA Region III Residential RBCs	Location of Maximum Detection
Sample ID			13E-SB01-04	13E-SB02-05	13E-SB03-05					
Sample Date			05/08/04	05/08/04	05/08/04					
Sample Depth (ft bgs)			7.00 - 9.00	9.00 - 11.00	9.00 - 11.00					
Volatiles Organic Compounds (ug/kg)										
Acetone	92,000,000	7,000,000	62 U	44 J	43 J	0/3		0/3		13E-SB02-05
Chlorobenzene	2,000,000	160,000	6.2 U	5.9 U	2.9 J	0/3		0/3		13E-SB03-05
Tetrachloroethene	5,300	1,200	6.2 U	5.9 U	2.4 J	0/3		0/3		13E-SB03-05
Semivolatile Organic Compounds (ug/kg)										
Dibenzo(a,h)anthracene	390	87	110 J	63 J	480 U	0/3		1/3	110J	13E-SB01-04
Indeno(1,2,3-cd)pyrene	3,900	870	110 J	60 J	480 U	0/3		0/3		13E-SB01-04
Benzo(g,h,i)perylene	NE	NE	120 J	75 J	480 U	NE		NE		13E-SB01-04
Total Petroleum Hydrocarbons (mg/kg)										
Diesel Range Organics	NE	NE	2.7 J	2.6 J	3.2 J	NE		NE		13E-SB03-05

Notes:

J - The reported result is an estimated concentration that is less than the PQL, but greater than or equal to the MDL.

U - The compound was analyzed for, but was not detected at or above the MDL/PQL.

NE - Not Established.

ft bgs - feet below ground surface.

ug/kg - micrograms per kilogram.

mg/kg - milligrams per kilogram.

Bold indicates exceedance of EPA Region III Residential RBCs

TABLE B-2

Revised: December 20, 2007

**SUMMARY OF INORGANIC DETECTIONS IN SUBSURFACE SOIL
SWMU 67 - FORMER GAS STATION
PHASE II ECP REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO**

Site ID	EPA Region III	EPA Region III	<u>2x Average</u>	13E-SB01	13E-SB02	13E-SB03	Number Exceeding EPA	Range Exceeding EPA	Number Exceeding EPA	Range Exceeding EPA	<u>Number Exceeding</u>	<u>Range Exceeding</u>	
Sample ID Sample Date Sample Depth (ft bgs)	Industrial RBCs (mg/kg)	Residential RBCs (mg/kg)	<u>Detected Background</u> (mg/kg)	13E-SB01-04 05/08/04 7.00 - 9.00	13E-SB02-05 05/08/04 9.00 - 11.00	13E-SB03-05 05/08/04 9.00 - 11.00	Region III Industrial RBCs	Region III Industrial RBCs	Region III Residential RBCs	Region III Residential RBCs	<u>2x Average Detected Background</u>	<u>2x Average Detected Background</u>	Location of Maximum Detection
Appendix IX Metals (mg/kg)													
Arsenic	1.9	0.43	2.05	1.2 U	0.85 B	1.3 U	0/3		1/3	0.85B	0/3		13E-SB02-05
Barium	7,200	550	222	<u>250</u>	190	140	0/3		0/3		1/3	250	13E-SB01-04
Beryllium	200	16	0.74	0.21 B	0.32 B	0.33 B	0/3		0/3		0/3		13E-SB03-05
Chromium	310	23	133	10	9	40	0/3		1/3	40	0/3		13E-SB03-05
Cobalt	2,000	160	30.0	10	23	<u>36</u>	0/3		0/3		1/3	36	13E-SB03-05
Copper	4,100	310	193	36	18	120	0/3		0/3		0/3		13E-SB03-05
Lead	400 ⁽¹⁾	400 ⁽¹⁾	8.68	1.9	0.83	1.9	0/3		0/3		0/3		13E-SB01-04, 13E-SB03-05
Mercury	31 ⁽²⁾	2.3 ⁽²⁾	0.093	0.019 B	0.023 U	0.019 B	0/3		0/3		0/3		13E-SB01-04, 13E-SB03-05
Nickel	2,000	160	31.9	4.9	5.4	18	0/3		0/3		0/3		13E-SB03-05
Tin	61,000	4,700	2.96	2 B	1.6 B	2.1 B	0/3		0/3		0/3		13E-SB03-05
Vanadium	100	7.8	462	240	210	200	3/3	200 - 240	3/3	200 - 240	0/3		13E-SB01-04
Zinc	31,000	2,300	88.6	52	<u>210</u>	67	0/3		0/3		1/3	210	13E-SB02-05

Notes:

B - The reported result is an estimated concentration that is less than the PQL, but greater than or equal to the MDL.

U - The compound was analyzed for, but was not detected at or above the MDL/PQL.

NE - Not Established.

⁽¹⁾ - 1996 Soil Screening Guidance.⁽²⁾ - Value based on the RBC for Mercuric Chloride.

ft bgs - feet below ground surface.

mg/kg - milligrams per kilogram.

Shading indicates exceedance of EPA Region III Industrial BCs

Bold indicates exceedance of EPA Region III Residential RBCs

Underline indicates exceedance of 2 x Average Detected Background

TABLE B-3

**SUMMARY OF ORGANIC DETECTIONS IN GROUNDWATER
SWMU 67- FORMER GAS STATION
PHASE II ECP REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO**

Site ID	Federal MCLs (ug/L)	EPA Region III Tap Water RBCs (ug/L)	PR Water Quality Standards (ug/L)	13E-SB02	13E-SB03	Number Exceeding Federal MCLs	Range Exceeding Federal MCLs	Number Exceeding EPA Region III Tap Water RBCs	Range Exceeding EPA Region III Tap Water RBCs	Number Exceeding PR Water Quality Standards	Range Exceeding PR Water Quality Standards	Location Maximum Detection
Sample ID				13E-GW02	13E-GW03							
Sample Date				5/10/2004	5/10/2004							
Volatile Organic Compounds (ug/L)												
Acetone	NE	550	NE	8 J	7 J	NE		0/2		NE		13E-GW02
Carbon disulfide	NE	100	NE	1 U	1.1	NE		0/2		NE		13E-GW03
Semivolatile Organic Compounds (ug/L)												
Not Detected												
Total Petroleum Hydrocarbons (mg/L)												
Diesel Range Organics	NE	NE	NE	0.81	0.71	NE		NE		NE		13E-GW02
Gasoline Range Organics	NE	NE	NE	0.014 J	0.05 U	NE		NE		NE		13E-GW02

Notes:

J - The reported result is an estimated concentration that is less than the PQL, but greater than or equal to the MDL.

U - The compound was analyzed for, but was not detected at or above the MDL/PQL.

ug/L - micrograms per liter.

mg/L - milligrams per liter.

NE - Not Established.

TABLE B-4

Revised: December 20, 2007

**SUMMARY OF INORGANIC DETECTIONS IN GROUNDWATER
SWMU 67 - FORMER GAS STATION
PHASE II ECP REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO**

Site ID	Federal MCLs (mg/L)	EPA Region III Tap Water RBCs (mg/L)	PR Water Quality Standards (mg/L)	13E-SB02 13E-GW02 5/10/2004	13E-SB03 13E-GW03 5/10/2004	Number Exceeding Federal MCLs	Range Exceeding Federal MCLs	Number Exceeding EPA Region III Tap Water RBCs	Range Exceeding EPA Region III Tap Water RBCs	Number Exceeding PR Water Quality Standards	Range Exceeding PR Water Quality Standards	Location Maximum Detection
Appendix IX (Dissolved) Metals (mg/L)												
Barium	2	0.26	NE	0.0061 B	0.043	0/2		0/2		NE		13E-GW03
Cobalt	NE	0.073	NE	0.01 U	0.0014 B	NE		0/2		NE		13E-GW03
Copper	1.3 ⁽¹⁾	0.15	1.3	0.02 U	0.0032 B	0/2		0/2		NE		13E-GW03
Mercury	0.002	0.0011 ⁽¹⁾	0.002	0.0012 B	0.004 U	0/2		1/2	0.0012B	0/2		13E-GW02
Nickel	NE	0.073	NE	0.0023 B	0.004 B	NE		0/2		NE		13E-GW03
Vanadium	NE	0.0037	NE	0.067	0.038	NE		2/2	0.038 - 0.067	NE		13E-GW02
Total Cyanide and Sulfide (mg/L)												
Not Detected												

Notes:

B - The reported result is an estimated concentration that is less than the PQL, but greater than or equal to the MDL.

U - The compound was analyzed for, but was not detected at or above the MDL/PQL.

NE - Not Established.

⁽¹⁾ - Value based on the Tap Water RBC for Mercuric Chloride.

mg/L - milligrams per liter.

Bold indicates exceedance of EPA Region III Tap Water RBCs

APPENDIX C
USEPA Region II – Groundwater 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 nephelometer 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 (A between-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

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

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